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The Research Strategy for a ‘Predator Free’ New Zealand

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ABSTRACT: The goal to make New Zealand ‘Predator Free,’ articulated as the eradication of rats, stoats, and possums by 2050, was announced as a New Zealand government initiative in 2016 and became a founding initiative for the International Union for Conservation of Nature (IUCN) Honolulu Challenge on Invasive Species. A new government owned company, Predator Free 2050 Limited (PF2050 Limited), was formed to coordinate partnership approaches to large landscape projects and breakthrough science. Consultation of both the general public and conservation stakeholders in New Zealand has given strong confidence of majority support for the Predator Free 2050 initiative, and both its target species focus (rats, stoats, and possums) and goal (landscape-scale eradication for the outcome of native biodiversity protection and restoration). A logical and robust process of research strategy development to help realise the Predator Free goals has been ongoing since 2012, when seven priority strategy and research areas were identified at a ‘Pest Summit’ workshop of researchers and stakeholders convened by the New Zealand Department of Conservation. The workshop also highlighted that past improvements in the ability to manage small mammalian pests have been driven by multiple complementary and often synergistic strands of research. The critical learning from such back-casting is that if the Predator Free 2050 goals are to be achieved, a similarly diverse research portfolio is essential moving forwards to drive the paradigm shift from current mainland predator suppression approaches to mainland predator eradication. This learning was implemented in construction first of a research project on small mammal management in the New Zealand’s Biological Heritage National Science Challenge, and, more recently, of PF2050 Limited’s research strategy. With the remit of focusing research efforts to achieve a breakthrough science solution capable of eradicating at least one small mammal predator by 2025, the strategy has four programmes (‘Environment and Society,’ ‘Best Use of Existing Approaches,’ ‘Exploring New Approaches,’ and ‘Computer Modelling’) designed to complement existing efforts to give the whole portfolio of relevant research the best chance of achieving the 2025 goal.

KEY WORDS: biodiversity, eradication, introduced species, New Zealand, possums, Predator Free, predators, rats, stoats

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INTRODUCTION

Prior to human colonisation, New Zealand was home to only three terrestrial mammal species: the greater short-tailed bat (*Mystacina robusta*), the lesser short-tailed bat (*M. tuberculata*), and the long-tailed bat (*Chalinolobus tuberculatus*) (Lloyd 2001), of which the greater short-tailed bat is thought to have gone extinct in the 1960s (O’Donnell 2008). However, as with many other regions of the world, human colonisation brought with it a deluge of exotic species (Allen and Lee 2006), including 31 terrestrial mammals (King 2005).

The impact of exotic terrestrial mammals on a native flora and fauna that, in recent evolutionary times has evolved in their absence, has been extreme, with multiple extinctions and ongoing population and distribution declines of extant species (Allen and Lee 2006). The continuing effects of introduced predators on native birds are particularly pernicious, with 80% of the 168 native bird species remaining in New Zealand being under threat primarily due to predator impacts (Parliamentary Commissioner for the Environment 2017). This is of concern to global biodiversity because 93 of these species are endemic: the level of endemism attained by the New Zealand flora and fauna, through its separation as a landmass for over 80 million years, is among the highest in the world, shared only with other Southern Hemisphere lands like New Caledonia, Australia, and South Africa (Gibbs 2006).

These ongoing biodiversity impacts, despite sustained efforts to manage them (Parkes et al. 2017), have driven an initiative to make the country ‘Predator Free’ (Russell

et al. 2015). The current articulation of this goal focuses on the most damaging species [ship rats (*Rattus rattus*), Norwegian rats (*R. norvegicus*), stoats (*Mustela erminea*), and brushtail possums (*Trichosurus vulpecula*)] with a target date of 2050 (Department of Conservation 2018). The initiative has generally high public support; for example, a survey conducted in the capital city of Wellington in 2017 indicated 84% of respondents supported ridding the city of such predators, with 69% of respondents willing to be actively involved (Newmann-Hall 2017).

The current articulation of the ‘Predator Free’ goal (to eradicate rats, stoats and possums by 2050) was announced as a New Zealand government initiative in 2016. The idea emerged from conservation discussions voiced by the late Sir Paul Callaghan in his last public speech at Zealandia Sanctuary, Wellington, in 2012, and explored in a ‘Pest Summit’ workshop of researchers and stakeholders convened by the New Zealand Department of Conservation (DOC) that year. Much of the strategy now invoked came to the fore at this workshop, which identified seven priority strategy and research areas for achievement of New Zealand’s ‘Predator Free’ goal to eradicate rats, stoats, and possums by 2050:

- Mass mobilisation, to get the whole country behind the mission;
- Extension to very large scale, through strategic and ecologically-based pest management;
- Continuing improvement to current toxin- and device-based (e.g., trap) approaches;
- Improved surveillance, detection and monitoring;

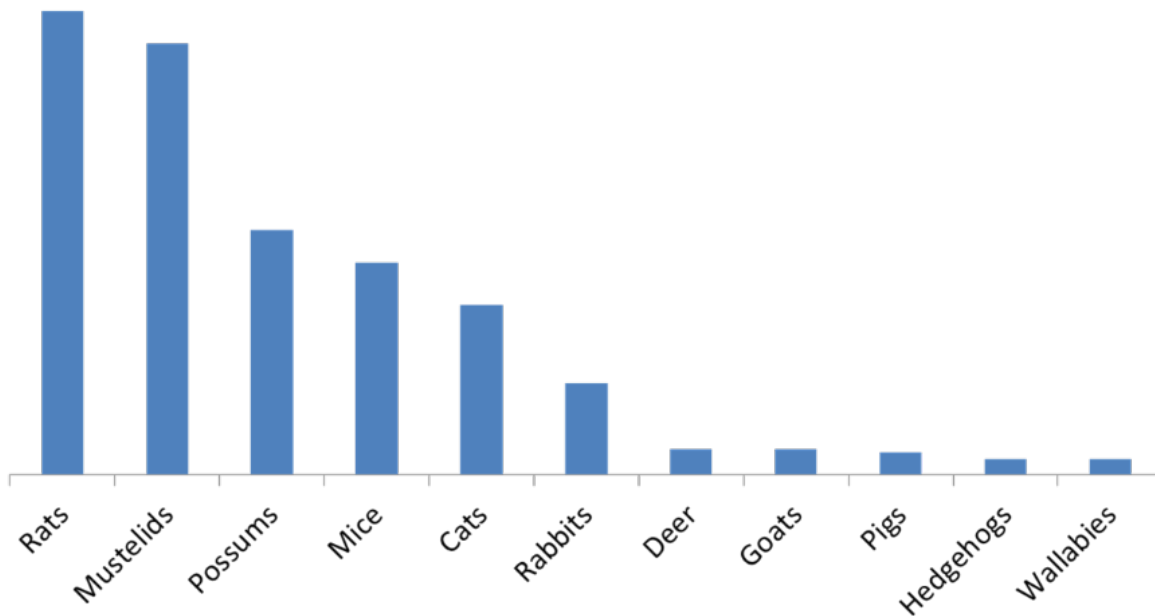


Figure 1. Stakeholder responses to the question “Which invasive mammal pests would you like to be better able to control, in order of priority?”, showing overall relative priorities (n = 19 stakeholders). Note over 90% of ‘mustelid’ references were to stoats.

- Better lures to increase predator interaction with control and surveillance devices;
- Exploring the potential of new genetics-based pest control approaches; and
- National coordination.

In November 2016, a new government-owned company, Predator Free 2050 Limited, was formed to coordinate partnership approaches to large landscape projects and breakthrough science.

BUILDING MOMENTUM FOR PREDATOR FREE NEW ZEALAND

From 2012, huge progress in large scale projects was made through initiatives such as Project Janszoon in New Zealand’s Abel Tasman National Park; Cape to City in Hawkes Bay; and, more recently, the Taranaki Mouna Project centred on Mount Taranaki in Egmont National Park. The investment on the New Zealand conservation estate is underpinned by The Tomorrow Accord between the philanthropic NEXT Foundation and the New Zealand Government, that requires agreed biodiversity outcomes to be maintained by government in perpetuity. DOC also increased its predator control work through the Battle For Our Birds initiative, designed to target predator populations following beech mast seeding events to prevent them from erupting to very high levels, and since broadened to cover all of DOC’s landscape-scale small mammal pest suppression and eradication activities. Beyond the conservation estate, commitments to landscape-scale predator management are being reflected in unitary authority strategies such as Regional Council Pest Management Plans and Long-Term Plans, notably in the Taranaki and Hawkes Bay regions of the country. These strands are now being consolidated through PF2050 Limited large landscape project funding, with the first of seven initial projects announced in May 2018 at a total

value of NZ\$48m for predator management in the Taranaki region.

Complementing these activities, the Predator Free New Zealand Trust, founded in 2012, has made a significant contribution to building community interest and capacity in the Predator Free 2050 movement. Many new community-driven initiatives focusing on predator management have sprung up in recent years, such as Predator Free Wellington and Predator Free Dunedin, both focussed on major New Zealand cities. Supporting these initiatives are new computer-based management tools to help the planning, monitoring, and reporting of community-based trapping (e.g., software applications TrapNZ and CatchIT). Most recently, the Kickstarter Campaign-funded Squawk Squad have helped lead the way into social media and education, teaming up with private companies Goodnature Limited and Encounter Solutions to provide crowd-sourced remotely-monitored trapping solutions for sanctuaries, and with DOC and other partners in engaging 40,000 children across 800 schools during Conservation Week in 2017.

From 2014 onwards, New Zealand has been restructuring its science system into a set of National Science Challenges. During construction of a research project on small mammal management for the New Zealand’s Biological Heritage National Science Challenge (BHNSC), confidence in the Predator Free 2050 goals was demonstrated through an informal stakeholder survey. A subset of stakeholders relevant to invasive mammal management in New Zealand was asked via email to provide brief responses to three questions. Nineteen survey returns were received: two from central government agencies, three from individuals employed at central government agencies, one combined Region Council return, two from individual Regional Councils, two from environmental consultants, three from non-

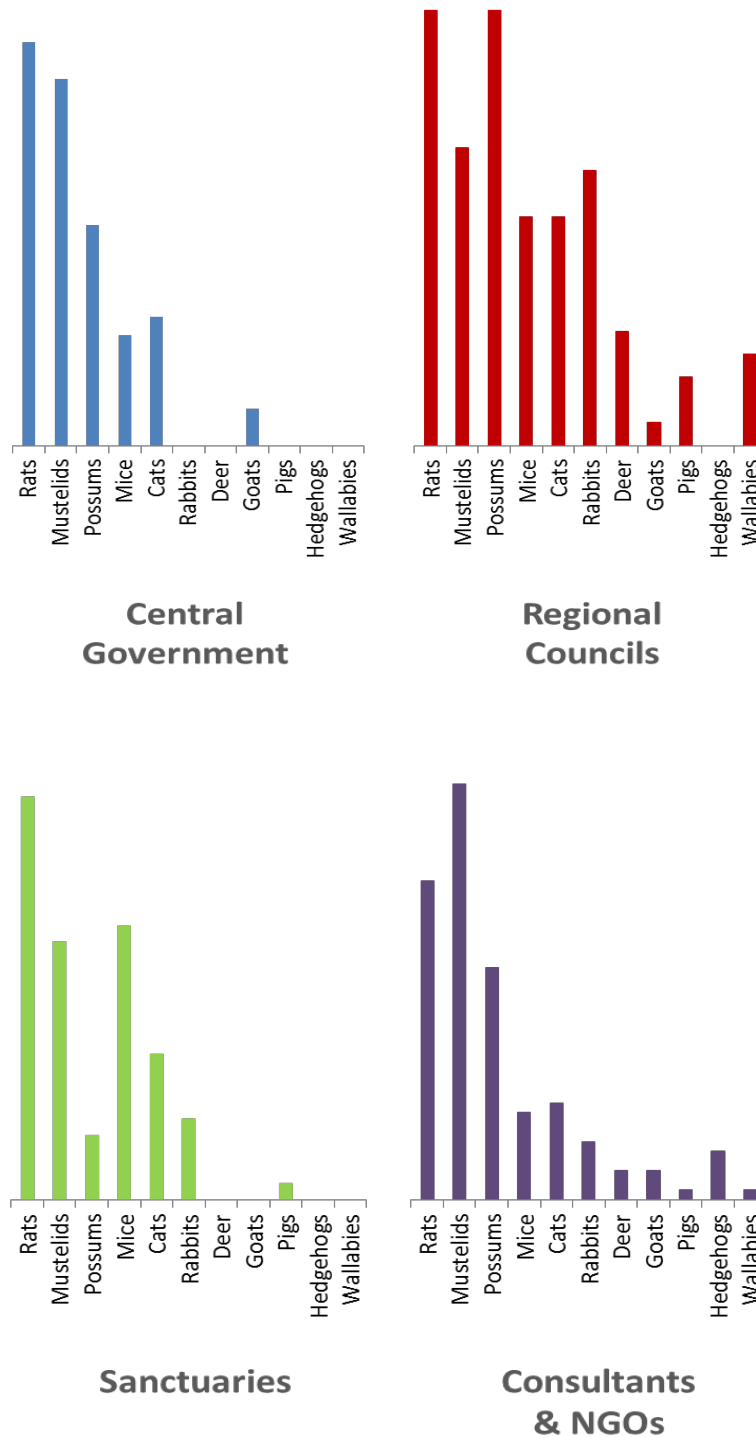


Figure 2. Stakeholder responses to the question “Which invasive mammal pests would you like to be better able to control, in order of priority?” by stakeholder category. See text for sample sizes.

government organisations, and six from sanctuaries (mainland areas of management for native biodiversity behind predator-proof fences).

In response to the question “Which invasive mammal pests would you like to be better able to control, in order of priority?”, survey respondents highlighted rats, stoats,

and possums as the top three of concern (Figure 1). Although there appeared to be some variation in priorities among stakeholder categories (Figure 2), a high level of consensus was observed. Interestingly, sanctuaries appear to be the only stakeholder category bucking the general trend: follow-up discussions indicated that this is due to

Table 1. General stakeholder responses, not specific to any pest, to the question “What are the management goals that you would like to be able to achieve for your priority pests but currently can’t?” (n = 19 stakeholders). Each ‘X’ represents a stakeholder raising that goal; dotted lines represent *post-hoc* categorisation of responses.

Post-hoc Category	Management Goal	Number of Responses
Landscape scale management	Landscape-scale suppression	XXXXXXXXXXXX
	Disease prevention	X
Eradication	Local/regional eradication	XXXXXXXXXXXX
	Toxin-free eradication	X
Surveillance / reinvasion prevention	Minimise/prevent reinvasion	XXXXXXXXXX
	Reliable detection	XX
	Effective response to incursion	X
Biodiversity outcomes	Increase populations of native species	XXXXXXXXXX
	Landscape protection	X
Management strategy	Achieve predictable levels of control	X
	Identify ‘trigger points’ for research/management	X
	Know when to start and stop control efforts	X
Community engagement	Integrate into sustainable community initiatives	X
	Empowered community conservation collectives	X
	Iwi-led conservation	X
	Link research initiatives to biodiversity and societal goals	X
	Integrate and facilitate new developments	X

rats, stoats, and possums all being manageable in relatively small areas behind predator-proof fencing.

In response to the question “What are the management goals that you would like to be able to achieve for your priority pests but currently can’t?”, most responses fit the *post-hoc* categories of ‘landscape-scale management,’ ‘eradication,’ and ‘surveillance/ reinvasion prevention,’ with others falling into the ‘biodiversity outcomes,’ ‘management strategy,’ and ‘community engagement’ categories (Table 1, Table 2).

Finally, in response to the question “What do you see as the key hurdles preventing you from achieving your desired mammal pest management goals?”, hurdles identified fell into five *post-hoc* categories (Table 3): control tool needs (n = 19), resourcing needs (n = 16), societal needs (n = 13), surveillance/detection/interaction needs (n = 11), and strategy needs (n = 10).

Overall, these responses give strong confidence that the majority of conservation stakeholders in New Zealand support the Predator Free 2050 initiative, with strong alignment to both the target species focus (rats, stoats, and possums) and the goal of landscape-scale eradication for the outcome of native biodiversity protection and restoration. And this confidence is not just national; internationally, the Predator Free 2050 initiative is a founding initiative for the IUCN’s Honolulu Challenge on Invasive Species, also launched in 2016.

THE ROLE OF RESEARCH IN PREDATOR FREE NEW ZEALAND

Management of invasive predators in New Zealand has been ongoing since the turn of the Twentieth Century. Up until the current Predator Free 2050 initiative, management for eradication has focused on island pest

populations (including mainland sanctuaries behind predator-proof fences; Innes et al. 2012). For predator management on true islands, the scale of eradications achieved has increased logarithmically since the 1960s (Clout & Russell 2006); our ability to suppress predator populations on the mainland has likewise scaled up (Parkes & Murphy 2003). The DOC Pest Summit in 2012 highlighted that the factor that has facilitated this capacity and capability has been multiple, complementary, and often synergistic strands of research into toxins (Eason et al. 2010, Blackie et al. 2013), traps (Gillies et al. 2012, Warburton and Gormley 2015), surveillance techniques (Sweetapple and Nugent 2011, Jones et al. 2015), ecology (Tompkins and Veltman 2006, Kelly et al. 2013), control and detection probability models (Tompkins and Ramsey 2007, Clayton et al. 2011), and social licence to operate (Allen et al. 2014, Russell 2014), among others (Eason et al. 2017).

The critical learning from such back-casting is that if the Predator Free 2050 goals are to be achieved, a similarly diverse research portfolio is essential moving forwards to drive the paradigm shift from current mainland predator *suppression* approaches to mainland predator *eradication*. When no single research stream can give assurance of success, despite occasional claims of ‘silver-bullet’ solutions to pest issues, a ‘bet-hedged’ portfolio of research is required to diversity risk of non-delivery. Following this model, the BHNSC research project on small mammal management progressed after the informal stakeholder survey documented above, through a joint stakeholder/researcher workshop held in 2016.

Building on the survey responses, research and strategy priorities very similar to those highlighted by the 2012 Pest Summit were independently converged upon

Table 2. Stakeholder responses, regarding specific pests, to the question “What are the management goals that you would like to be able to achieve for your priority pests but currently can’t?” (n = 19 stakeholders).

Species	Response
Rats	Landscape-scale, long-term suppression Effective ways to minimise reinvasion Detect at low density Consistent reduction to 5%; 1% prior to bird breeding season
Mustelids	Detect at low density Control neophobic stoats Landscape-scale suppression
Possums	Maintain possum reductions post bovine tuberculosis eradication Landscape-scale suppression Effective ways to minimise reinvasion Disease prevention
Cats	Landscape-scale suppression
Rabbits	Landscape-scale suppression Minimise economic loss Monitor and control
Mice	Landscape-scale suppression Alternative toxins to brodifacoum
Pigs	Community-led management at selected sites Effective suppression
Deer	Control/eradication outside gazetted range Community-led management at selected sites
Wallabies	Eradication or long-term control

and further developed (Figure 3). With the remit to invest in potentially game-changing research, the BHNSC subsequently initiated work on the following: an improved lure for stoats, biosensors for vertebrate pest surveillance, sequencing the full genome of the brushtail possum, foundational exploration into the feasibility of new genetic-based pest control approaches, the development of a possum-specific toxin, and societal perspectives and the bioethics of mammal pest control. This complemented ongoing work on lure and specific toxin development for other pests, and ongoing development and improvement of a range of traps, conventional toxins, and surveillance approaches across the pest research and management community. Recognising the importance of close-to-market investment to get improved tools into the hands of conservation practitioners now, the BHNSC also conducted a review to identify the priorities in this topic. Some of these have already been picked up by a ‘Tools-to-Market’ research fund administered by DOC, with recent support for predator-selective and rat-specific toxins, and long-life rat lures.

Complementing the traditional approaches in research for pest management, a newly-formed joint New Zealand government- and philanthropy-supported research and development company, Zero Invasive Predators (ZIP), is employing an agile adaptive management model to

develop approaches to eradicate invasive mammals, and then defend predator-free areas from reinvasion. After initially focusing on peninsulas, ZIP are now using remove-and-protect methodologies in mainland areas, with success to date at 2500 ha and an eye to push this up by an order of magnitude over two to three years.

THE PREDATOR FREE 2050 LIMITED RESEARCH STRATEGY

Further developing the research portfolio approach is PF2050 Limited’s research strategy, developed in 2017 with the remit of focusing research efforts to achieve a breakthrough science solution capable of eradicating at least one small mammal predator by 2025. The strategy was constructed by a team of ten experts convened through the BHNSC and was independently peer-reviewed, with the goal of complementing existing efforts to give the whole portfolio of relevant research the best chance of achieving the 2025 goal. Following this strategy, PF2050 Limited is now investing across four research programmes:

- **Environment and Society** is building on work underway in the BHSNC to explore social and cultural views about predator eradication and confirm and expand our understanding of environmental and ecological consequences of Predator Free 2050.
- **Best Use of Existing Approaches** is testing whether advances with currently-employed tools and approaches can make eradication at the landscape-scale possible. Based on the current situation regarding rat, stoat, and possum management in New Zealand (specifically, there already being a concentrated body of research and operational activity on the landscape-scale management of possums for the purpose of bovine tuberculosis eradication), the possum is the species initially targeted.
- **Exploring New Approaches** is building on foundational work in the BHNSC, to address knowledge gaps with regards to risk, benefit, and technical feasibility of new genetic approaches, enabling an informed consideration of their potential. Ship rats were identified as the best target predator species for development, due to modelling predictions of the potential for new genetic approaches to the control of such pests (Prowse et al. 2017), and the challenge of eradicating them using existing approaches.
- **Computer Modelling** underpins the strategy and is developing shared tools that all communities and agencies contributing to Predator Free 2050 can use to design, monitor, and improve the best approach for their goals and environment.

The strategy is not set in stone but will be modified according to research progress and developments in the wider science community; ways to also support research in other areas that would increase our ability to achieve the Predator Free 2050 goals are being explored. This high-level strategy was introduced to the 28th Vertebrate Pest Conference in Rohnert Park, California, in February 2018. The first project presentations were made at the Society for Conservation Biology’s Symposium for Conservation Biology Oceania Section Congress in Wellington, New Zealand, in July 2018.

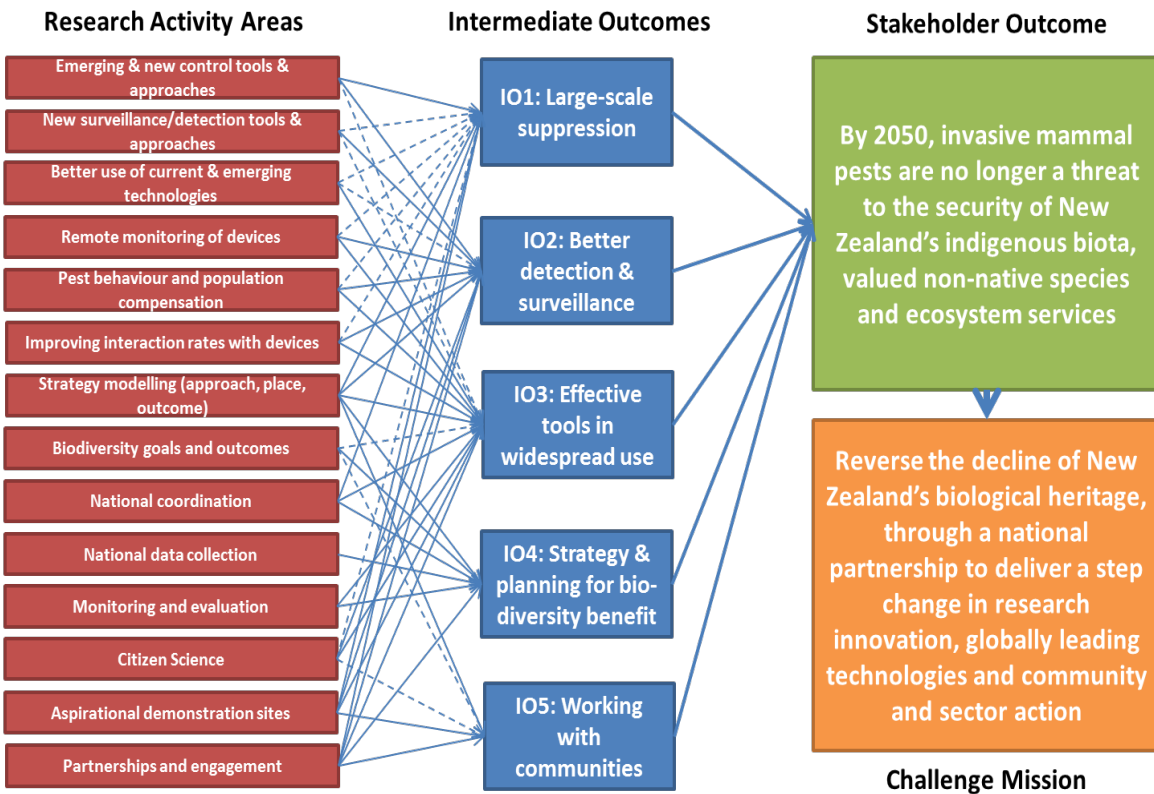


Figure 3. The Predator Free 2050 research/strategy landscape, as constructed by a New Zealand's Biological Heritage National Science Challenge stakeholder/researcher workshop in 2016.

CONCLUSION

The need to shift the goal of predator eradication in New Zealand was driven home by the New Zealand Parliamentary Commissioner for the Environment's 'Taonga of an Island Nation: Saving New Zealand's Birds' report released in 2017 (Parliamentary Commissioner for the Environment 2017). Without the proposed paradigm shift of mainland suppression to mainland eradication there is no end-game: New Zealand's native biodiversity will always be at risk from introduced predators. The resourcing currently available for predator suppression is not preventing ongoing biodiversity declines, and such declines are of a scale such that incremental gains in current suppression approaches will be insufficient stop them. And, should currently available resourcing be diverted to address other pressing future priorities (e.g., climate change adaptation or other societal needs), unless eradicated, the predators will come right back.

Progress to date, however, shows that New Zealand is well on the way to addressing this issue, through a logical and robust process of research strategy development and stakeholder engagement. There is now real confidence in a national partnership between Iwi, communities, business, researchers, and government, following a common agenda to eradicate the introduced predatory mammals critically threatening native biodiversity, using globally leading technologies delivered through a step-change in research innovation.

ACKNOWLEDGEMENTS

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Table 3. Stakeholder responses to the question “What do you see as the key hurdles preventing you from achieving your desired mammal pest management goals?” (n = 19).

Categories	Response
Control tool needs	<p>Need cost-effective tools for sustained rat control. Need more effective tools. Lack of cost-effective efficient tools. (x2) Maintenance costs of manually applied toxins and traps. Lack of tools for some species. Lack of tools to detect then kill a device-shy stoat. Socially acceptable tools for eradicating. Lack of acceptable tools (1080 is best). Not able to sustainably implement available tools over sufficient scale to achieve results. Lack of available tools for mainland eradication (regulatory, and lack of tool, issues). Lack of sufficiently cost-effective tools for pest control at larger scales. Self-resetting traps might be a big step forward, but currently very expensive. Lack of proven multi-kill self-setting trap for rodents. Effective fence-end exclusion mechanism for cats. Tools to detect and kill 'bush rabbits'. More humane tools for control at scale. Sustainable solutions to keep pests at non-impacting levels in lieu of eradication (biocontrol). Need for aerial application of new toxins such as PAPP.</p>
Resourcing needs	<p>Insufficient resourcing (time and money). Lack of funding to DOC for landscape-scale pest control. Lack of \$\$ (x5) Lack of investment. Lack of time. Lack of physical ability. Lack of technical knowledge. Rat control too labour intensive (sanctuaries). Lack of \$\$ for research to develop tools and ideas. Too low investment in research and management. Need cost-effective tools that are labour efficient. Monitoring of impact of control on key indicator species difficult to resource and implement.</p>
Societal needs	<p>Issues with public acceptability of toxins (particularly aerial). Constraints on 1080 use - DOC where some native birds, Ministry of Health exclusion zones. Regulatory hurdles (bar is currently set high). Public perception of 1080. Social acceptance (e.g. controlling companion animals). Some finds toxins not acceptable. Inability to 'tell the story' (understand links betw research, management, outcome benefits). Need for targeted conservation advocacy - simple, accessible, powerful story-telling. Need for education (particularly secondary and tertiary). Lack of public awareness/concern (education). Limits to volunteering. Need social licence (toxins and animal welfare). Need social licence to operate.</p>
Surveillance, detection, and interaction needs	<p>Need higher interactions rates for detection and control devices. Lack of low-cost sensitive techniques for rat detection at low density. Total lack of highly sensitive stoat detection. Lack of suitable rat and stoat incursion response tools (large scale, timely, effective). Lack of effective lures. Lack of long-lasting non-toxic bait. Technology to detect traps set-off / requiring attention. Lack of knowledge of pest behaviour at low density (not interacting with devices). Need research behaviour at super-low densities (how detect/destroy eradication survivors.) Need lures to attract survivor pests over large distances. Difficulty in detection/monitoring.</p>
Strategy needs	<p>Need new predictive models. User-pays requirements. Lack of control opportunity (rabbits). Effective dialogue between management and science. Lack of inclusive strategic planning and cooperative management. Lack of regional/catchment/landscape wide strategies. Rapid rat bounce back after 1080. What's an effective level of control to measure success? What outcomes to focus on? Increase biodiversity? Need consistency of data and information systems (standardised ways of measuring).</p>

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