Biodiversity Conservation Science Prospectus

Department of Conservation
Te Papa Atawhai

New Zealand Government

Cover: Fork Stream, Mackenzie Basin, Annual DOC Freshwater Field Trip. *Photo: DOC, Crown copyright*

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1 Introduction and context

1.1 Why we need a Biodiversity Conservation Science Prospectus

Aotearoa New Zealand's biodiversity is a treasure - a taonga. It is unique, special and wondrous. The word awesome has become overused in recent times but it truly applies to the natural world that surrounds us in this country. The varied species and ecosystems native to Aotearoa New Zealand are also at the core of national identity, add immeasurable value to our culture, and are central to our well-being. In addition to having intrinsic value, our biodiversity provides us with diverse ecosystem services that support our lives, our society and our economy.

The Ministry for the Environment and Statistics NZ report *Our Land 2018*[1] found that indigenous biodiversity and ecosystems continue to be under threat, notably:

- there is a continued loss of indigenous land cover
- coastal and lowland ecosystems continue to decline in extent
- nearly 83 percent (285 of 344 taxa) of the land vertebrates classified in the threatened species system are either threatened or at risk of extinction, and the status of 11 species declined
- predation and plant-eating by pests, as well as disease and weeds, continue to threaten indigenous biodiversity.

Similarly, the Ministry for the Environment and Statistics NZ report *Our Marine Environment 2019*[2] found that:

- An estimated 30 percent of Aotearoa New Zealand's biodiversity is in the sea but many species and habitats are in trouble. Very few marine species are assessed, but of these 22 percent of marine mammals, 90 percent of seabirds, and 80 percent of shorebirds are threatened with, or at risk of, extinction
- Our activities on land, especially agriculture and forestry, and growing cities, increase the amount of sediment, nutrients, chemicals, and plastics that enter our coasts and oceans
- Our activities at sea are affecting the marine environment, including fishing, aquaculture and shipping/boating.

And the Ministry for the Environment and Statistics NZ report *Our Freshwater 2020*[3] highlights that:

- Our native freshwater species and ecosystems are under threat
- Water is polluted in urban, farming, and forestry areas
- Changing water flows affect our freshwater
- Climate change is affecting freshwater in Aotearoa New Zealand.

There are currently significant gaps in knowledge that limit our ability to understand the current state of, and threats to, indigenous biodiversity. And we need to innovate new tools and techniques, harness and develop new technology and further refine our management of species, ecosystems and landscapes to successfully tackle the biodiversity crisis in Aotearoa New Zealand.

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[1] Ministry for the Environment & Stats NZ (2018). *New Zealand's Environmental Reporting Series: Our land 2018*. Retrieved from www.mfe.govt.nz and www.stats.govt.nz.
[2] Ministry for the Environment & Stats NZ (2019). *New Zealand's Environmental Reporting Series: Our Marine Environment 2019* https://www.mfe.govt.nz/publications/environmental-reporting/our-marine-environment-2019
[3] Ministry for the Environment & Stats NZ (2020). *New Zealand's Environmental Reporting Series: Our Freshwater 2020*. https://www.mfe.govt.nz/publications/environmental-reporting/our-freshwater-2020

The launch of the Aotearoa New Zealand Biodiversity Strategy (ANZBS) in 2020 offers an unprecedented opportunity to address these issues, to partner with iwi hapū and whanau, and to elevate mātauranga Māori in biodiversity management. It also offers an opportunity for greater collaboration between government, industry and the research community. It is a strategy for the whole of Aotearoa New Zealand and we will all have to make a contribution to achieve its goals. The challenge that lies before us is to work together and to align our efforts behind this shared vision.

1.2 Purpose: how this Prospectus will be used

The Biodiversity Conservation Science Prospectus (the Prospectus) is a statement of strategic and operational tool-based research needs over the next five to ten years. If addressed, this research will drive significant advancement toward achieving the goals of the Aotearoa New Zealand Biodiversity Strategy (ANZBS). The Prospectus complements, builds on, and provides more direction to, the Conservation and Environment Science Roadmap (2017) (CESR) and other related strategies.[4] It is also closely aligned with the Department of Conservation (DOC) Heritage and Visitor Strategy.[5]

The Prospectus is intended to help drive and influence research for New Zealand Inc. That not only includes DOC but also others involved in biodiversity-related research such as government agencies, Treaty partners, Crown Research Institutes (CRIs), research consultancies and universities. It is intended to create greater coherence and improve opportunities for collaboration. It will provide a focus for DOC's own research and for its endeavours in supporting other research, and in helping it and others to achieve key biodiversity conservation outcomes.

Although setting out medium-term priorities (5-10 years), the Prospectus should be viewed as an initial step – a living document to help drive and support the achievement of the ANZBS goals. As implementation of the ANZBS begins to take shape, with a first plan for 2021 – 2022 currently being developed and a 5-yearly review cycle planned, there will be opportunities to revisit the Prospectus and build on its foundations to make sure that research priorities are aligned with actions.

1.3 Process for developing the Prospectus

The Prospectus is not new work, it is an extension of the biodiversity-related priorities identified in the CESR, with the same overall scope but with more direction. It was commissioned by the previous Prime Minister's Chief Science Advisor (PMCSA) with development supported by the Minister of Conservation. Responsibility for its preparation was with the Department of Conservation's Chief Science Advisor (CSA) and the strategic science advisor to the PMCSA, supported by the Director of the Biological Heritage National Science Challenge (BHNSC). DOC resourced the work through its Biodiversity Group, and where appropriate draft material has been referred to external experts for comment, including MPI, MfE, MBIE, key regional council biodiversity staff and NIWA (for marine related work). Consideration of the Prospectus was incorporated into hui with iwi and hāpu, alongside discussions on the development of the ANZBS, as part of the DOC Policy hui process.

[4] For example: Primary Sector Science Roadmap 2017 and the related draft Biosecurity Science Statement, Regional Councils Biodiversity Strategies, Iwi research strategies, Dairy NZ Science Strategy, PF 2050 science strategy, draft Threatened Species Strategy – the key science principles of these have been summarised by the Biological Heritage NSC and that summary has been used to inform this Prospectus.

[5] DOC (2020). Heritage and Visitors Strategy (draft)

1.4 How the priority research areas were generated

Four main strands of input drove the priority area and refinement process:

1. The CESR themes and immediate 5-year priorities were the first area of focus and were the original driver of the priority areas of science need
2. The strategic science advisor to the Prime Ministers chief Science Advisor (PMCSA), DOC's Chief Science Advisor (CSA) and the Director of the BHNSC used the above and a review (undertaken by the Challenge) of science strategies to refine that list further
3. DOC's Biodiversity Group science teams undertook an exercise to identify the big science questions that if answered would best progress the Department's biodiversity relevant Stretch Goals (see https://www.doc.govt.nz/about-us/our-role/vision-purpose-and-outcomes/). These questions were then cross referenced to the work undertaken in 1 and 2.
4. The research priorities were aligned with goals and pathways set out in the Aotearoa New Zealand Biodiversity Strategy (ANZBS) and where relevant the DOC Heritage and Visitor Strategy.

1.5 Te Mana o te Taiao - The Aotearoa New Zealand Biodiversity Strategy (ANZBS)

Te Mana o te Taiao, launched in August 2020, will guide the protection, restoration and sustainable use of biodiversity, particularly indigenous biodiversity, in Aotearoa New Zealand, from 2020 to 2050.

It provides a framework to optimise, deliver and measure the outcomes of investment in nature. The framework includes a vision, outcomes and goals for biodiversity work in the short, medium and long term. It will be closely connected to and guide national and regional biodiversity action.

The vision of *Te Mana o te Taiao* is 'Te mauri hikahika o te taiao' – a future where the life force of nature is vibrant and vigorous. The vision will be realised by achieving five outcomes by 2050:

- ecosystems, from mountain tops to ocean depths, are thriving
- indigenous species and their habitats are thriving
- people's lives are enriched through their connection with nature
- Treaty partners, whānau, hapū and iwi are exercising their full role as rangatira and kaitiaki
- prosperity is intrinsically linked with a thriving biodiversity

Under each of these five outcomes, a range of more specific goals and pathways have been defined. The science priorities in this Prospectus have been mapped against relevant pathways from *Te Mana o te Taiao* (see below: "The priority areas – justification and links to biodiversity conservation priorities").

Te Mana o te Taiao is for all of Aotearoa New Zealand to own and implement – it will drive action by government agencies, local government, Treaty partners, communities, science institutes, sectors and businesses.

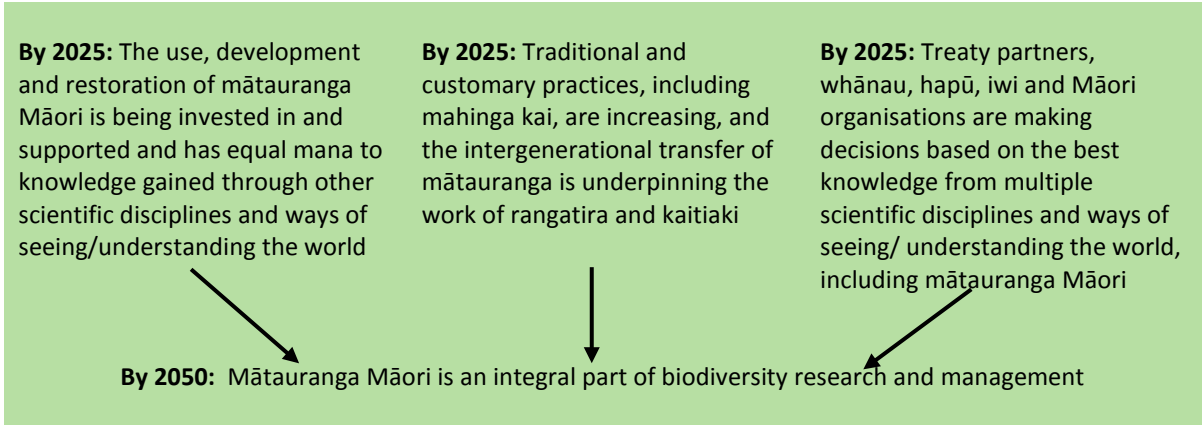
Now that Te Mana o te Taiao has been released, the first implementation plan for 2021 – 2022 will be developed. This plan will set out actions that focus on setting up the systems and processes needed to support the delivery of the strategy. It will also align work that has already begun, or is ready to get started, with the strategy's direction.

Key aspirations of the ANZBS include the roles of Treaty partners in exercising tino rangatiratanga and kaitiakitanga, as well as the elevation of mātauranga Māori, in biodiversity management. The 2021-2022 implementation plan will set up processes to ensure the journey of engagement and collaboration with Treaty partners continues on how these aspirations, and the other goals and outcomes, can be realised.

As work on implementing the ANZBS progresses, further insights on research priorities from Treaty Partners and other contributors are likely to be gained. The Prospectus should be regularly reviewed to ensure these are included.

1.6 Mātauranga Māori – a cross cutting priority for implementation

The identified research priorities do not include a specific item relating to mātauranga Māori. This is because mātauranga Māori is not a separate, stand-alone research focus but is a priority when implementing all of the potential work identified in this prospectus. The ANZBS sets out the following pathway for mātauranga Māori.



The implementation plan will provide greater clarity on the next steps; on how the 2025 goals set out above can be reached. The users of this Prospectus, and the projects resulting from it, will need to be mindful of this development and look to the implementation plan for guidance on improving the connection and equal balance between mātauranga Māori and western science in research.

1.7 Treaty partner engagement

All aspects of the Prospectus should be implemented in accordance with the need to embrace Te Ao Māori. In this regard the Prospectus has adopted the commitment made by the Biological Heritage National Science Challenge, namely:

- Giving effect to the Treaty partnership and DOC's 'section 4' obligations
- Manaakitanga (building trust, an ability to be more caring, being a good host and creating a place that others want to be a part of)
- Whanaungatanga (familial relationships, working as a family, having fun together)
- Mana motuhake / tino rangatiratanga (Aotearoa/NZ has a lot to offer to our international colleagues, we need to demonstrate leadership in better ways of working and showcase this on the world stage)
- Whakapapa (interconnections, and the importance of the intergenerational nature of our work);
- Enabling hapū and whānau to practice kaitiakitanga, and weaving mātauranga Māori alongside mainstream scientific method
- Using appropriate tikanga in all research activities.

1.8 Responsible Research

Science and research are not separate from society. It is vital that those involved are mindful of their responsibilities beyond the Treaty partner engagement set out above and beyond adhering to robust methodologies and scientific principles.

Research should be conducted:

- with ethical integrity
- within the mandate of the organisations initiating and conducting the research
- with transparency

2 Biodiversity conservation priority research areas

This table lists, in no particular order, the 17 priority areas of science focus for this Prospectus. Appendix 1 shows the links between these research areas and the ANZBS. Appendix 2 shows the links between these research areas and the Conservation and Environment Science Roadmap, and to DOC's Stretch goals.

Table 1: Priority Research Areas (in no particular order)

1	The state of New Zealand's biodiversity from genepools to ecosystems - understanding and mapping the state and trend of indigenous biodiversity
2	Innovation in environmental monitoring and reporting – understanding the effectiveness of management interventions
3	Tipping points and interactions - understanding and managing the critical drivers of ecosystem health and species population change
4	Securing ecosystem resilience under a changing climate – predicting climate change impacts on ecosystems and species to inform management
5	Working together to understand the institutional, social, economic and cultural dimensions of biodiversity conservation
6	The human dimensions of biodiversity conservation
7	Solving the terrestrial pest plant problem
8	Solving the terrestrial animal pest problem
9	Solving the freshwater pest problem
10	Solving the marine pest problem
11	Biosecurity: disease management for ecosystem and species resilience
12	Developing effective tools and actions for managing populations of migratory and widespread species
13	Production landscapes for environmental outcomes–determining the current and potential contribution to biodiversity conservation
14	Connecting people to biodiversity conservation in the urban environment
15	Restoring New Zealand's vulnerable freshwater and estuarine ecosystems
16	Protecting New Zealand's freshwater species – understanding drivers of freshwater decline and critical pathways for recovery
17	Achieving spatial protection for marine species, habitats and ecosystems

3 The priority areas – justification and links to biodiversity conservation priorities

Prioritisation is always challenging. We invariably want to do more of everything, and every part of the Aotearoa New Zealand Biodiversity Strategy (ANZBS) is important. However, we also have to deal with the reality of limited time and resources, so having a clear idea of priorities can help us in making decisions about where to focus effort over the coming decade.

The following is a justification of why each priority research area was selected, and how they link to pathways in the ANZBS. Please note that the pathways are taken directly from the ANZBS but the headings are not – they are a guide for the reader of this Prospectus.

3.1 ANZBS 'information pathway'

By 2025: Prioritised research is improving baseline information and knowledge of species and ecosystems

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By 2030: Improved baseline information, comprehensive mapping, and improved knowledge of species and ecosystems and causes of their decline are informing management

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By 2050: Comprehensive baseline information integrated with spatial information and knowledge about effective management is informing the adaptive management of species and ecosystems

Priority area 1: The state of New Zealand's biodiversity from genepools to ecosystems - understanding and mapping the state and trend of indigenous biodiversity.

The ANZBS recognises that we have to enhance our knowledge base so that we can understand the problems and identify solutions. This approach is also consistent with the CESR emphasis on building the knowledge base that is Aotearoa New Zealand's biodiversity resource. Acknowledging we cannot do it all immediately there is a focus on marine biota and terrestrial invertebrates, but with a signal also to longer term needs. Understanding how this resource is faring, its state and trend, is also emphasised.

3.2 Part of ANZBS 'knowledge systems pathway'

By 2025: A national, agreed set of indicators and an effective environmental monitoring and reporting system are informing biodiversity management and decision making

By 2025: Innovative solutions to biodiversity issues, including the development of new tools and technologies, are being collaboratively developed and actively sought from a range of sources and deployed on the ground

By 2050: Improved systems for knowledge, science, data and innovation inform our work

Priority area 2: Innovation in environmental monitoring and reporting – understanding the effectiveness of management interventions.

State of the Environment Reporting is a Statistics New Zealand and MfE responsibility. Much of the biodiversity data though is from DOC monitoring. This monitoring is being extended to cover all of New Zealand and requires innovation, in multiple areas, to be cost effective, timely and to inform management. But what also needs signalling is the changing/ developing nature of increasingly remote, automated and very smart technology, and its ability complemented by the Internet of Things (IOT) and machine and related learning to drive big data and real time management.

3.3 ANZBS 'cumulative impacts pathway'

By 2025: The cumulative effects of pressures on biodiversity are better understood

By 2030: Management at different scales and across domains is reducing the cumulative effects of pressures on biodiversity

By 2050: The cumulative effects of pressures on biodiversity have been reduced to a level that does not have significant detrimental effects on biodiversity

Priority area 3: Tipping points and interactions - understanding and managing the critical drivers of ecosystem health and species population change.

The range of pressures on biodiversity, and the interaction between them, has been recognised in the ANZBS. It is vital to improve our understanding of them to inform management. Monitoring, science based, mātauranga Māori, and anecdotal, should and will help identify points at which ecosystems, communities and species change into more or less desirable states, and the drivers of such changes (habitat loss, predators, diseases for example). Understanding these points is key to focusing management interventions.

3.4 ANZBS 'climate adaptation pathway'

By 2025: Potential impacts from climate change have been integrated into ecosystem and species management plans and strategies, and a research and rangahau strategy has been developed to increase knowledge and understanding of climate change effects

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By 2030: Risks to biodiversity from climate change, including cascading effects (e.g. increases in introduced invasive species, water abstraction, fire risk, sedimentation) have been identified and assessed, and indigenous ecosystems, habitats and species are being managed to build resilience where possible

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By 2050: Adaptive management is addressing the impact of climate change on biodiversity, including cascading effects, and is building resilience to future risks

Priority area 4: Securing ecosystem resilience under a changing climate – predicting climate change impacts on ecosystems and species to inform management.

The ANZBS contains several pathways relating to climate change, including improving ecosystem resilience. While enhanced knowledge of ecosystems and their component parts is important in driving management direction, there is the global looming pressure that is climate change. Managers, managing for conservation resilience, require information that can inform policy choices over a range of time periods influenced by climate change.

3.5 ANZBS 'capability pathway'

By 2025: Research is improving our understanding of societal values, norms and beliefs, as well as the motivators, barriers and enablers of action to support biodiversity management and decision making

No 2030 milestone

By 2050: All New Zealanders have the skills, knowledge and capability to be effective

The ANZBS recognises the importance of engaging with and empowering people to make a difference for biodiversity.

Priority area 5: Working together to understand the institutional, social, economic and cultural dimensions of biodiversity conservation.

Management to achieve biodiversity conservation is complex and multi-faceted – it occurs in many institutional contexts, with diverse groups of people, multiple drivers and of course with many direct connections to Treaty obligations. Understanding the opportunities and identifying arrangements that work, and those that don't and why, is fundamental to designing and implementing new initiatives.

Priority area 6: The human dimensions of biodiversity conservation.

Ultimately conservation on the ground is achieved by people, either directly or indirectly. Understanding individual behaviour and drivers of that behaviour is fundamental to designing initiatives that are seeking to implement change, or those that are potentially controversial.

3.6 ANZBS 'biosecurity pathway'

By 2025: New and emerging biosecurity threats, including weeds, animal pests and diseases (e.g. introduced invasive plants, algae, mammals, fish, invertebrates and micro-organisms), in all domains are actively identified and managed early through improvements in decision making, Treaty partnership approaches, skills and technology

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By 2030: The highest priority biosecurity threats, including weeds, animal pests and diseases (e.g. introduced invasive plants, algae, mammals, fish, invertebrates and microorganisms), in all domains have been identified and are being managed based on current and potential future impacts on indigenous biodiversity

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By 2050: Introduced biosecurity threats, including weeds, animal pests and diseases (e.g. introduced invasive plants, algae, mammals, fish, invertebrates and micro-organisms), in all domains have been eradicated or are being managed to reduce negative impacts in areas of high biodiversity value

Plant pests, animal pests and diseases, are massive issues for biodiversity conservation, in terrestrial, freshwater and marine environments. Because of the enormity of the issues and the associated research challenges, 5 individual areas of priority focus have been identified. The first four are as follows. The fifth is on the next page.

Priority area 7: Solving the pest plant problem.

Plant pests are one of the major drivers of conservation loss, often at large scale, e.g., wilding pines. The problem is increasing both in scale and in terms of diversity of the threat. Improved and new tools are required to manage this problem.

Priority area 9: Solving the freshwater pest problem.

Both introduced aquatic plants and fish are significant pests to native fish, invertebrates and the freshwater environment generally – in rivers, lakes and wetlands. New technologies are needed to control these pests and improved understanding of ecological implications explored.

Priority area 10: Solving the marine pest problem.

Multiple introduced species have invaded parts of New Zealand's coastal and marine environment. These organisms act to both displace and at times predate on indigenous biodiversity. Control options are limited with newer more effective solutions required.

Priority area 11: Biosecurity: disease management for ecosystem and species resilience.

Diseases (mostly introduced) can be extremely harmful to species and to ecosystems. Kauri die back and myrtle rust are two relatively recent examples which are having catastrophic impact on biodiversity conservation. Current methods of control are often very limited. Better ecological understanding of how to build and sustain resilience, and new technologies are required to help solve these and potential future incursions.

3.7 ANZBS 'mammalian pest pathways'

By 2025: Introduced predators (ferrets, weasels, stoats, possums and rats) have been suppressed across 1 million hectares of mainland and eradicated from all uninhabited offshore islands

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By 2030: Introduced predators (ferrets, weasels, stoats, possums and rats) have been eradicated from one inhabited island, one city or town, and 10 000 hectares of rural production land, and their eradication in 10 large mainland sites is underway

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By 2050: Aotearoa New Zealand is free from ferrets, weasels, stoats, possums and rats

By 2025: The impacts of introduced browsers, including valued introduced species (pigs, deer, tahr and chamois), on indigenous biodiversity have been quantified, and plans for their active management have been developed with Treaty partners, whānau, hapū, iwi, Māori organisations and stakeholders

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By 2030: Introduced browsers, including valued introduced species, are actively managed to reduce pressures on indigenous biodiversity and maintain cultural and recreational values

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By 2050: Introduced browsers, including valued introduced species, have been removed from high priority biodiversity areas and threatened ecosystems and are under ongoing management elsewhere to maintain functioning ecosystems and cultural and recreational values

Priority area 8: Solving the terrestrial pest problem, including mammalian predators.

Mammalian predators, mammalian herbivores and insect pests are probably the single biggest driver of current terrestrial biodiversity decline and loss. While existing technologies can operate at increasingly large scales, it is unlikely that in the long run they will drive key species to extinction. Much more research is needed to improve and build on the current toolbox, to understand the ecological implications of selectively removing predators, and the potential for new technologies to contribute in the longer term.

3.8 ANZBS 'species pathway'

By 2025: There have been no known human-driven extinctions of indigenous species

By 2030: Populations of all indigenous species known to be at risk of extinction are being managed to ensure their future stability or an improving state

By 2050: Indigenous species have expanded in range, abundance and genetic diversity and are more resilient to pressures, including climate change

Priority area 12: Developing effective tools and actions for managing populations of migratory and widespread species.

Animals that have local, regional, national and international migratory behaviours pose multiple challenges to effective conservation management. These animals are represented in all three domains, e.g., Westland black petrel from the land domain, long finned eel from the freshwater domain, and migratory marine mammal species. The challenges are not just ecological but also social, cultural, economic and jurisdictional.

Priority area 16: Protecting New Zealand's freshwater species – understanding drivers of freshwater decline and critical pathways for recovery.

Most of New Zealand's native freshwater fish species are under conservation threat. Relatively little is known about many of these species and thus it is difficult to define management interventions with certainty.

3.9 ANZBS 'sustainable use pathway'

By 2025: The potential for different sectors to contribute to improved indigenous biodiversity is understood, and sustainable use practices that include benefits for indigenous biodiversity are becoming more widespread

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By 2030: Sustainable use practices that include benefits for indigenous biodiversity are standard practice for biodiversity resource users (including tourism and recreation) and primary industry (including agriculture, forestry, fisheries, aquaculture and horticulture)

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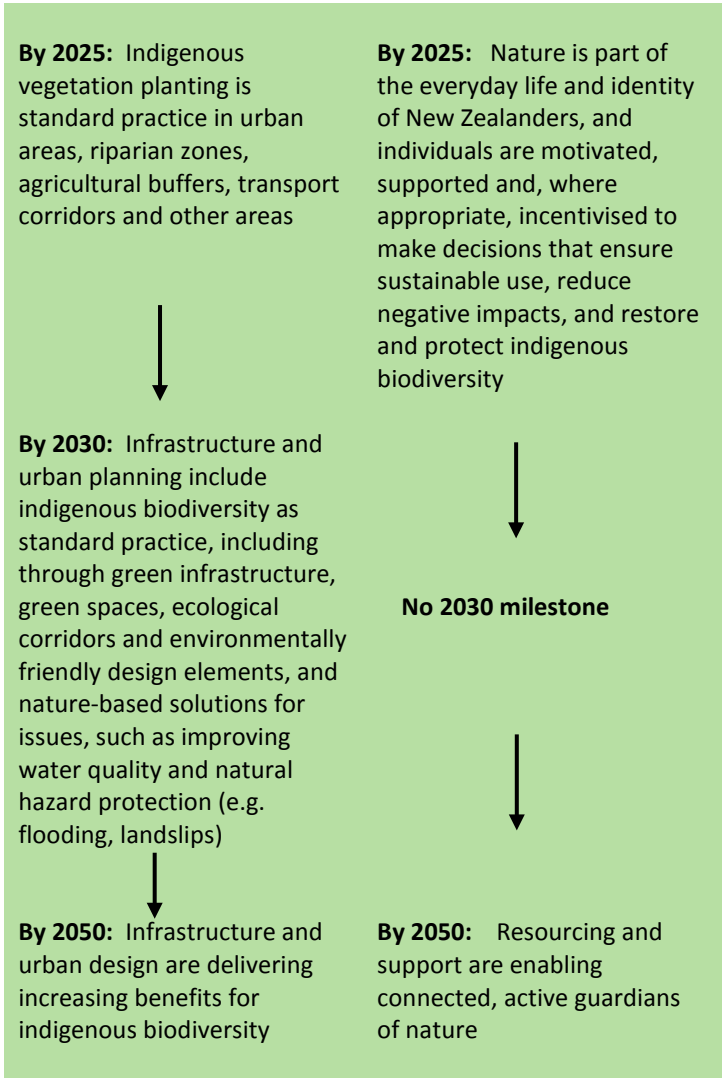
By 2050: Sustainable use practices are providing benefits for indigenous biodiversity and maintaining ongoing economic and wellbeing benefits for people

Priority area 13: Production landscapes for environmental outcomes– determining the current and potential contribution to biodiversity conservation.

There is a commonly held assumption amongst many that biodiversity conservation occurs in designated parks and reserves. But for most species this is not the case – they occur in multiple production environments. The ANZBS recognises this in its 'sustainable use' pathway. The question is how to sustain production while delivering conservation. This production philosophy can be applied to the land, freshwater and marine domains, and thinking from an integrated ecosystems perspective.

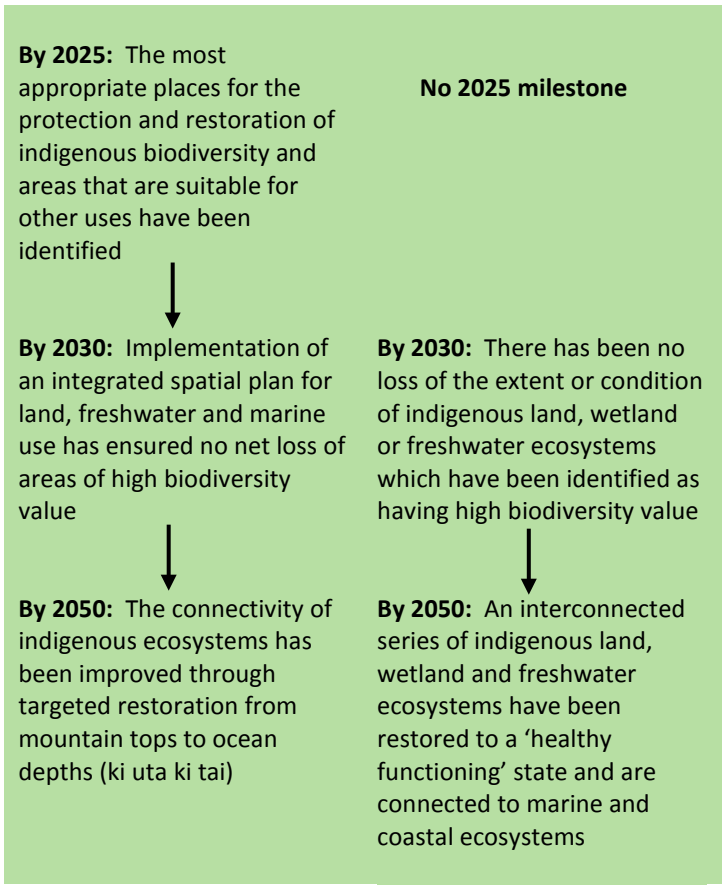
3.10 ANZBS 'urban infrastructure' and 'resourcing and support' pathways



Priority area 14: Connecting people to biodiversity conservation in the urban environment.

Engaging New Zealanders in biodiversity conservation is a key part of the ANZBS. Well over 80% of the New Zealand population, and certainly almost all recent migrants, live in urban environments – increasingly these people and these environments are failing to deliver or connect with priority conservation outcomes. What approaches and tools can be used to promote these connections and lead to improved outcomes in urban environments?

3.11 ANZBS 'freshwater protection and restoration pathways'



Priority area 15: Restoring New Zealand's vulnerable freshwater and estuarine ecosystems.

Freshwater management has been a priority for recent New Zealand governments. Much habitat has been damaged or lost, and a high proportion of New Zealand's native species are considered threatened. New and more cost-effective restoration approaches are needed that work at scale.

3.12 ANZBS 'marine protection and restoration pathways'

By 2025: A protection standard for coastal and marine ecosystems established and implementation underway

By 2025: Significant progress has been made in identifying, mapping and protecting coastal ecosystems and identifying and mapping marine ecosystems of high biodiversity value

By 2030 Significant progress made in establishing an effective network of marine protected areas and other protection tools

By 2030: No loss of the extent or condition marine and coastal habitats which have been identified, mapped and designated as having high biodiversity value

By 2035: An effective network of marine protected areas and other tools, including marine and coastal ecosystems of high biodiversity value is established and is meeting the agreed protection standard

By 2050: An interconnected series of marine and coastal ecosystems have been protected and restored to a 'healthy functioning' state and are connected to indigenous land, wetland and freshwater ecosystems

Priority area 17: Achieving spatial protection for marine species, habitats and ecosystems.

New Zealand has one of the world's largest Exclusive Economic Zones – it is known to be highly diverse and to contain globally important conservation values, yet, less than 1% is protected through marine parks. New approaches to identifying and managing areas to protect these values are required in a world where there are multiple demands on these resources.

4 Prioritisation

As noted above, the 17 priority areas identified are consistent with those identified in the 2017 CESR. While a prioritisation assessment was undertaken for that document, no formal process was undertaken for this Prospectus. However, guidance is provided in the form of an impact severity ranking created by the DOC team who developed this Prospectus. These are shown clustered in Table 2 and are indicative of relative ranking.

Table 2. Impact severity of priority area biodiversity conservation problem

Severity of impact	Impact description	Priority Areas
5.	Very high immediate to short term and probably ongoing	1: State of biodiversity 3: Tipping points for species and ecosystems 6: Human dimensions including social licence 8: Terrestrial animal pests 11: Biosecurity: diseases 15: Freshwater restoration
4.	Very high medium to longer term	2: Monitoring management effectiveness 4: Biodiversity and resilience to climate change 7: Terrestrial plant pests 9: Freshwater biosecurity 10: Marine pests 16: Freshwater species conservation 17: Marine protected areas
3.	Moderate in the short to medium term, but considered to be potentially more significant in the longer term	5: Institutional and economic arrangements 12: Migratory species 13: Production landscapes 14: Urban environments
2.	Low in the short to medium terms but potentially much higher in the longer term	
1.	Low now but possible longer term more significant impact	

While this ranking should be taken into account, it is expected that, over time, the focus will shift between these various priorities to account for circumstances in any given year.

5 Evaluation and review

Our understanding of the world around us is continually changing. Our understanding of how to make real the Treaty Partnership is also a work in progress. But we need some degree of certainty to help us focus and prioritise over the coming years so there is a balance to strike on the longevity of this document.

This Prospectus should be reviewed at the latest three years after being signed-off. However, significant developments, such as the creation of an ANZBS implementation plan for mātauranga Māori, could bring such a review forward.

6 The priority areas and what they contain

Each priority area is presented on a single page. The information presented is a subset of a master spreadsheet template held for each of the 17 priority areas. The additional information housed will be used when seeking to implement the research. As presented each priority is standardised by:

1. An introductory section containing:
   - Key context – the problem to be researched, defined in brief; the magnitude and urgency of the problem on a 1-5 scale (5= Very high immediate to short term and probably ongoing; 4= Very high medium to longer term; 3= Moderate in the short to medium term, but considered to be potentially more significant in the longer term; 2= Low in the short to medium terms but potentially much higher in the longer term; 1= Low now but possible longer term more significant impact)
   - Potential conservation gain from undertaking the research, i.e., the value proposition if the research is undertaken and implemented
   - The management and/or policy need

2. Strategic research and operational tool needs:
   - Specific research directions are identified complemented by information in brief on the current state of knowledge, and the management outcome from implementing the research findings
   - Specific tool needs are listed alongside information on the current state of knowledge, and the management outcome from having and using the tool
   - The approximate duration of the research has been estimated.

There are, naturally, multiple examples of overlapping priorities. These are dealt with in two main ways:

1. Where there is a dominant Priority Area (PA), e.g., State, and there is 'state' related work identified in another PA but there is nothing particularly 'distinctive' about the priority work then it will have been encompassed in the dominant PA;
2. Where there is a dominant Priority Area (PA), e.g., State, and there is 'state' related work identified in another PA and that work is 'distinctive' it will have been retained in that PA but with a cross reference to the dominant PA.

6.1 Priority Area 1: The state of New Zealand's biodiversity from genepools to ecosystems - understanding and mapping the state and trend of indigenous biodiversity

Context:

- NZ lacks basic information on our biodiversity. Completing taxonomic inventories of coastal and oceanic species and land-based invertebrates is particularly important, along with cataloguing information on our lizards, cryptic species (including some birds) and plants. Understanding genetic diversity, and classifying ecosystems over a range of spatial scales are also a priority
- Impact rank: 5 – Without this understanding and ability to deploy necessary management approaches there will be enormous biodiversity losses.

Potential conservation gain from the research:

- Having fundamental knowledge about biodiversity will allow us to make better informed management decisions, better assess risk, set more effective conservation priorities and more effectively assess the potential impacts of development on habitats and species.

Management need:

- Achieving successful biodiversity conservation relies on good basic knowledge - this research will provide that knowledge

	Priority directions	Ultimate conservation outcome	Yrs
Strategic research	• Taxonomic inventories of coastal and oceanic species, land-based invertebrates, lizards, cryptic species (including some birds) and non-vascular plants using new, advanced and cost-effective techniques	• Completing these inventories will enable more informed environmental and conservation management decisions	5-10
	• Real time and remotely sensed data acquisition followed by automated processing and analysis using AI/ computer vision etc based approaches to monitoring the effectiveness of interventions for biodiversity conservation in terrestrial, freshwater and marine domains (see also PA 2)	• Having these tools and approaches available will improve mapping, monitoring and reporting and enable more informed, real time, decision making	2-5
	• Understanding the role of genetic diversity in the long-term survival of individuals, populations, species and ecosystems	• Consideration of maintenance of genetic diversity will enable more informed conservation management decisions	3-4
	• Classification of ecosystems and habitats using ground-truthed observations and remotely sensed data	• Consistency in describing NZ terrestrial, freshwater and marine ecosystems at a range of spatial scales. Identification of critical supporting habitat, distribution of functional groups and complexity.	2-4
Tools	• Remote, automated and electronic detection tools, and identification technologies (see also PA 2)	• Will enable real time or rapid identification (and monitoring) to inform management needs	1-3
	• Building a 'traffic light' tool to signal the real time state of NZ's biodiversity across all domains	• Will enable real time reporting on the state of NZ's biodiversity	2
	• Decision support tools - based on fit for purpose analytics, adequate storage capacity and accessible data and information integrated into decision making	• Will enable rapid, transparent and evidence-based decision-making based on the state of NZ's biodiversity and ecosystems	2

6.2 Priority Area 2: Innovation in environmental monitoring, evaluation and reporting – understanding the effectiveness of management interventions

Context:

- Our ability to evaluate, adapt and improve management, and to demonstrate the difference being made to the state of biodiversity is an ongoing management necessity, which is poorly researched globally and in NZ.
- Impact rank: 4 – Without these tools, frameworks and disciplined approaches it is difficult to demonstrate management effectiveness. Poor decision making, and conservation loss is almost an inevitable consequence.

Potential conservation gain from the research:

- Better informed, real time based decision making will improve conservation performance and enable more gains to be made.

Management need:

- There is a need to develop remote collection and automated/AI analysis of real time big data, to demonstrate and track the differences being made by management, adapt that management, and to identify where future investment is needed.

	Priority directions	Ultimate conservation outcome	Yrs
Strategic research	• Real time and remotely sensed data acquisition approach and framework that cuts across all potential management interventions, complemented by automated processing and analysis using AI etc	• Having these tools and approaches available will improve management and enable more informed, real time, decision making	2-5
	• Real time and other remotely sensed monitoring of highly mobile species that use New Zealand on a broader landscape or global scale (see also PA12)	• Mapping networks will improve management and enable more informed, real time, decision-making and advocacy for a wide range of taxa that are currently not monitored effectively	5
	• Real time monitoring of indicator/umbrella species	• Intensive monitoring of a small range of indicator species enable more cost-effective decision-making for a wide range of taxa	2-4
Tools			
	• Real time and other remotely sensed monitoring and reporting tools	• Will enable real time monitoring of management effectiveness	1-3
	• Decision support tools - based on fit for purpose analytics, adequate storage capacity and easily accessed data and information integrated into decision making (see also PA 1)	• Will enable rapid, transparent and evidence-based decision-making based on the state of NZ's biodiversity and ecosystems	1-3
	• Specific methods for cryptic threatened species	• Will improve management and enable more informed, real time, decision making for a wide range of taxa and ecosystems that need to be monitored effectively for assessment of risk.	5
	• Building citizen science into cost effective monitoring	• Will increase citizen engagement and reach of monitoring potential	1-4

6.3 Priority Area 3: Tipping points and interactions - understanding and managing the critical drivers of ecosystem health and species population change

Context:

- Ecosystems and species display varying resilience to threats and managing those threats in isolation may have unintended adverse impacts on ecosystem health and populations.
- Impact rank: 5 – lack of knowledge is contributing to a lack of properly informed, proactive decision making thus leading to conservation loss, at scale, across all domains

Potential conservation gain from the research:

- Understanding the interactions among threats and how they vary spatially and temporally is critical to determining when and where ecosystems and species should be managed and the critical thresholds for intervention.

Management need:

- Greater understanding is needed to make effective, appropriate and timely management decisions and to fully understand the consequences of those decisions.

Better knowledge of different tipping points will help decision making for Te Waihora lake openings to the sea

	Priority directions	Ultimate conservation outcome	Yrs
Strategic research	• Understanding the full suite of reasons for decline, how they interact with other threats, how they vary in space and time, and the consequences of managing single threats or suites of threats	• The full range of threats are managed appropriately and effectively for realistic and enhanced conservation outcomes.	10
	• How much do ecosystems vary in condition, and species populations vary, in natural systems, and what are the limits of acceptable change before management intervention is triggered.	• Management intervention is triggered at the appropriate time.	10
	• Understanding the consequences of managing a single pest species (or multiple pest species) on their competitors and predators (see also PA 8)	• The full range of threats are managed appropriately and effectively for beneficial whole-of- ecosystem outcomes	5+
	• Understanding the long-term consequences of mammalian herbivores in native ecosystems, and potential for forest collapse once a threshold is reached (see also PA 8)	• Better knowledge of the relationships between herbivores and their density and other relationships with desired vegetation condition will improve decision making	3-5
Tools	• Fit for purpose, real time informed, management tools that achieve predicted outcomes	• Will enable rapid, transparent and evidence-based decisions to adapt future management	1-3

6.4 Priority Area 4: Securing ecosystem resilience under a changing climate – predicting climate change impacts on ecosystems and species to inform management

Eastern rockhopper penguin - vulnerable to climate change as it relies on the sea's food resources

Context:

- Negative impacts from climate change including more frequent severe storms, and increases or declines in rainfall, wind speed and temperature, are already happening, and impacting on biodiversity, eg, almost all Chesterfield skink habitat was lost in the 2018 West Coast storm.
- Impact rank: 4 - These climate change events and changes will incrementally (and occasionally catastrophically) impact ecosystems (and species).

Potential conservation gain from the research:

- Understanding regional and finer scale impacts on biodiversity will enable managers to make strategic choices about conservation actions in the face of short, medium, longer term climate change impacts, thus improving ecosystem and species resilience.

Management need:

- Improved knowledge, including temporal and spatial, is needed to inform management and policy options

	Priority directions	Ultimate conservation outcome	Yrs
Strategic research	• Finer scale - spatial and temporal - predictions of climate change and potential ecosystem level responses to these changes	• Knowledge that informs policy and management decisions in relation to climate change risks	5+
	• Understanding how climate change will affect native species (and pest species and diseases) and ecosystems, including range shifts, but also how changes in timing, frequency of events affect ecosystem function etc	• Knowledge that informs management decisions	5+
	• Understanding how climate change interacts with other threats to exacerbate ecosystems / species loss. And what are the limits of acceptable change before management intervention is triggered	• Full range of threats are effectively managed for whole-of-ecosystem outcomes.	5+
	• Determining how well our suite of species / ecosystem management practices meet the climate change challenge and what new tools are required	• Knowledge of how to manage climate change risks	1-2
	• 'Develop better understanding of the combined impacts of climate change and socio-economic drivers of change	• Consideration of the impact on NZ's biodiversity and the efficiency of DOC's management strategies and policies under different future scenarios	2-3
Tools			
	• Tool(s) for identifying which ecosystems / species are most at risk	• Options for ecosystem management in the face of climate change	5+
	• Action plan with management decision support tools	• Will enable rapid, transparent and evidence-based decisions to adapt future management, including strategic decision making.	2

6.5 Priority Area 5: Working together to understand the institutional, social, economic and cultural dimensions of biodiversity conservation

Context:

- Achieving desired conservation outcomes requires an appropriate institutional framework supported by a thorough understanding of the tools and approaches that harness social, cultural and economic factors in ways that act to achieve those outcomes.
- Impact rank: 3 - Poorly designed institutional frameworks and the use of inappropriate instruments and approaches can severely compromise the achievement of desired conservation outcomes.

Potential conservation gain from the research:

- This research aims to identify the institutional arrangements that are most likely to deliver the best conservation outcomes.

Management need:

- Managers (including policy makers) need to know the structures, tools and approaches that are most likely to deliver desired outcomes.

	Priority directions	Ultimate conservation outcome	Yrs
Strategic research	• Identification of institutional approaches that promote and/or inhibit the achievement of conservation outcomes	• Delivery of knowledge that results in better structures and approaches to deliver outcomes	3+
	• Approaches for building cultural and social capital leading to better delivery of conservation outcomes	• Delivery of conservation outcomes	3+
Tools			
	• Guidance on the design and implementation of institutional approaches	• Institutional structures and associated approaches delivering optimal conservation outcomes	1-5
	• Guidance on the design and implementation of approaches to building social and cultural capital	• Higher levels of social and cultural capitals are helping deliver improved outcomes	1-5

6.6 Priority Area 6: The human dimensions of biodiversity conservation

Context:

- Conservation problems are fundamentally caused by human behaviour. Understanding and enhancing public behaviour is therefore necessary to mitigate these problems.
- Impact rank: 5 – Many conservation interventions, especially those around introduced pests, weeds, diseases, and involving new or existing but sometimes controversial technologies, involve difficult conversations and the need to gain broad social and cultural acceptance and support. This support when not gained can result in significant conservation loss.

Potential conservation gain from the research:

- Understanding human values and behaviours and how to leverage to achieve desired conservation outcomes will be important to reversing biodiversity loss.

Management need:

- Social licence will be required if DOC and others are to manage cost effectively at scale for ecosystems and for species.

	Priority directions	Ultimate conservation outcome	Yrs
Strategic research	• Social licence for new technologies (e.g., linked to mammalian predators & invasive plant diseases)	• Social licence gained to achieve conservation goals by trialling and where appropriate implementing new technologies	3+
	• Behaviour change to achieve desired conservation outcomes (individual, community, business, government)	• Cost-effective measures taken and working to achieve conservation outcomes	5+
Tools	• Guidelines and processes to enable informed progression of social licence debates	• Will enable essential conservation work to be undertaken	1-5

6.7 Priority Area 7: Solving the terrestrial pest plant problem

Context:

- The current spread of non-native invasive weed species is causing declines in biodiversity through competition and habitat transformation. This threat will only increase as new weed species arrive in NZ.
- Impact rank: 4 – plant pests, e.g., wilding pines in the high country of the South Island, are causing catastrophic biodiversity change and loss at scale.

Spreading wilding conifers on Clarence River, Marlborough

Potential conservation gain from the research:

- Integrated and cost-effective management of the suite of weeds across terrestrial environments will deliver enormous conservation benefits.

Management need:

- For biodiversity conservation to work at scale, in the face of a massively increasing weed problem, new tools and approaches are needed. These must deliver cost effectively at scale, and have long last benefits, to succeed.

	Priority directions	Ultimate conservation outcome	Yrs
Strategic research	• How to restore resilient ecosystems after woody weed control in the presence of exotic herbivores and non-woody weeds.	• We are not replacing one problem with another and native ecosystem protection is assured long term	3
	• Detecting weeds at low densities over large and complex landscapes	• Enhanced detection of weeds opens to door to more cost effective eradication and control strategies	5+
	• Controlling weeds across large and complex landscapes	• When combined with enhanced detection tools, we expect to more precisely target weeds at lower costs and with fewer non-target impacts.	5+
Tools			
	• Refinement/ improvement of existing control and detection tools (e.g. for wilding conifers)	• Enables managers to conduct surveillance, plan interventions and monitor effectiveness to deliver cost-effective weed management.	1-3
	• Tools for weed species not currently managed or not managed at scale	• Will allow conservation gains at scale and cost effectiveness	1-5+

6.8 Priority Area 8: Solving the terrestrial animal pest problem

Context:

- Introduced animal species are having a massive impact on our native biodiversity. Predation (mainly by introduced mammals) is one of the primary causes of biodiversity decline and loss in NZ, especially for our native bird species. Mammalian browsing significantly impacts native vegetation when animal populations reach and exceed threshold densities. And social insects, especially wasps, also have significant ecological impacts.
- Impact rank: 5 – Extremely severe impacts on many native bird, other animals and on native plant species and communities.

Potential conservation gain from the research:

- Successful control of these species will lead to nationwide large-scale conservation gain, including for many threatened and at risk species.

Management need:

- Biodiversity conservation needs new tools that can work at scale and cost-effectively to manage the threats caused by mammalian predation, browsing and social insects.

	Priority directions	Ultimate conservation outcome	Yrs
Strategic research	• Underpinning genomics of key predator species mapped for linked control option exploration (stoat, possum, rat and ferret (and wasps) especially)	• Understanding species' genomics enables more effective exploration of wide ranging control options	3
	• Understanding individual species and guild impacts across ecosystems and species to inform control needs at multiple scales	• Enables managers to confidently target individual or multiple species for desired conservation gains	5+
	• Novel technologies (including biotech) to deliver control at scale, cost-effectively.	• Long term probably the most likely eradication solution and thus contributing to multiple conservation outcomes	5+
	• Building a better understanding of what drives pest pressures (e.g., masting)	• Will enable more strategic targeting of management response initiatives in all masting forest ecosystems	3-5
Tools	• Eradication techniques for urban and production landscapes, including barriers for movement	• Acceptable methods of eradicating pests to achieve conservation outcomes	1-3
	• Remote, automated and electronic detection & monitoring technologies	• Will enable real time surveillance and monitoring to inform management needs	1-3
	• Tools for species not currently managed at scale (pigs, mice, ants, wasps, etc).	• Will allow conservation gains at scale and cost effectiveness	1-5+
	• Refinement/ improvement of existing tools - including alternative baits and improvements to baits and poisons, and better traps	• Will improve cost-effectiveness of management intervention	1-5+

6.9 Priority Area 9: Solving the freshwater pest problem

Context:

- Multiple introduced fish species are having multiple detrimental effects on native fish and on their habitats including in lakes, rivers and in other wetlands. Notable are carp species but also trout in a few specific locations.
- Impact rank: 4 – Some species, e.g., carp, are having very significant negative impacts on habitat and therefore indirectly on native fish populations.

Potential conservation gain from the research:

- Cost effective management of freshwater pests safeguards New Zealand's freshwater biodiversity.

Management need:

- Methods to achieve eradication (or cost-effective control to low levels) of freshwater pests causing the most harm to freshwater species and ecosystems.

	Priority directions	Ultimate conservation outcome	Yrs
Strategic research	• Predicting the future state of freshwater pests in New Zealand	• Future impact of freshwater pests is predictable and informs government and community investment	3-5
	• Pest species impacts on freshwater biodiversity - interactions in multi-stressor environments	• Managers confidently target individual or multiple species for desired conservation gains	5+
	• Freshwater biosecurity risk in a changing world	• Incursion risks and biodiversity impact from all key unwanted organisms is known and effective preventative measures are in place	3-5
	• Novel technologies to deliver freshwater pest control at scale, cost-effectively (see also PA 6)	• Multiple, large-scale freshwater pest control programmes are rolled out and successful	3-5
Tools			
	• Remote, automated and electronic monitoring technologies (See also PA 2)	• World leading technologies are being applied to help solve the freshwater pest problem and delivering tangible biodiversity conservation outcomes	3-5

6.10 Priority Area 10: Solving the marine pest problem

Context:

- Animal and plant (and disease) incursions are significant threats to New Zealand's marine environment. Many arrive at ports and some pose ongoing challenges in terms of eradication, sustained control and prevention of expansion. A key example is Undaria pinnatifida, a brown seaweed, which grows rapidly and excludes many native coastal species - it has been described as the gorse of the sea.
- Impact rank: 4 – marine pests pose major conservation and economic challenges and often occur at scale and due to the nature of the marine environment are very difficult to manage.


Mediterranean fanworm

Potential conservation gain from the research:

- Understanding of the potential impact of marine pests and effective tools for detecting and responding to marine pests will deliver improved conservation outcomes including helping protect New Zealand's diverse marine biodiversity.

Management need:

- Effective, cost effective, timely and targeted responses to incursions.

	Priority directions	Ultimate conservation outcome	Yrs
Strategic research	• Targeted research on the ecological effects of non-indigenous marine species	• Knowledge on effects of marine pests will inform decisions on response, based on risk to species, ecosystems.	5
	• Understanding the potential for climate change to modify pathways to the introduction and spread of invasive marine species (see also PA 4)	• Avoiding or mitigating impacts of marine invasives	5
	• Targeted research on the effects of marine invasives on social, cultural and economic values	• Will assist with determining level and nature of response	5
Tools			
	• Novel tools for rapid detection of marine invasives	• Effective detection tools may allow for more rapid and effective response to incursions, provide for cost savings, allow more widespread monitoring	2
	• Improved tools for responding to marine invasives	• Reducing risk to native biodiversity and associated social, cultural and economic values	3-5
	• Effective methods that address pathways to marine pest introduction and spread	• Minimising introductions and spread of unwanted organisms	3-5

6.11 Priority Area 11: Biosecurity: disease management for ecosystem and species resilience

Context:

- Introduced plant diseases are having significant impacts across NZ. Kauri dieback is threatening one of our iconic species with extinction, and myrtle rust was first recorded in NZ in 2017 and is now widespread and causing significant conservation loss. Other invasive diseases are also present and threatening to both plant and animals in land, freshwater and marine domains, and there are often limited tools for effective control.
- Impact rank: 5 – The negative impacts of some diseases occur at very broad scales and across multiple species, e.g., myrtle rust.


Kauri dieback

Potential conservation gain from the research:

- This research will contribute to current major disease problems, e.g., myrtle rust, to better preparation for future incursions, and to better management of diseases that when managed properly give positive conservation outcomes.

Management need:

- Integrated approaches that inform better and more resilient control options, where possible proactively.

	Priority directions	Ultimate conservation outcome	Yrs
Strategic research	• Genomics of invasive diseases	• Understanding species' genomics enables more effective exploration of wide ranging control options	Ongoing
	• Basic ecology of diseases - range, short and long term impacts: development of rapid assessment techniques	• Enables managers to better understand potential conservation impacts and thus inform pathway management, vectors and control options	Ongoing
	• Novel technologies (including biotech, breeding for resilience) to develop control strategies at scale to cost-effectively sustain desired species	• In the long term probably the most likely eradication/ or sustained control solution and thus contributing to multiple conservation outcomes	Ongoing
Tools			
	• Improved surveillance and detection tools (see also PA 1)	• Will enable real time surveillance and monitoring to inform management needs	1-3
	• Improved control tools	• Will enable on-the-ground management to protect species and ecosystems	5-10
	• Pathway and vector management tools	• Restrict disease distribution to enable feasible site based control techniques to operate effectively	5

6.12 Priority Area 12: Developing effective tools and actions for managing populations of migratory and widespread species

Context:

- Internationally migratory species including shore birds (e.g., godwit/koaka), marine mammals (blue whale), and freshwater eels (e.g., long-finned tuna), and within New Zealand migratory species (e.g., wrybill plover/ngutu pare) face multiple ecological challenges and multiple jurisdictional and other issues in ensuring their conservation.
- Impact rank: 3 – Global and domestic scale issues requiring a strategic integrated approach to management.

Potential conservation gain from the research:

- The tools and knowledge required to provide a dynamic, effective, coordinated and targeted management approach to species that occur over wide distributional extents.

Management need:

- A coordinated and targeted approach is required for effective management of species that occur over large geographic scales

	Priority directions	Ultimate conservation outcome	Yrs
Strategic research	• Identifying critical habitats, including migratory corridors and ecological connections	• Provide underpinning data to support management decisions and meeting commitments under international agreements.	5
	• Development of management approaches, including across jurisdictions, for migratory and widespread species	• Implementing the most effective, efficient management measures to ensure long term persistence of these species	5
	• Future-proofing management of widespread and migratory species in the face of environmental change (see also PAs 3 and 4)	• Forecasting required management measures to maximise long term persistence of these species	5
Tools			
	• Prioritising management of widespread and migratory species at scale	• Application of management measures to maximise impact on species	5
	• Dynamic management techniques for migratory and widespread species: real-time threat mitigation	• Gathering fine-scale environmental and biological data to inform species management; real-time management of impacts.	5
	• Improved quantification of risk to inform species conservation	• Mitigation of key threats to widespread and migratory species	5

6.13 Priority Area 13: Production landscapes for environmental outcomes–determining the current and potential contribution to biodiversity conservation

Context:

- From an Ecosystem Services or Natural Capital perspective New Zealand is essentially a production landscape. Thinking in terms of producing conservation outcomes could result in more informed discussion with traditional 'producers', and the opportunities to better integrate biodiversity conservation into the broader production landscape.
- Impact rank: 3 – intensification, and simplification, of land, freshwater and marine space use is threatening the resilience of nature conservation at scale.

Potential conservation gain from the research:

- Large scale consideration of such possibilities and the pragmatics supporting them will lead to landscape change enhancing biodiversity conservation and delivering a range of other ecosystem services.

Management need:

- Biodiversity conservation (which is a form of production) working at scale needs new tools and approaches that can be integrated within an overall production (typically economic frame) context.

	Priority directions	Ultimate conservation outcome	Yrs
Strategic research	• Visualisation and scenario modelling, linked to ecosystem services and economic modelling, to inform biodiversity conservation integration into production systems at scale	• Decision support enabling biodiversity conservation to be much better integrated into 'production' landscapes (including freshwater, and marine)	3-5
	• Co-benefits for biodiversity and water quality in multi-functional landscapes	• As above - plus environmental outcomes are framed in production contexts	2-3
	• Transitioning to mosaics of land use - how can "conservation" incentives drive land use change?	• Land users are incentivised to integrate water quality/biodiversity gains into farming systems	3-5
	• Incorporating natural values into interoperable modelling frameworks	• Increasing prediction capacity and reliability enhances system performance	2-3
	• "Regenerative" farming - scaling up biological processes for multiple outcomes	• Resilience in terms of both production systems and ecosystems is enhanced	3-5
Tools			
	• Guidelines for better integrating biodiversity conservation into production systems	• Guidelines that can be used with 'producers' to increase conservation outcome investment	1-3
	• Decision Support Tool for 'production' system user to enable biodiversity conservation integration to be maximised	• A tool that can be used alongside producers to assist with conservation related decision making	1-3

6.14 Priority Area 14: Connecting people to biodiversity conservation in the urban environment

Context:

- Over 80% of New Zealanders, including most recent migrants, live in urban environments. These environments typically have a very poor state of indigenous biodiversity. There is an opportunity to better engage urban residents in biodiversity conservation importance by involving them in biodiversity restoration.
- Impact rank: 3 – Biodiversity loss in urban environments is often extreme.

Potential conservation gain from the research:

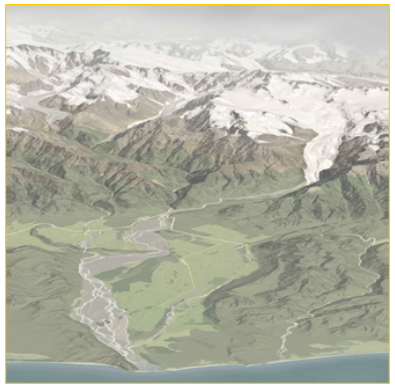
- Engaging with diverse urban populations with programmes that improve investment and performance in terms of achieving biodiversity conservation outcomes, e.g., in parks, estuaries, urban streams, at home, will greatly increase social capital and enhance natural capital and biodiversity conservation achievement.

Management need:

- Tools and approaches for engaging more successfully with urban populations to achieve biodiversity conservation in urban environments, and elsewhere.

	Priority directions	Ultimate conservation outcome	Yrs
Strategic research	• Cost effective co-design and implementation of 'urban' biodiversity inclusion processes that build social and cultural capital, while respecting the existence of economic capital	• Co design will lead to innovative and manageable ideas and approaches that will deliver significant nature conservation outcomes within the urban environment	3-5
	• How to develop a 'connected' and functioning biodiversity-urban ecosystem	• An operational model of an urban biodiversity system will enable planning and implementation to achieve biodiversity conservation	3-4
	• Identification of critical ecological factors, including positive and negative tipping points, which are inhibiting and promoting biodiversity (species, communities and ecosystems) in urban environments	• Understanding critical success factors will enable better and more cost effective planning to deliver biodiversity conservation outcomes	3
Tools			
	• Planning tools that enable urban biodiversity at scale across communities	• Tools that when applied deliver significant biodiversity conservation outcomes across the urban landscape	1-3

6.15 Priority Area 15: Restoring New Zealand's vulnerable freshwater and estuarine ecosystems



Context:

- Estuaries and harbours, many wetlands and many rivers and lowland lakes are deteriorating in multiple ways, including in terms of their indigenous biodiversity (e.g., Te Waihora, Kaipara Harbour). Restoration of some will be extremely challenging while efforts in others will be expensive and ongoing.
- Impact rank: 5 - Increasing number of lakes, rivers, wetlands and estuaries across New Zealand are in a degraded state, with many sites not able to be restored due to the severity of impact.

Potential conservation gain from the research:

- More cost-effective restoration (operational and policy based) that delivers essential biodiversity conservation outcomes at greater scales.

Management need:

- Evidence to improve policy-based efforts to reduce adverse effects of land use change on freshwater and estuarine environments. Aquatic restoration options (specific to hydrosystem) tested, scalable and integrated into catchment management.

	Priority directions	Ultimate conservation outcome	Yrs
Strategic research	• Critical drivers of freshwater and estuarine ecosystem decline (see also PA 3 and 4)	• Management actions reduce all key pressures through targeted management prescriptions (by ecosystem type and place)	5+
	• Predicting the future state of freshwater and estuarine ecosystems in New Zealand (see also PA 1)	• Future of freshwater/estuarine ecosystems is predictable and informs government and community investment	3-5
	• Resolving legacy impacts on aquatic ecosystems - interrupting and resetting processes that sustain biotic and abiotic pressures	• Freshwater and estuarine systems that are highly degraded are 'reset' through innovative solutions	5+
	• Trade-offs. The social, environmental and cultural values of aquatic ecosystems under different scenarios	• Cost-benefit of aquatic management decisions is known for all projects	1-3
Tools			
	• Remote sensing of freshwater and estuarine ecosystems - inventory, monitoring and management performance (see also PA1 & 2)	• High-quality remote data is the basis for targeted biodiversity interventions and national monitoring and reporting	3-5
	• Management techniques to scale-up the restoration of aquatic ecosystems in New Zealand including prevention of impacts by informed land use planning.	• Multiple, large-scale freshwater and estuarine restoration initiatives are rolled out and successful and landuse changes damaging to freshwater, estuarine and marine ecosystems are avoided	5+
	• Aquatic ecosystem models - state, pressure, response	• Accessible models are applied to all systems that examine tradeoffs and identify restoration options	3-5

6.16 Priority Area 16: Protecting New Zealand's freshwater species – understanding drivers of freshwater decline and critical pathways for recovery

Context:

- New Zealand's freshwater fish and invertebrate fauna and flora are globally specialised. Notably also many freshwater fish species are classified as 'threatened' or 'endangered' including some species currently subject to harvest pressure.
- Impact rank: 4 – For migratory and non-migratory species there are major pressures and concerns that are unresolved.

Potential conservation gain from the research:

- An integrated approach to gaining and applying essential knowledge will help build a resilient approach to species and habitat
- conservation.

Management need:

- More definitive species information and new techniques to help achieve freshwater species recovery at scale, including novel management approaches and tools for rapid assessment of state and trend.

	Priority directions	Ultimate conservation outcome	Yrs
Strategic research	• Critical drivers of freshwater threatened species decline (see also PA 3)	• Management actions reduce all key pressures through targeted management prescriptions (by species, by place)	5+
	• Resilience of harvested and mahinga kai species	• Information base guides policy and management response to ensure long-term resilience of harvested/mahinga kai species, and improved conservation status.	5+
	• Pathways to achieve recovery of nationally critical species (see also PA 3)	• Removal of freshwater species from nationally critical status	3-5
	• Environmental flows, water levels and aquatic connectivity - species response models	• Hydrological-species responses are known for all freshwater systems across NZ - enabling improved catchment management	3-5
	• Environmental tolerances of threatened species (see also PA 4)	• Environmental tolerances known for majority of species - enabling informed policy and management	3-5
	• Taxonomic resolution of indeterminate species (see also PA 1)	• Species are described and distribution understood to inform policy and management directions	3-5
Tools	• Rapid inventory and monitoring of threatened, at-risk species and data deficient species (see also PA 1 & 2)	• Step-change in data gathering tools and the data underpinning conservation status assessment for freshwater species	1-3
	• Population models to predict changes in freshwater species in response to policy and management (see also PA 2)	• Benefits of policy initiatives and investment in freshwater management are predictable in advance	3-5
	• Species recovery methods that can be applied at scale	• Multiple freshwater species recovery programmes are rolled out and successful	5+

6.17 Priority Area 17: Achieving spatial protection for marine species, habitats and ecosystems

Context:

- Suboptimal spatial protection may not provide adequate protection for representative and important marine features. This could unnecessarily impact users of the marine environment and may fail to fully account for the range of uses and values associated with marine species.
- Impact rank: 4 - Sub optimal approaches lead to poor decision making in the face of mounting pressures on the marine environment.

Potential conservation gain from the research:

- Optimised protection of marine biodiversity, underpinned by a sound information base.

Management need:

- Better information/tools for optimising protection will increase our efficiency in meeting domestic and international targets for marine protection and help inform the refinement of legislative and policy approaches.

	Priority directions	Ultimate conservation outcome	Yrs
Strategic research	• Identification of key ecological areas and patterns of marine biodiversity	• Robust underpinning data on areas of conservation importance and patterns in biodiversity will ensure spatial protection for species and habitats is implemented in a more effective way	2
	• Future-proofing marine conservation management by taking into account emerging threats to biodiversity and climate change effects	• Knowledge of the effect of climate change and emerging threats on achieving a representative network of spatial protection and species management would improve resilience	2
	• Understanding protected areas network effectiveness and viability (see also PA 2)	• Enhancement of MPA network performance	4
	• Quantifying the ecosystem services of marine biodiversity and natural ecosystems (see also PA 5)	• Information on marine ecosystem value will improve planning processes, support better decision-making and also inform the Govt's assessment of the impact of establishing spatial protection.	4
	• Incorporating marine spatial protection into a broader integrated approach to management of NZ's environment	• An integrated approach may provide more effective outcomes for biodiversity	5
Tools			
	• Improving NZ's marine information systems, providing ready access to tools and consolidated information for marine planning	• Access to consolidated data and delivery of platforms, e.g., SeaSketch to facilitate this will provide for more robust and efficient planning processes, including at national- and regional-scales	1
	• Meeting Maori objectives for marine biodiversity conservation	• Demonstrating commitment to achieving the objectives of Treaty partners for biodiversity conservation	5
	• Dynamic approaches to marine conservation management	• Novel, more dynamic approaches to conservation may be more effective than traditional spatial approaches to management	5
	• Tools for evaluating network effectiveness	• Being able to evaluate network performance will enable us to determine if the network is achieving objectives such as the protection of species and habitats or the maintenance of ecological processes.	3

7 Strategies to ensure the research is undertaken

This Prospectus and its component priority areas provide multiple opportunities for traditional and innovative investment, design and implementation pathways. And while the Prospectus represents the priorities for Aotearoa as a whole the Department of Conservation (working alongside MfE and MPI) will take responsibility for coordinating the promotion and achievement of the research proposed. To this end it has agreed to undertake the following:

1. Look to the implementation plan of the ANZBS for guidance on improving the incorporation of mātauranga Māori into research. In the meantime, seek opportunities to better connect and afford equal status between mātauranga Māori and western science on a project-by-project basis through engagement.

2. Work with Natural Resource Sector (NRS) agencies and Regional Councils to promote, participate in, and where appropriate contribute resources to the research mapped in this Prospectus.

3. Work with the NRS and MBIE to develop and implement an 'applied' research fund as a mechanism to assist funding the priority research areas.

4. Support establishment of a dedicated 'biodiversity (or equivalent) operational research fund' focused on management application tools.

5. To allocate a specific fund for early career development in the tertiary education sector (Masters and PhD). This fund should be used to encourage capacity building in the conservation management sector based on the priorities in this document

6. Investigate other funding mechanisms for Priority Areas/projects that are struggling to access funding through traditional channels.

8 Appendices

8.1 Appendix 1: Science Prospectus Priorities and the ANZBS long term Goals

Priority Research Areas	Relevant ANZBS 2050 goal(s)
The state of New Zealand's biodiversity from genepools to ecosystems - understanding and mapping the state and trend of indigenous biodiversity	Comprehensive baseline information integrated with spatial information and knowledge about effective management is informing the adaptive management of species and ecosystems
Innovation in environmental monitoring and reporting – understanding the effectiveness of management interventions	Improved systems for knowledge, science, data and innovation inform our work
Tipping points and interactions - understanding and managing the critical drivers of ecosystem health and species population change	The cumulative effects of pressures on biodiversity have been reduced to a level that does not have significant detrimental effects on biodiversity
Securing ecosystem resilience under a changing climate – predicting climate change impacts on ecosystems and species to inform management	Adaptive management is addressing the impact of climate change on biodiversity, including cascading effects, and is building resilience to future risks
Working together to understand the institutional, social, economic and cultural dimensions of biodiversity conservation	All New Zealanders have the skills, knowledge and capability to be effective
The human dimensions of biodiversity conservation	
Solving the terrestrial animal pest problem	Aotearoa New Zealand is free from ferrets, weasels, stoats, possums and rats Introduced browsers, including valued introduced species, have been removed from high priority biodiversity areas and threatened ecosystems and are under ongoing management elsewhere to maintain functioning ecosystems and cultural and recreational values
Solving the terrestrial pest plant problem	Introduced biosecurity threats, including weeds, animal pests and diseases (e.g. introduced invasive plants, algae, mammals, fish, invertebrates and micro-organisms), in all domains have been eradicated or are being managed to reduce negative impacts in areas of high biodiversity value
Solving the freshwater pest problem	
Solving the marine pest problem	
Biosecurity: disease management for ecosystem and species resilience	
Developing effective tools and actions for managing populations of migratory and widespread species	Indigenous species have expanded in range, abundance and genetic diversity and are more resilient to pressures, including climate change
Protecting New Zealand's freshwater species – understanding drivers of freshwater decline and critical pathways for recovery	
Production landscapes for environmental outcomes–determining the current and potential contribution to biodiversity conservation	Sustainable use practices are providing benefits for indigenous biodiversity and maintaining ongoing economic and wellbeing benefits for people

Connecting people to biodiversity conservation in the urban environment	Indigenous vegetation planting is standard practice in urban areas, riparian zones, agricultural buffers, transport corridors and other areas
Restoring New Zealand's vulnerable freshwater and estuarine ecosystems	An interconnected series of indigenous land, wetland and freshwater ecosystems have been restored to a 'healthy functioning' state and are connected to marine and coastal ecosystems
Achieving spatial protection for marine species, habitats and ecosystems	2035: An effective network of marine protected areas and other tools, including marine and coastal ecosystems of high biodiversity value is established and is meeting the agreed protection standard

8.2 Appendix 2. Links between the Priority research Areas and the Conservation and Environment Science Roadmap, and to DOC's Stretch goals

	Research priority areas	Thematic and related links to the Conservation and Environment Science Roadmap	Links to DOC's Stretch goals
1	The state of New Zealand's biodiversity from genepools to ecosystems - understanding and mapping the state and trend of indigenous biodiversity	*Species and populations* - Improved tools for completing taxonomic inventories of coastal and oceanic species and land-based invertebrates.	90% of our threatened species across New Zealand's ecosystems are managed to enhance their populations A nationwide network of marine protected areas is in place, representing New Zealand's marine ecosystems
2	Innovation in environmental monitoring and reporting – understanding the effectiveness of management interventions	*Environmental monitoring* - New and improved tools for gathering and reporting data on condition and trends for our land, freshwater, air and marine environments.	90% of our threatened species across New Zealand's ecosystems are managed to enhance their populations A nationwide network of marine protected areas is in place, representing New Zealand's marine ecosystems
3	Tipping points and interactions - understanding and managing the critical drivers of ecosystem health and species population change	*Integrated ecosystems* - Predicting environmental thresholds and tipping points so we can look after our natural ecosystems better. - Models and data that help communities make resource management decisions that have implications across our land, freshwater and marine ecosystems.	90% of our threatened species across New Zealand's ecosystems are managed to enhance their populations
4	Securing ecosystem resilience under a changing climate – predicting climate change impacts on ecosystems and species to inform management	*Climate change* - Adaptation and mitigation scenarios that test and demonstrate the sensitivity of New Zealand's environment, economy, and society to climate-related impacts and extreme events.	
5	Working together to understand the institutional, social, economic and cultural dimensions of biodiversity conservation	*Social and economic factors* - How to build social and cultural capital to manage the environment more effectively (including the acceptance of new technologies).	Whānau, hapū and iwi are able to practise their responsibilities as kaitiaki of natural and cultural resources on public conservation lands and waters

		- Comprehensive models of New Zealanders' values, beliefs and understanding of conservation and the environment.	
6	The human dimensions of biodiversity conservation	*Social and economic factors* - How to build social and cultural capital to manage the environment more effectively (including the acceptance of new technologies). - Comprehensive models of New Zealanders' values, beliefs and understanding of conservation and the environment.	90% of New Zealanders' lives are enriched through connection to our nature
7	Solving the terrestrial pest plant problem	*Species and populations* - Cost-effective technologies to manage the threats to native species, particularly to help achieve the 'predator-free New Zealand 2050' goal. *Biosecurity* - Widely accepted and affordable solutions to invasive pests, weeds and diseases that have high-risk conservation, economic or health implications.	50% of New Zealand's natural ecosystems are benefiting from pest management
8	Solving the terrestrial animal pest problem	*Species and populations* - Cost-effective technologies to manage the threats to native species, particularly to help achieve the 'predator-free New Zealand 2050' goal. *Biosecurity* - Widely accepted and affordable solutions to invasive pests, weeds and diseases that have high-risk conservation, economic or health implications.	50% of New Zealand's natural ecosystems are benefiting from pest management
9	Solving the freshwater pest problem	*Species and populations* - Cost-effective technologies to manage the threats to native species, particularly to help achieve the 'predator-free New Zealand 2050' goal. *Biosecurity* - Widely accepted and affordable solutions to invasive pests, weeds and diseases that have high-risk conservation, economic or health implications.	50% of New Zealand's natural ecosystems are benefiting from pest management
10	Solving the marine pest problem	*Species and populations* - Cost-effective technologies to manage the threats to native species, particularly to help achieve the 'predator-free New Zealand 2050' goal. *Biosecurity*	50% of New Zealand's natural ecosystems are benefiting from pest management

		- Widely accepted and affordable solutions to invasive pests, weeds and diseases that have high-risk conservation, economic or health implications.	
11	Biosecurity: disease management for ecosystem and species resilience	*Species and populations* - Cost-effective technologies to manage the threats to native species, particularly to help achieve the 'predator-free New Zealand 2050' goal. *Biosecurity* - Widely accepted and affordable solutions to invasive pests, weeds and diseases that have high-risk conservation, economic or health implications.	50% of New Zealand's natural ecosystems are benefiting from pest management 90% of our threatened species across New Zealand's ecosystems are managed to enhance their populations
12	Developing effective tools and actions for managing populations of migratory and widespread species	*Integrated ecosystems* - Predicting environmental thresholds and tipping points so we can look after our natural ecosystems better. *Coasts and oceans* - Understanding present and future threats to these habitats, including from climate change, and assessing management options.	90% of our threatened species across New Zealand's ecosystems are managed to enhance their populations
13	Production landscapes for environmental outcomes– determining the current and potential contribution to biodiversity conservation	*Freshwater* - A better understanding of how contaminants, including excess sediment, affect ecosystems, human health, and recreation to inform how we manage urban and rural land and water use. - Improved understanding of how our use of land affects freshwater quality and ecosystems *Coasts and oceans* - Identifying key marine habitats that provide for the values we hold for biodiversity, traditional food gathering (kaimoana), recreation, and commercial fisheries. - Understanding present and future threats to these habitats, including from climate change, and assessing management options. *Integrated ecosystems* - Predicting environmental thresholds and tipping points so we can look after our natural ecosystems better. - Models and data that help communities make resource management decisions that have implications across our land, freshwater and marine ecosystems.	90% of New Zealanders' lives are enriched through connection to our nature

14	Connecting people to biodiversity conservation in the urban environment	*Social and economic factors* - How to build social and cultural capital to manage the environment more effectively (including the acceptance of new technologies). - Comprehensive models of New Zealanders' values, beliefs and understanding of conservation and the environment.	90% of New Zealanders' lives are enriched through connection to our nature
15	Restoring New Zealand's vulnerable freshwater and estuarine ecosystems	*Freshwater* - A better understanding of how contaminants, including excess sediment, affect ecosystems, human health, and recreation to inform how we manage urban and rural land and water use. - Improved understanding of how our use of land affects freshwater quality and ecosystems.	90% of our threatened species across New Zealand's ecosystems are managed to enhance their populations 50 freshwater ecosystems are restored from 'mountains to the sea'
16	Protecting New Zealand's freshwater species – understanding drivers of freshwater decline and critical pathways for recovery	*Integrated ecosystems* - Models that assess the effectiveness of interventions, particularly freshwater restoration programmes, including whitebait fisheries.	50 freshwater ecosystems are restored from 'mountains to the sea'
17	Achieving spatial protection for marine species, habitats and ecosystems	*Coasts and oceans* - Identifying key marine habitats that provide for the values we hold for biodiversity, traditional food gathering (kaimoana), recreation, and commercial fisheries. - Understanding present and future threats to these habitats, including from climate change, and assessing management options.	A nationwide network of marine protected areas is in place, representing New Zealand's marine ecosystems