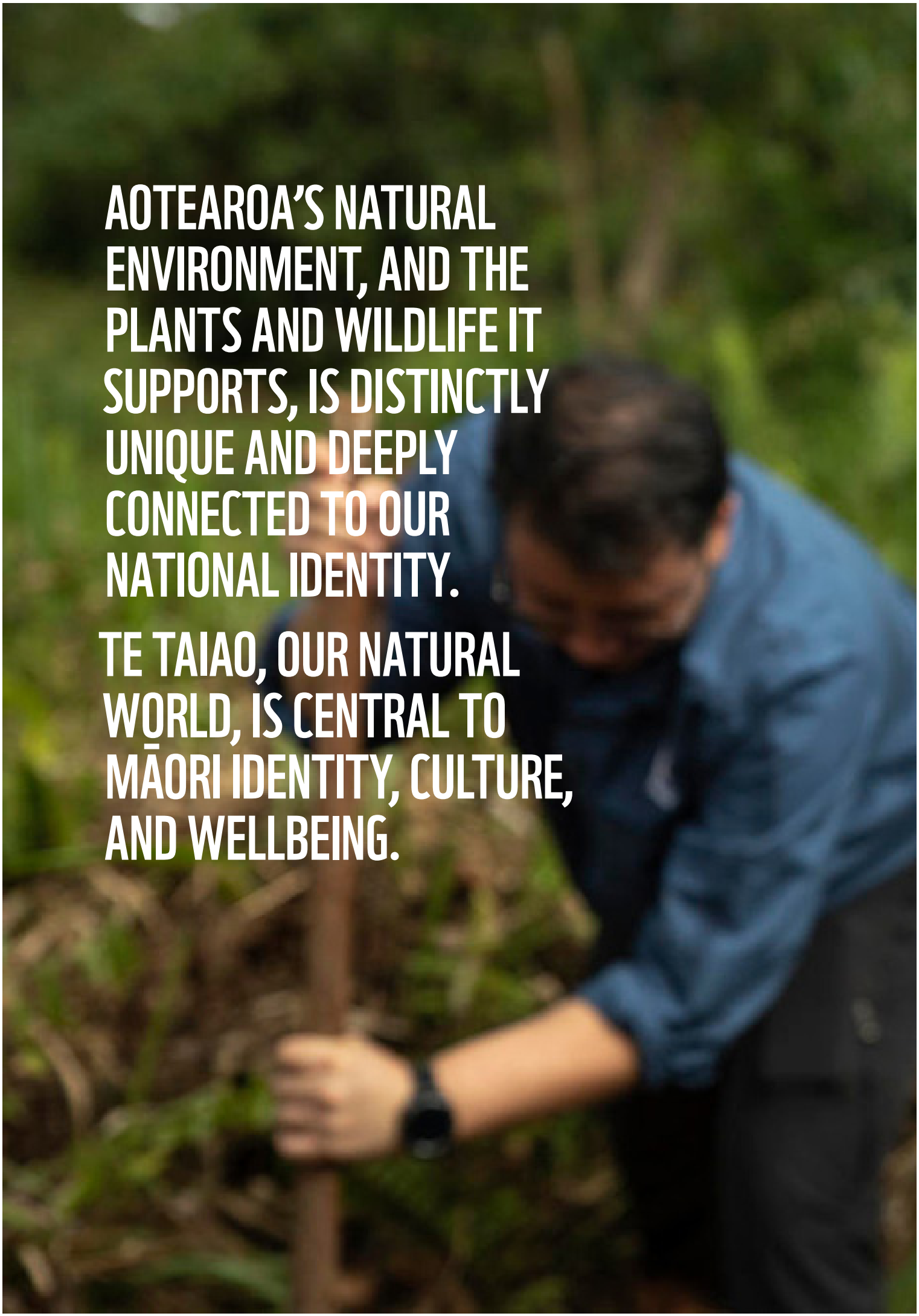
A NATURE POSITIVE AOTEAROA

Economic Analysis of Aotearoa New Zealand's Nature Opportunity

October 2024


AOTEAROA'S NATURAL ENVIRONMENT, AND THE PLANTS AND WILDLIFE IT SUPPORTS, IS DISTINCTLY UNIQUE AND DEEPLY CONNECTED TO OUR NATIONAL IDENTITY.
TE TAIAO, OUR NATURAL WORLD, IS CENTRAL TO MĀORI IDENTITY, CULTURE, AND WELLBEING.

RELEASE NOTICE

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PREFACE

Healthy nature is central to human health, wellbeing and our economy. When nature is thriving, people are too. Aotearoa's natural environment, and the plants and wildlife it supports, is distinctly unique and deeply connected to our national identity. Te Taiao, our natural world, is central to Māori identity, culture, and wellbeing

IT'S IN ALL OUR INTERESTS TO PROTECT OUR MOST IMPORTANT ASSET: NATURE.

But nature is in trouble. Per capita, Aotearoa New Zealand has the highest proportion of threatened species globally – with over a third (approximately 4,000) of our indigenous species now threatened or at risk of extinction.[1,2] What's more, increasingly severe and frequent climate-related weather events are showing us the enormous cost of climate change and pushing our native species even closer to the brink. Cyclone Gabrielle was not only the second most costly disaster in Aotearoa New Zealand's history[3] – it also had a widespread adverse impact on our native species.[4] In Hawke's Bay alone, the population of the threatened tūturiwhatu/New Zealand dotterel declined by 36% – the most significant decline ever observed for the species in that region.[5]

Ina raru ana Te Taiao, kei te raru hoki tatou. When nature is in trouble, so are we. The reality is that Aotearoa New Zealand is on the front lines of the twin crises of climate change and nature loss. We need nature to survive – and prosper, but despite this confronting reality, the case for urgently addressing nature loss in Aotearoa is still poorly understood.

WWF New Zealand is a not-for-profit, environmental non-governmental organisation, and part of the international environmental organisation WWF (World Wide Fund for Nature). WWF is the world's leading conservation organisation, and is active in over 100 countries.

Globally, WWF has been a leading voice on the development of tools and approaches to support a nature-positive future, particularly through the negotiation of the Kunming-Montreal Global Biodiversity Framework, as a co-founder of the Taskforce on Nature-related Financial Disclosures, and as a member and convenor of the Nature Positive Initiative. In Aotearoa New Zealand, WWF advocates for the establishment of the enabling conditions required to support our domestic transition to a nature-positive future and supports the uptake of nature-positive practice by industry with tools like the WWF Biodiversity Risk Filter.[6]

WWF New Zealand and EY New Zealand have partnered to deliver this report on the costs of advancing critical actions to halt and reverse biodiversity decline in Aotearoa by 2030, along with the costs of inaction. The scale of halting and reversing biodiversity decline means that many hands are needed. We illustrate the roles that different actors – such as government, industry, tangata whenua, and communities – have in supporting critical actions. The report highlights the opportunities and risks for some of our key industries and identifies the enabling conditions businesses need to make nature-positive changes in their supply chains.

Nature-positive action by industry can have wide-reaching impact and also give our businesses and industries a point of competitive advantage. It's in all our interests to protect our most important asset: nature.

ABOUT THIS REPORT

This Report focuses on five of the 23 Kunming-Montreal Global Biodiversity Framework Targets (the "Targets") and looks at the economic impacts, challenges and opportunities of achieving these Targets in Aotearoa New Zealand. These five Targets were selected based on their critical importance to Aotearoa New Zealand and are outlined in Table 1.

This report is:

- An economic analysis of the first order ecological impacts for Aotearoa New Zealand by taking certain actions to meet four of the 2030 Targets guided by bottom-up research
- An exploration of the Nature Finance Gap and potential pathways to overcome it
- A deep dive into the nature-related challenges and opportunities for key primary industry sectors of our economy
- A conversation starter aimed at elevating and accelerating the discussion on the benefits of, and need for investment into, nature-positive projects
- An invitation to collaborate and gain further insights into the economic relationships within this report and the challenges and opportunities for action

This report is not:

- A definitive and complete assessment of the costs and benefits associated with taking action to restore nature in Aotearoa New Zealand and meet the GBF Targets
- A set of recommendations on which nature actions in particular should be taken, who should be responsible for the costs and investments, and how the redistributive impacts of the actions should be addressed
- A summary of actions and economic impacts co-designed through extensive stakeholder consultation

Target 2:

Restore 30% of all degraded ecosystems

Target 3:

Conserve 30% of land, waters and seas

Target 4:

Halt species extinction, protect genetic diversity, and manage human-wildlife conflicts

Target 6:

Reduce the introduction of invasive alien species by 50% and minimise their impact

Target 10:

Enhance biodiversity and sustainability in agriculture, aquaculture, fisheries, and forestry

Table 1: Kunming-Montreal Global Biodiversity Framework Targets explored through this report

Target 2: Restore 30% of all Degraded Ecosystems

Ensure that by 2030 at least 30 per cent of areas of degraded terrestrial, inland water, and marine and coastal ecosystems are under effective restoration, in order to enhance biodiversity and ecosystem functions and services, ecological integrity and connectivity.

Why this is important for Aotearoa New Zealand

In Aotearoa New Zealand, 66% of our native forest cover and 90% of our wetlands have been lost since the arrival of humans. Urban expansion and pastoral farming continue to reduce the space for indigenous habitats. Restoring land, freshwater and marine ecosystems is essential to enhance ecosystem services, ecological integrity and connectivity.

Target 3: Conserve 30% of Land, Waters and Seas

Ensure and enable that by 2030 at least 30% of terrestrial and inland water areas, and of marine and coastal areas, especially areas of particular importance for biodiversity and ecosystem functions and services, are effectively conserved and managed through ecologically representative, well-connected and equitably governed systems of protected areas and other effective area-based conservation measures, recognising indigenous and traditional territories, where applicable, and integrated into wider landscapes, seascapes and the ocean, while ensuring that any sustainable use, where appropriate in such areas, is fully consistent with conservation outcomes, recognising and respecting the rights of indigenous peoples and local communities, including over their traditional territories. Target 3, or '30 by 30', is the global flagship protected areas Target emerging from the Kunming-Montreal Global Biodiversity Framework.

Why this is important for Aotearoa New Zealand

Target 3, or '30 by 30', is the global flagship protected areas Target emerging from the Kunming-Montreal Global Biodiversity Framework. Establishing protected areas is one of the most effective ways to preserve biodiversity. In Aotearoa New Zealand, while over 30% of our land is a part of the Protected Areas Network, less than 0.5% of our ocean territory is highly protected and only 17 freshwater ways are protected. To contribute to this flagship Target, significant steps need to be taken to protect our freshwater and marine ecosystems.

Target 4: Halt Species Extinction, Protect Genetic Diversity, and Manage Human-Wildlife Conflicts

Ensure urgent management actions to halt human induced extinction of known threatened species and for the recovery and conservation of species, in particular threatened species, to significantly reduce extinction risk, as well as to maintain and restore the genetic diversity within and between populations of native, wild and domesticated species to maintain their adaptive potential, including through in situ and ex situ conservation and sustainable management practices, and effectively manage human-wildlife interactions to minimise human-wildlife conflict for coexistence.

Why this is important for Aotearoa New Zealand

Aotearoa New Zealand has the highest proportion of threatened native species in the world. 94% of our reptile species, 82% of bird species, 80% of bat species, 76% of freshwater fish species, and 46% of vascular plant species are either facing extinction or are at risk of being threatened with extinction. To stop irreversible losses to our biodiversity we need to halt extinctions of our native species.

Target 6: Reduce the Introduction of Invasive Alien Species by 50% and Minimise Their Impact

Eliminate, minimise, reduce and/or mitigate the impacts of invasive alien species on biodiversity and ecosystem services by identifying and managing pathways of the introduction of alien species, preventing the introduction and establishment of priority invasive alien species, reducing the rates of introduction and establishment of other known or potential invasive alien species by at least 50 per cent by 2030, and eradicating or controlling invasive alien species, especially in priority sites, such as islands.

Why this is important for Aotearoa New Zealand

One of the main threats to biodiversity in Aotearoa New Zealand is from invasive species. Aotearoa New Zealand is considered, from an ecological perspective, one of the most invaded countries in the world and these invasive species threaten our native biodiversity through competition, predation, and diseases. Reducing the introduction of new species and eradicating the most negatively impactful invasive speciesv is key to reaching better biodiversity outcomes in Aotearoa New Zealand.

Target 10: Enhance Biodiversity and Sustainability in Agriculture, Aquaculture, Fisheries, and Forestry

Ensure that areas under agriculture, aquaculture, fisheries and forestry are managed sustainably, in particular through the sustainable use of biodiversity, including through a substantial increase of the application of biodiversity friendly practices, such as sustainable intensification, agroecological and other innovative approaches contributing to the resilience and long-term efficiency and productivity of these production systems and to food security, conserving and restoring biodiversity and maintaining nature's contributions to people, including ecosystem functions and services.

Why this is important for Aotearoa New Zealand

Primary industries in Aotearoa New Zealand make up 7% of our economy and earn annual export revenue of NZD$54.6 billion (2024). Additionally, they are highly dependent on and impactful to our natural environment.

Summary of sections

01 Introduction, we provide an overview of key concepts underpinning this research, such as Natural Capital and the Kunming-Montreal Global Biodiversity Framework (GBF).

02 Our Approach, we introduce the complexity of valuing nature and our approach to our economic and case study analysis.

03 Modelling results and findings, we explore the results of our economic analysis, including the long-term economic impacts of Aotearoa New Zealand taking action towards selected biodiversity Targets set out in the GBF.

04 Primary sector deep dive, we investigate the sectoral impacts to key primary industries, along with actions that could be taken to overcome sectoral challenges and realise these opportunities.

05 Closing the Investment Gap, we outline the Nature Finance Gap, existing barriers to investment in nature and the opportunities to enable investment and unlock economic value.

EXECUTIVE SUMMARY

Nature is central to our wellbeing, culture and identity as a nation. 'Clean and green' is Aotearoa New Zealand's global brand and our relationship with Te Taiao / the natural world is one of our defining characteristics as a nation. Primary industries, which are heavily reliant on nature, make up 7% of our economy, and much of our important tourism industry also depends on Aotearoa New Zealand's natural capital.[7]

What will happen if we fail to stop and reverse the decline in Aotearoa New Zealand's landscapes, ecosystems, flora and fauna: the things that underpin our global brand, our collective identity, and our economy?

Human activities, including direct exploitation, changes in the way we use our land and oceans, and the impact of invasive species, pollution, and climate change, have led to an alarming decrease in the amount and variety of life on Earth,[8] and in Aotearoa New Zealand particularly.[9] The rate of biodiversity loss is higher now than in any other time in human history.[10] Global experts in academia, business, government and civil society believe that biodiversity loss and ecosystem collapse will be the third most severe risk to humanity in the next decade.[11] This crisis is generating significant but largely overlooked risks to the economy, the financial sector and the wellbeing of current and future generations.

This Report delves into five[12] of the 23 Kunming-Montreal Global Biodiversity Framework Targets and looks at the economic impacts, challenges and opportunities of achieving these Targets for Aotearoa New Zealand. Our analysis has shown that the benefits of taking action towards these Targets could exceed the upfront and ongoing costs required to meet the Targets and provides a net benefit to Aotearoa New Zealand's economy over a 50-year period from 2025 to 2080 of an estimated NZD$271.8 billion (NPV 2023).[13] This benefit is driven both by protecting Aotearoa New Zealand from impacts associated with nature decline (avoided costs of inaction) and through the realisation of additional opportunities provided through a thriving natural environment.

Protecting nature could save Aotearoa New Zealand more than $270 billion over the next 50 years.

For Aotearoa New Zealand to achieve these Targets, avoid the costs associated with nature loss and realise the nature-related opportunities, a transformation of our economy will be required.

Whilst most sectors of our economy are forecast to grow in the long term by meeting these Targets, the structural changes required are modelled to leave some sectors smaller, compared to a scenario where no action is taken towards these Targets. Placing protections over natural resources, for example through marine protected areas or water conservation orders, and repurposing land to support native forest growth and wetland restoration will result in decreased agricultural output and have short term negative impacts on the fishing sector, compared to a no action scenario.

However, by 2039, the positive impacts on the fishing sector are modelled to outweigh the negatives. Action taken by farmers to support achievement of these Targets is modelled to not only protect the brand value and price premium afforded to the sector through Aotearoa New Zealand's current environmental reputation, but could reduce costs and more significantly enable revenue diversification benefits. Through the restoration of wetlands and through native planting, an additional 13.7 Mt CO_2e of carbon is modelled to be sequestered annually from 2030, resulting in a GNI[14] increase totalling NZD$56.4 billion (NPV 2023) from 2030 to 2080. This benefit, realised through the sale of carbon credits, would be shared by landowners and the Government. By 2042, the benefits to landowners are expected to be greater than the negative economic impacts to output in the primary industry sectors. By 2080 the net benefit to the primary industries of nature action is forecast to be NZD$7.7 billion (NPV 2023).

Investment into nature needs to increase by ~6.5 times the current spend on nature, or NZD$22.5 billion (2024) per annum, for this transformation to be possible. The economic modelling in this Report shows the longer we wait the more costly the action will become, and the more likely irreversible damage will occur. There will also inevitably be a lag between mobilising finance, undertaking activities and having the desired effect on biodiversity which increases the pressure to act quickly. Enabling conditions are needed urgently to bridge the nature financing gap and support investment into nature. There is an accelerating role for government to build supporting infrastructure such as through mandating nature reporting, and to stimulate investment into nature through blended finance or other scalable investment vehicles. Business model transformations can unlock further investment into nature with the sale of biodiversity or carbon credits or ecosystem services payment structures enabling the monetisation of nature action.

Ko au Te Taiao, ko Te Taiao ko au (I am nature, and nature is me). We all have a role to play to protect and restore Aotearoa New Zealand. We hope this research will accelerate action towards a nature-positive future for Aotearoa New Zealand and bring us together to more effectively tackle the growing crisis of nature loss.

01

INTRODUCTION

THE IMPORTANCE OF NATURAL CAPITAL TO OUR ECONOMY

The natural world underpins our economy, society, and communities. Beyond having intrinsic value, both living and non-living components of the natural world provide benefits to humans and are critical to our survival. These benefits include the food, fibre and raw materials we depend on, the regulation of water, air and soil cycles to create a stable planet and cultural services, which promote our physical, mental and spiritual wellbeing.

It is estimated that over 50% of the world's Gross Domestic Product (GDP), the equivalent of USD $58 trillion per annum, is moderately or highly dependent on nature.[15] In Aotearoa New Zealand, land-based ecosystems deliver benefits equivalent to 27% of our GDP[16] and indirectly, all economic activity depends on nature.

Since 1970, global wildlife populations have plummeted by 69% on average[17] with roughly 1 million animal and plant species now facing extinction.[18] Continued rapid biodiversity loss could lead to catastrophic impacts for both the economy and society, with the World Economic Forum's Global Risks Report 2024 ranking biodiversity loss and ecosystem collapse as one of the top 3 threats to humanity over the next 10 years.[19]This crisis is generating significant but largely overlooked risks to the economy, the financial sector and the well-being of current and future generations.

There is, however, a vast opportunity to protect and restore nature as we build a net zero economy. These two goals can, in fact, be mutually reinforcing. Limiting global temperatures to below 1.5°C is not possible without reversing nature loss and enhancing nature-based carbon sinks.[20] Protecting and restoring nature is not possible without ambitious global and local action on climate change.

THE BIODIVERSITY CRISIS

One of the most significant crises that our natural world faces is the ongoing loss of biodiversity. Human activities, including direct exploitation of the natural world, changes in the way we use our land and oceans, and the impact of invasive species, pollution, and climate change, have led to an alarming decrease in the amount and variety of life on Earth,[21] and in Aotearoa New Zealand particularly.[22]

All ecosystems are impacted by this crisis. Globally, 75% of the land surface has been significantly altered, 66% of the ocean area is experiencing increasing cumulative impacts,[23] and over 85% of wetlands have disappeared.[24]

Aotearoa New Zealand has a particularly strong connection and dependency to nature given our unique ecosystems, cultural identity, and economy. Because of our geographical isolation, we have a very high level of endemic biodiversity, meaning many of our native species are found nowhere else on Earth.

Tangata whenua (Indigenous people) of Aotearoa New Zealand – the various Māori tribes and sub-tribes of Aotearoa New Zealand – view nature and people as one, connected through whakapapa, or a common ancestry. Primary industries, which are heavily reliant on nature, make up 7% of our economy, and our tourism industry also depends on Aotearoa New Zealand's natural capital.[25]

In Aotearoa New Zealand, 66% of our native forest cover, 90% of our wetlands and over 75 animal and plant species have been lost since human arrival.[26,27] 46% of lakes have poor water quality.[28] One quarter of New Zealanders do not have access to drinking water that meets the national standards.[29]

The cost of inaction is huge. By just 2030, conservative estimates suggest a global GDP decline of USD$2.7 trillion (2021) if we do not act to protect and restore nature quickly.[30] The nonfinancial costs would be even larger.

Globally, our key export markets are responding to this risk and increasing their expectations and focus on restoring natural capital and meeting zero carbon goals. This is becoming evident through:

- Mandatory sustainability disclosure requirements, such as the European Union Corporate Sustainability Due Diligence Directive (CSDDD) and the recent United States SEC ruling requiring registrants to provide climate disclosures in their annual reports and registration statements beginning with annual reports for the year ending 31 December 2025.[31]
- Increasing pressure from export customers for suppliers to disclose on nature-related risks through the approach recommended by the Taskforce on Nature-related Financial Disclosures (TNFD). For example, Nestle has set new Targets for protecting nature which includes sourcing 20% of its key ingredients from farmers who adopt regenerative agricultural practices.[32]
- Trade measures increasing costs or barriers for environmentally damaging products. This includes the European Carbon Border Adjustment Mechanism (CBAM) which taxes the embodied GHG emissions within certain imported products, bans on the importation of solid and plastic waste streams, and free trade agreement requirements, such as the UK-NZ Free Trade Agreement (FTA), which contains a detailed Environment Chapter committing each Government to "ensure that its environmental law and policies provide for and encourage a high level of environmental protection and to continue to improve its respective levels of environmental protection".[33]
- Investor requirements to identify and disclose the percentage of investments from green activities through green taxonomies, such as the EU Taxonomy, the ASEAN Taxonomy for Sustainable Finance and the Australian Sustainable Finance Taxonomy. Additionally, the Finance for Biodiversity Foundation has produced guidance to help investors align financial flows with the GBF.[34]

Aotearoa New Zealand's exports are highly exposed to these forces, with 80% of our exports by value going to markets that have mandatory sustainability reporting in force or proposed.[35] Further, the landscapes, ecosystems, flora and fauna of Aotearoa are a part of our national branding and how we market ourselves and our goods and services overseas. If these are degraded, Aotearoa New Zealand's 'green and clean' brand value and the ability to receive a price premium could be impacted.

69%

OF GLOBAL WILDLIFE POPULATIONS HAVE PLUMMETED SINCE 1970

Global Targets, to be achieved by 2030

REDUCING THREATS TO BIODIVERSITY

MEETING PEOPLE'S NEEDS THROUGH SUSTAINABLE USE AND BENEFIT-SHARING

TOOLS AND SOLUTIONS FOR IMPLEMENTATION AND MAIN-STREAMING

THE GLOBAL BIODIVERSITY FRAMEWORK

The Framework

In 2022, at the 15th meeting of the Conference of the Parties (COP 15), the United Nations Kunming-Montreal Global Biodiversity Framework (GBF) was adopted by 196 nations to take urgent action to respond to the biodiversity crisis.[36] The framework 'sets out an ambitious plan to implement broad-based action to bring about a transformation in our societies' relationship with biodiversity by 2030'. The Framework is guided by a 2050 vision:

"To take urgent action to halt and reverse biodiversity loss to put nature on a path to recovery for the benefit of people and planet by conserving and sustainably using biodiversity and by ensuring the fair and equitable sharing of benefits from the use of genetic resources, while providing the necessary means of implementation."

The Framework provides 23 Global Targets, to be achieved by 2030. These Targets are split into the following groupings:

1. Reducing threats to biodiversity (Targets 1-8)
2. Meeting people's needs through sustainable use and benefit-sharing (Targets 9-13)
3. Tools and solutions for implementation and mainstreaming (Targets 14-23)

Aotearoa New Zealand's response to the Framework

Aotearoa New Zealand is a signatory to the GBF. Te Mana o Te Taiao – Aotearoa New Zealand Biodiversity Strategy 2020[37] and, to a lesser extent, the National Policy Statement for Indigenous Biodiversity (NPSIB)[38] guides Aotearoa New Zealand's response to the biodiversity crisis.

Aotearoa New Zealand's biodiversity objectives are guided by Te Mana o Taiao, the Aotearoa New Zealand Biodiversity Strategy, which outlines ambitious goals to protect and restore the nation's unique ecosystems and native species. Countries are required to create National Biodiversity Strategy Action Plans (NBSAPs) that set interim Targets and actions for achieving the GBF Targets prior to the 16th meeting of the Conference of the Parties (COP 16) in October 2024. Aotearoa New Zealand has not yet updated its Biodiversity Strategy to reflect the GBF Targets nor developed an Action Plan ahead of the COP16 deadline.[39]

Te ao Māori and the biodiversity crisis

Te Taiao – the natural world that contains us – including whenua, koiora, wai and āhuarangi,[40] refers to the interconnected relationship of people and nature. In Te ao Māori, the health of Te Taiao is central to the health and wellbeing of people.

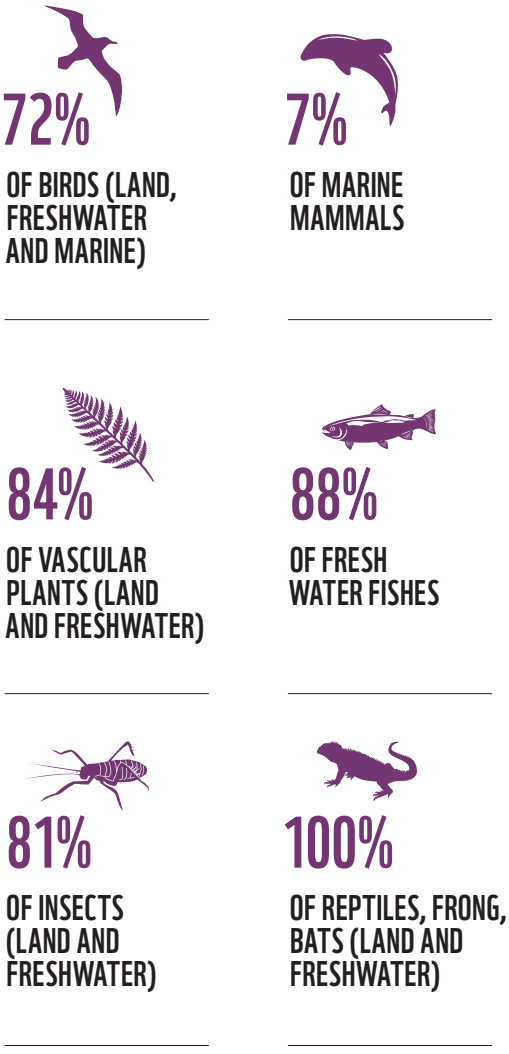
Ko au Te Taiao, ko Te Taiao ko au
(I am nature, and nature is me)

The biodiversity crisis directly threatens the health of Papatūānuku (Earth), the wellbeing of our communities and our collective and cultural identity. To uphold the commitments under Te Tiriti o Waitangi, the interests of iwi and hapū in Aotearoa New Zealand's flora and fauna must be recognised and actively supported.

Aotearoa New Zealand's response to the crisis of nature loss should consider how to remedy inequities and to make space for iwi, hapū and whanau to exercise the right of self-determination. Mātauranga (Māori knowledge, knowledge systems and scientific methods) can be used to inform and guide our response and build on the intergenerational approach to managing nature that underpins Te ao Māori.

As the generation of people living here at this time, we have a duty to this land, to the people here now and those to come in the future to restore ecosystems and protect our lands, waters and seas.

Figure 1: Proportion of Aotearoa New Zealand's species found nowhere else on Earth[41]



02

OUR APPROACH

THE PRINCIPLES UNDERPINNING OUR MODELLING APPROACH

This research aims to improve our understanding of the economic value of nature within Aotearoa New Zealand, and specifically, to identify the value associated with investing in the GBF Targets. Our modelling approach was developed with the knowledge that we will not fully capture all the complexities inherent in the relationship between the environment and the economy.

It aims to provide insights into the relationships that nature-related actions have with our broader economy and identify parts of the economy that are expected to experience financial benefits. This will strengthen our understanding of the investment case for nature-related actions.

Our modelling aims to use a conservative approach to valuing the economic benefits of nature restoration. That is, where we have made assumptions in the development of our bottom-up "impact functions", we aim to apply a conservative assessment that likely underestimates the economic benefits of the nature-related action. This approach was taken in order to provide results that are evidence-based and focus on areas of material value. Therefore, this modelling approach only represents a subset of nature's value.

OUR MODELLING APPROACH

Our work explored the long-term economic impacts of actions to support Aotearoa New Zealand to achieve four of the GBF Targets. The GBF Targets and actions required to meet them manifest differently in every country due to the unique context and ecology and differing drivers of nature loss in each country. The GBF Targets included in this report were selected as they address some of Aotearoa New Zealand's key drivers of nature loss:

- Land clearance and human activity has resulted in the degradation and loss of many of Aotearoa New Zealand's terrestrial ecosystems – for example, wetlands and native forests.[42]
- Human activity has similarly significantly degraded other key ecosystems. For example, bottom-impacting fishing methods have had indiscriminate impacts on marine ecosystems; and poor regulation of freshwater management, particularly in the context of agricultural production, has led to a huge decline in the quality of Aotearoa New Zealand's inland freshwater bodies.[43]
- Aotearoa New Zealand has very high levels of endemism and an increasing risk of species extinctions given habitat space for endemic species is limited due to land clearance, human activity and climate change causing loss of climatic niches required by certain species.[44]
- Invasive predators and pests, especially mustelid species, threaten wildlife. Weeds impact upon habitats and ecosystems that we rely on for food and are expensive to address.[45]

Depending on the complexities and challenges of modelling the costs and benefits of the actions identified, to support meeting each of these Targets, either an economy-wide or a case study specific modelling approach was used. Both approaches are explained in further detail in this Section.

The GBF Targets considered in this Report and the approach taken in each are shown below:

Table 2: Modelling Approach

GBF Target	Modelling approach
Target 2: Restore 30% of all Degraded Ecosystems	Economy-wide model
Target 3: Conserve 30% of Land, Waters and Seas	Economy-wide model
Target 4: Halt Species Extinction, Protect Genetic Diversity, and Manage Human-Wildlife Conflicts	Case study
Target 6: Reduce the Introduction of Invasive Alien Species by 50% and Minimise Their Impact	Case study
Target 10: Enhance Biodiversity and Sustainability in Agriculture, Aquaculture, Fisheries, and Forestry	Qualitative assessment

RESTORATION PROJECTS IMPROVE THE QUALITY OF THE WATERWAYS, WHICH WE RELY ON FOR OUR DRINKING WATER

ECONOMY-WIDE MODELLING APPROACH

For Target 2 and Target 3 we used an economy-wide modelling approach to analyse the value of nature-related actions. For each Target, three[46] significant actions were identified to meet each Target and the most financially significant costs and benefits associated with these actions were estimated based on research. We have called these "impact functions". For example: the implementation of river and lake restoration projects support the achievement of Target 2 by restoring our freshwater ecosystems.

These restoration projects improve the quality of the waterways, which we rely on for our drinking water. This improved water quality is expected to result in a reduction in treatment required to make the water safe for drinking, lowering costs to councils and ratepayers. This is one impact function, which is displayed in Figure 2. We have listed the impact functions considered in our analysis in Table 3 and we have provided further detail on the modelling approach and the source data for each impact function in Appendix C.

Figure 2: Illustrative representation of an impact function

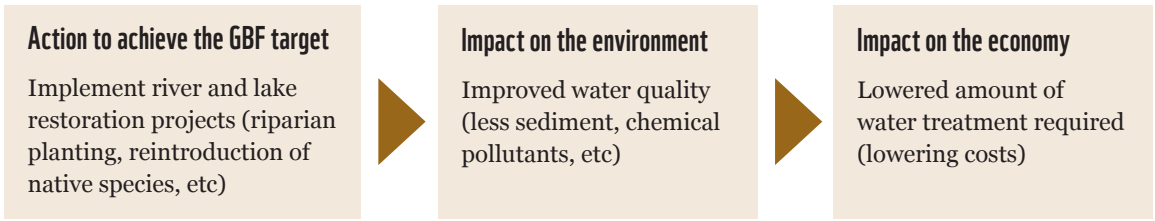


Table 3: Impact functions modelled for Targets 2 and 3

Target 2:

Restore 30% of all Degraded Ecosystems

Target 2: Restore 30% of all Degraded Ecosystems

COSTS:	BENEFITS:
Action 1: *Re-wet 667,477ha of degraded wetlands and peatlands*	
• Creating the wetlands and peatlands • Purchasing land for conversion • Maintaining and monitoring the wetlands	• Carbon sequestration • Protection from flooding and coastal inundation • Increased fishing yield from habitat restoration
Action 2: *Implement localised restoration programmes to improve the water quality in 30% of Aotearoa New Zealand's rivers and lakes, by achieving an applicable water quality rating of Band A.*	
• Implementing the river restoration projects • Implementing the lake restoration projects • Maintaining and monitoring the waterways	• Reduced water treatment • Contribution to protecting the tourism industry • Protection from flooding and drought
Action 3: *Reduce nutrient runoff and sedimentation pollution into coastal marine ecosystems, by planting native trees on riparian zones, reducing the use of synthetic fertiliser and planting highly erodible land.*	
• Riparian planting programmes • Native planting programmes on erosion prone land	• Contribution to protecting the tourism industry • Increase in fishing yield from habitat restoration • Carbon sequestration

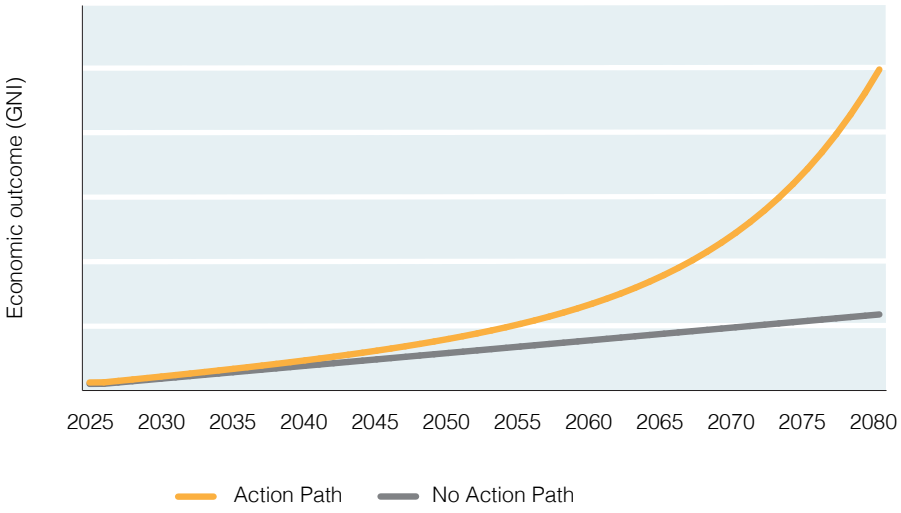
Target 3:

Conserve 30% of Land, Waters snd Seas

Target 3: Conserve 30% of Land, Waters and Seas

Action 1: *Achieve full mammalian predator-free status in all terrestrial protected areas.*	
• Initial pest eradication • Maintenance and monitoring	• Contribution to protecting the tourism industry
Action 2: *Implement water conservation orders on 30% of Aotearoa New Zealand's rivers and lakes*	
• Reduced agricultural yield • Establishment costs of orders • Consenting costs of orders	• Reduced water treatment • Improved reputational resilience in agricultural sector • Contribution to protecting the tourism industry • Safer swimming conditions
Action 3: *Create marine protected areas to grant the maximum level of protection (as enabled through legislation) to 30% of Aotearoa New Zealand's Exclusive Economic Zone and Territorial Seas*	
• Displaced fisheries and foregone revenue • Establishing the MPAs • Monitoring and enforcement of the MPAs	• Improved reputational resilience in fisheries sector • Contribution to protecting the tourism industry • Increase in fishing yield

Figure 3: Illustrative representation of economic deviation result



A computable general equilibrium (CGE) model was developed to estimate the economy-wide impacts of Aotearoa New Zealand meeting Targets 2 and 3. The model assumed that the actions to support the achievement of the Targets will be successfully completed by 2030. The CGE model incorporated the impact functions outlined above. The CGE model is a representation of the flow of goods and services in the global economy, built on national accounts data from government and a robust macroeconomic theory-driven framework. The model has a rich level of detail across economic sectors both in Aotearoa New Zealand and the broader global economy. This detail includes production requirements such as raw inputs, labour, and capital, each with appropriate restrictions reflective of resource availability.

CGE modelling is an important economic tool used to assess the impacts of investment decisions or policy action, capturing the ripple effects across the economy. These flow-on effects are critical because of the interconnected nature of economic sectors and flows of resources. The overall impact of action therefore expands beyond the targeted components of the natural environment, and more broadly adds or subtracts to national production and income, jobs growth and household wealth. The economic impact of nature action is then captured by assessing the difference between the "action path" and the "no action path", illustrated in Figure 3 above.

The CGE model for this analysis aggregates 24 economic sectors that represent the entire Aotearoa New Zealand economy and is further described in Appendix B. Two distinct action paths are developed to estimate the economic impact of achieving Targets 2 and 3, compared to the no action path as described above.

THE FLOW-ON EFFECTS ARE CRITICAL BECAUSE OF THE INTERCONNECTED NATURE OF ECONOMIC SECTORS AND FLOWS OF RESOURCES

Both costs and benefits are considered in the analysis; with costs falling into two categories which require different modelling treatments:

- Negative economic impacts that result from the implementation of specific actions are input into the CGE as negative outputs by sector. An example of this is the reduction in land and water available for farming in Aotearoa New Zealand, which, on its own, would directly, negatively impact on output in Aotearoa New Zealand's agricultural output. Please see Appendix B for the full list of costs input into the CGE Model.
- The investment required to enable the Targets such as implementation, maintenance and monitoring costs, are not input into the CGE model. The reason for exclusion is to avoid the need to allocate the cost to a specific sector within the CGE model given these costs are likely to be borne by a number of different stakeholders. Instead, these costs have been compared to the outputs of the CGE model to estimate the net economy-wide impact of the actions considered in our analysis.

The modelling outputs capture both the immediate economic effects of action (direct impacts) and secondary economic effects from inter-industry linkages (indirect impacts). This provides a comprehensive analysis of both direct changes to industry outputs and broader effects on supply chain activity, employment, trade and income distribution. Economic impacts of Target 2 and Target 3 actions are quantified against the following key macroeconomic indicators:

a) Gross National Income (GNI) measures the total income in an economy and is used to track the wealth generated both domestically and through overseas investment. GNI is an important measure to track when there are significant cross border income flows, such as exports of agricultural products.
b) Gross Domestic Product (GDP) measures the total value of goods and services produced in the economy, representing an aggregate of the value-add components of each sector's production.[47] GDP is a key metric in tracking the overall progress of an economy, estimated as the sum of consumption, investment, government expenditure and net exports in real terms.
c) Output measures the value of goods and services produced by all economic sectors. Unlike GDP, this measure considers both the value-add and non-value-add components of production within each sector, providing an estimate of total intermediate and final production. It is a good measure to assess the sectoral impacts of actions. Changes in GDP span across the economy and include sectors that are beneficiaries of the proposed actions, and those that are likely to lose out. Therefore, assessing changes in output is required to measure the individual impacts.
d) Employment measures the full time equivalent (FTE) jobs supported in the economy, where each FTE is equal to one employee working full time for one year.
e) Wage rates measure the earnings of employed persons in the region. This metric is measured as the average of each year's percentage deviation from the no action scenario.

The modelling was conducted out to 2080. This period was selected because it was 50 years after the Targets were achieved in the scenario and aligned to key impact function timelines. The results are calculated annually and can be cumulated over the 56-year assessment period from 2025 to 2080. For monetary impacts such as GNI, values in future years are discounted back to current dollars using a discount rate of 5%,[48] summarised as a net present value (NPV). For employment and wage rate growth, results are summarised as an average across the period.

CASE STUDY APPROACH

Our approach to the case studies included a qualitative and quantitative assessment of the impacts of achieving *Target 4: Halt Species Extinction, Protect Genetic Diversity, and Manage Human-Wildlife Conflicts* and *Target 6: Reduce the Introduction of Invasive Alien Species by 50% and Minimise Their Impact for a single species*. We undertook a literature analysis to identify appropriate research on the costs and economic benefits of taking actions towards each Target and selected a case study related to one species.

We assessed the current state of the chosen species in Aotearoa New Zealand, the threats it posed to our ecosystems, or which endangered it, and the potential actions to resolve the threats. Once we had selected the most important actions necessary to achieve the GBF Target for that species, we scaled the cost and benefit analysis from our literature analysis to estimate the total costs and benefits.

LIMITATIONS OF OUR MODELLING APPROACH

We note the following limitations to our modelling approach:

- Reliance on public information in undertaking our bottom-up analysis of potential nature-related restorative actions
- National-level modelling that has not considered the regional distribution of economic impacts
- Consideration of the first-order ecological impacts which has not considered the cascading nature-related impacts
- Consideration of all GBF Targets. Only four Targets have been considered within the economic modelling
- Constraints on the time and resource available to develop a comprehensive study of the economic impacts of meeting the GBFs for Aotearoa New Zealand.

Benefits that are not considered in our modelling include, but are not limited to:

- The intrinsic value of the natural world, ecosystems and species
- The value nature brings to cultural identity, cultural practices and subsistence harvesting
- The regulation of soil, water and air cycles
- The scientific value of nature.

We hope this research can lead to accelerated action towards nature positive outcomes for Aotearoa New Zealand. We welcome collaboration in this area and encourage ideas of how we can more effectively tackle the growing crisis of nature loss.

03

MODELLING RESULTS AND FINDINGS

SUMMARY OF OUR MODELLING RESULTS AND FINDINGS

Taking actions to support the achievement of Target 2 and Target 3 by 2030 is estimated to generate significant positive economic value to Aotearoa New Zealand of NZ$272 billion (2023 dollars) from 2025 to 2080.

This economic benefit, measured through GNI, of conserving and restoring 30% of ecosystems (achieving both Target 2 and Target 3) increases rapidly over the modelling period towards 2080, with an increase of NZD$59.3 billion (2023) or 4.3% of GNI in 2080, compared to the no action scenario (see Figure 4 and Table 4). This result highlights that costs outweigh the benefits through to 2030 (the period where implementation is occurring), while the economic benefits compound and continue to increase out to 2080.

The breakeven year, where economic benefits fully over set the total costs is 2035, which is only 11 years after the modelling assumes implementation commences (the payback period).

The overall benefit realised is driven both by the realisation of additional opportunities provided through a thriving natural environment and through protecting Aotearoa New Zealand from impacts associated with nature decline (avoided costs of inaction).

The key economic benefits from achieving these Targets are driven by the factors depicted in Figure 5 and outlined below:

- Meeting the GBF Targets supports increased levels of carbon sequestration through the restoration of natural assets, supporting Aotearoa New Zealand to meet its net GHG emissions reduction Targets covered by its future Nationally Determined Contributions (NDC).[49] This means fewer international carbon credits will need to be purchased, providing a benefit to Aotearoa New Zealand's economy. These benefits will be shared by owners and developers of these projects and the Government, saving the economy billions of dollars annually.
- Restorative actions lead to improvements in insurance risks, water quality and health compared to the no action scenario. The model highlights how these flow-on effects boost productivity and lead to greater economic growth. For example, a reduction in flood risk compared to the no action scenario is estimated to reduce insurance costs by billions of dollars annually.

Figure 4: Economic impact of action, deviation from no action scenario

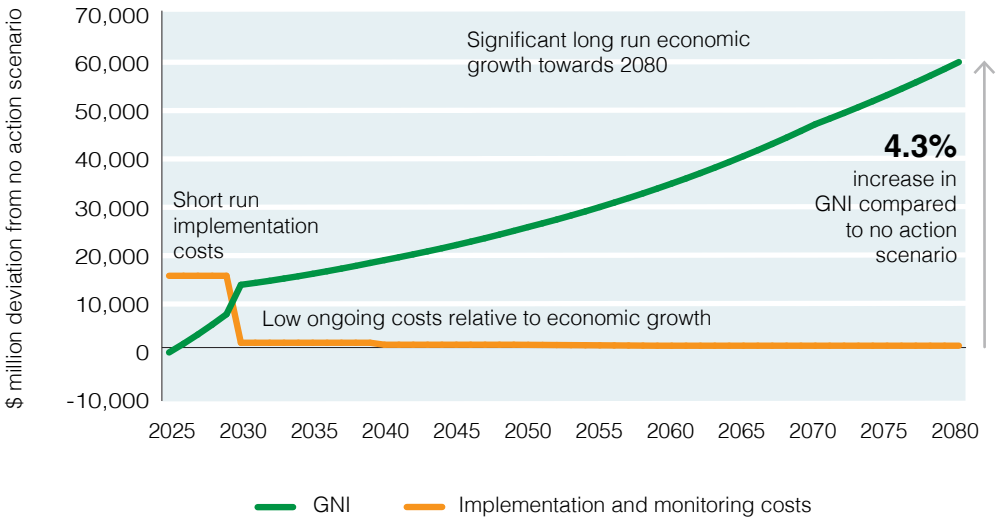
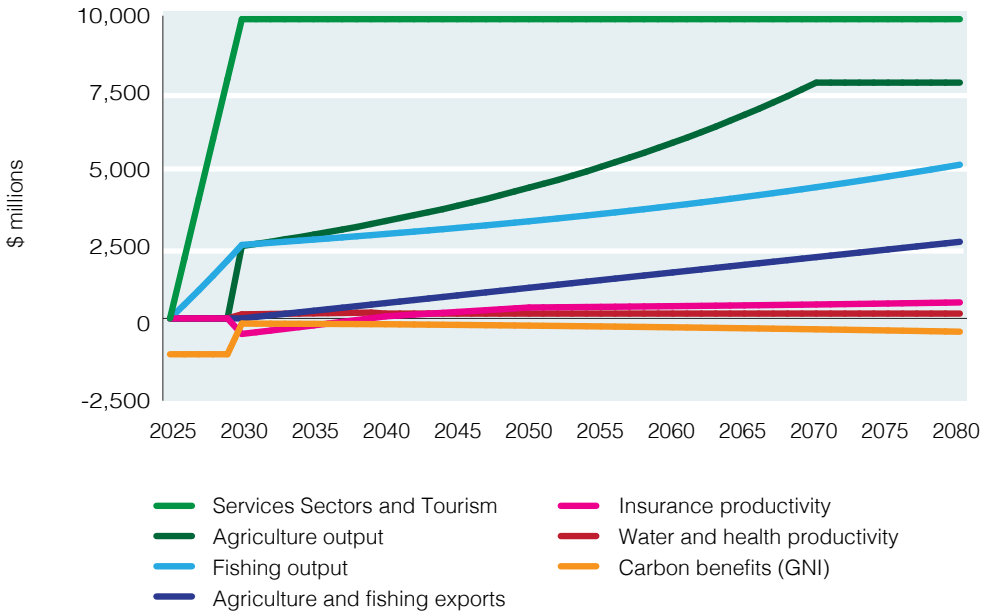


Table 4: Summary of economic impact findings from meeting both Target 2 and Target 3 in 2030 (value in NZD 2023)

Measure	Deviation from no action scenario, 2025 to 2080
Economic benefits from the actions	
Gross national income ($ million NPV)	346,563
Total industry output ($ million NPV)	110,112
Employment (average FTEs)	12,994
Change in wage rates (average % deviation per year)	2.60
Costs associated with the actions	
Implementation costs ($ million NPV)	64,554
Maintenance and monitoring costs ($ million NPV)	10,206
Total costs ($ million NPV)	74,760
Net economic impact	
GNI minus out-of-model costs ($ million NPV)	271,803

Note: a discount rate of 5% is used

Figure 5: Drivers of economy wide impacts (value in NZD 2023)



The key avoided costs from preserving and restoring nature compared to the no-action scenario include:

- Preserving our ability to continue to enjoy Aotearoa New Zealand's natural assets, such as our native bush, rivers, lakes and moana supports economic activity in the services sector. It also protects Aotearoa New Zealand's reputation internationally and therefore our international tourism sector compared to the no action scenario, where our natural capital diminishes, which reduces our appeal as a tourist attraction and the revenue to the service sectors that support our experiences with nature.
- Protecting our 'clean and green' brand and taking action to reduce nature-related risks also supports our primary industry export markets. Aotearoa New Zealand is seen as a provider of premium, high-quality and sustainable agricultural products. Acting immediately and successfully to meet these Targets is modelled to reduce the loss of brand value and support more sustainable business models.

Given the principle of conservatism applied in our modelling it is likely that we have underestimated avoided costs of inaction which have been modelled through decreases in demand due to reputation and also underestimated some of the benefits of action, such as reduced spend on insurance and natural disaster recovery, reduced costs associated with water treatment and reduced spend on health care.

Due to complexities and data limitations, we have also assumed no reductions in productivity or yield from the primary section under the no action scenario where nature continues to decline. To see how conservative this assumption could be for the results of this modelling, an analysis of the economic impacts as a result of potential reduced fish stocks from the Exotic Caulerpa infestation in the Hauraki Gulf, Bay of Islands and Coromandel is provided at the end of this Section and shows how economically impactful a small shift in yield can be, supporting the likely underestimation of the cost of inaction.

The results also show the transitionary impacts from meeting the Targets. Sectors across Aotearoa New Zealand's economy are modelled to experience a variety of economic outcomes, as outlined in Figure 6.

Services sectors such as accommodation and food are expected to experience positive economic impacts relative to the no action scenario driven through protecting our ability to enjoy and experience nature recreationally, including through the protection of Aotearoa New Zealand's international tourism industry.

The dairy and livestock sectors are modelled to experience reductions in outputs due to water conservation orders restricting water availability in some regions, and land conversion to support the restoration of wetlands and reduce nutrient runoff and sedimentation.

However, this contraction in dairy and livestock output is modelled to be compensated through higher prices and a more sustainable business model. Higher prices are enabled as a result of the actions taken protecting and growing Aotearoa New Zealand's 'green and clean' brand value providing a price premium. A more sustainable business model is enabled through the following actions:

- The restoration of rivers and lakes supports a reduction in the risk of fluvial flooding and drought, including that brought about by climate-related weather events. There is a reduction in the magnitude and significance of these events and associated insurance and natural disaster recovery costs.
- Achieving mammalian predator-free status reduces livestock disease and enhances agricultural yield.
- New and diverse revenue streams become available through carbon or biodiversity crediting schemes.

On top of these benefits, the modelling has not accounted for the increased revenue to landowners from carbon sequestration through the identified actions. Instead, this benefit is treated as a direct positive impact on GNI. However, in reality, this benefit would be shared with landowners where carbon sequestration projects were located and by 2080 this benefit is expected to be significantly larger than the reductions in output experienced by these sectors. This is explained in more detail in section 3.5 and shown in Figure 9.

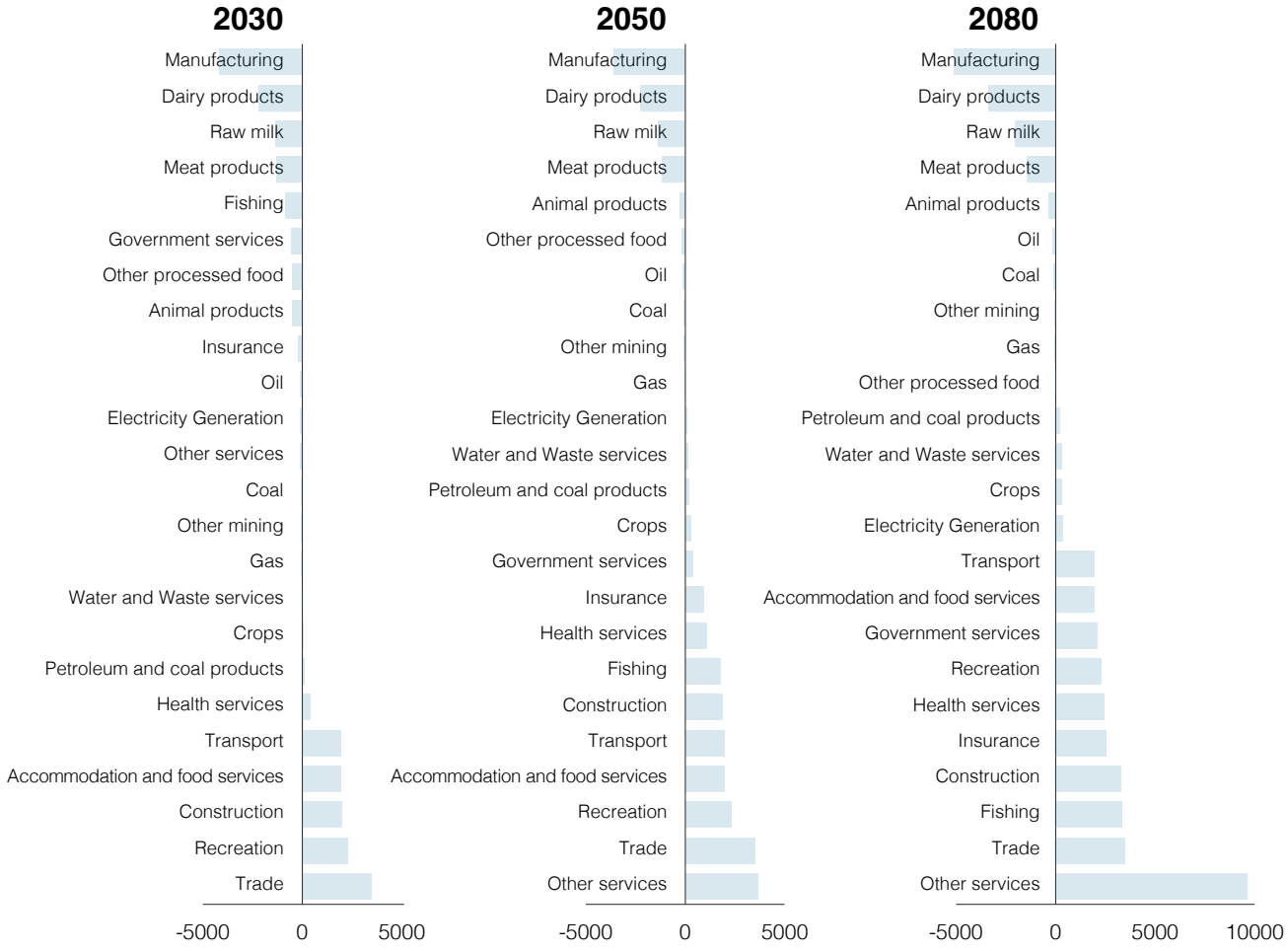
There are also expected to be initial reductions in output in the commercial fishing sector due to increases in marine protected areas displacing fisheries. However, from 2039 the fishing sector experiences positive net economic impacts against the no action scenario, as the resilience and abundance of fish stocks increase as the result of habitat restoration actions and the fisheries sectors reputation as sustainable is maintained.

The health sector is modelled to be positively impacted because of improved freshwater quality and reduced healthcare costs from safer swimming and drinking water, whilst the insurance sector is expected to also benefit with the restoration of wetlands supporting reduced insurance costs.

The manufacturing sector is shown to produce less output compared to the no action scenario. A significant driver of this movement is the crowding out effect from other shocks, meaning growth in other sectors leads to reduced activity in manufacturing due to competition for limited resources – labour, capital and land.

Resource sectors are modelled as experiencing minimal impacts as a result of these actions.

Figure 6: Sector impacts, deviation on output from base (NZD$ million 2023)[50]

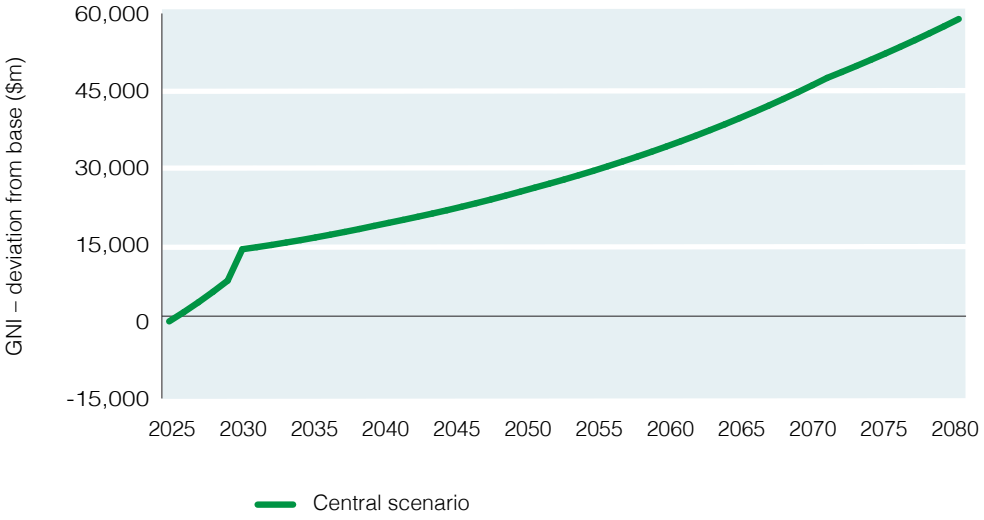


Key findings:

Looking at the detail behind these economic impacts, we have identified the following key findings for Aotearoa New Zealand. These are explored in more detail in this section of the Report:

- Meeting Target 2 and Target 3 makes economic sense
- Putting nature-based solutions at the heart of our climate response can improve economic outcomes
- Restoring and protecting our natural assets safeguards our ability to enjoy and experience nature and supports our services sector
- Nature provides resiliency, brand enhancement, cost savings and revenue diversification opportunities as a transition pathway for primary industries.

Figure 7: Economic impact of action, deviation from no action scenario



MEETING TARGET 2 AND TARGET 3 MAKES ECONOMIC SENSE

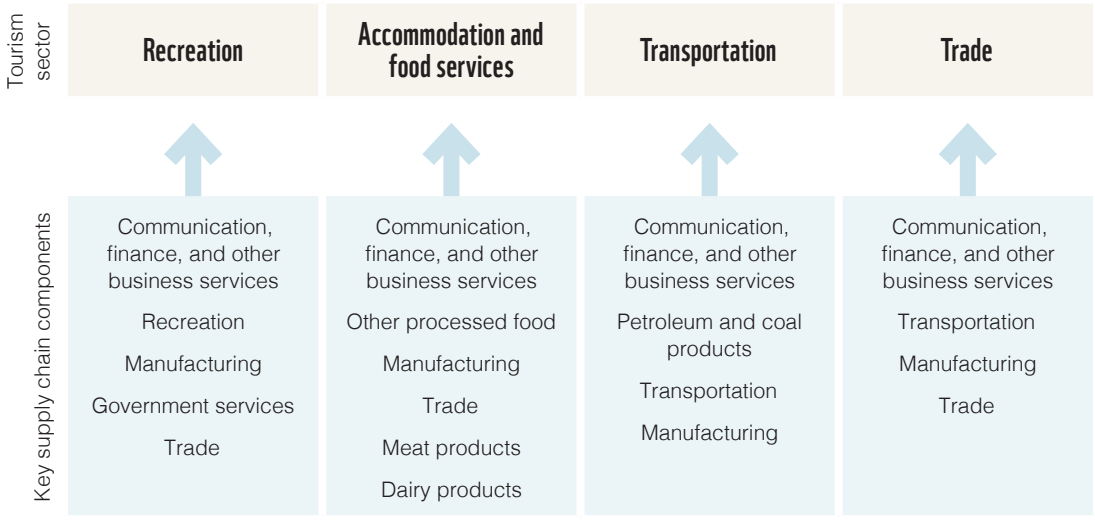
The net benefits of achieving the identified Targets exceed the upfront and ongoing costs required to meet them, providing a net benefit to Aotearoa New Zealand's economy over the 50-year period of an estimated NZD$271.8 billion (NPV 2023).

While initial implementation costs are more substantial, most of these costs are borne over a limited period from 2025 to 2030, with less substantial maintenance and monitoring costs continuing until 2080. From 2030 onwards, benefits are expected to outweigh costs annually as Targets are achieved. Benefits continue to incline rapidly towards 2080. This represents significant long term economic growth which would continue beyond the modelling period. The benefits reflect both avoided economic losses and additional growth by protecting nature in Aotearoa New Zealand.

PUTTING NATURE-BASED SOLUTIONS AT THE HEART OF OUR CLIMATE RESPONSE CAN IMPROVE ECONOMIC OUTCOMES

According to current estimates, Aotearoa New Zealand will be required to purchase a significant volume of international carbon credits to achieve its first Nationally Determined Contribution (NDC1, over 2021-2030).[51] The central estimate made by Treasury calculated this as 99.2 MtCO2e equating to a cost potentially as high as NZD$8.6 billion (2022).[52] Given the ambition principle of the Paris Agreement, each successive NDC is required to be more ambitious than the next meaning annually Aotearoa New Zealand may be required to purchase even larger volumes of international units to meet future NDCs. Upwards of 11.0 MtCO2e of offshore mitigation could therefore need to be purchased annually out to 2080, if the same volume estimates per Treasury's central case for the period covering NDC1 are applied to future commitment periods.[53] Depending on how this obligation is managed by future Governments, this national expenditure could impact on government spending decisions or increase national debt levels.

Figure 8: Tourism sectors and supply chains



Through the actions suggested in this report, to restore wetlands and reduce nutrient runoff and sedimentation through native planting, an additional 13.7 Mt CO_2e of carbon could be sequestered annually from 2030. This additional carbon sequestration has been modelled to provide total economic benefits equal to NZD$56.4 billion (NPV 2023). These actions should support Aotearoa New Zealand to meet its future NDCs domestically and result in the government saving NZD$16.9 billion (NPV 2023) from 2030 to 2080, reaching peak annual savings of NZD$2.3 billion (real 2023) by 2080.[54] Reducing or even avoiding the future financial burden of purchasing offshore mitigation is important as regulations become stricter and international carbon prices might rise. The action should also support Aotearoa New Zealand to allocate more resources towards productive investments, infrastructure and social programmes domestically rather than towards international compliance costs. In the event that more carbon is sequestered through these actions than is required under Aotearoa New Zealand's future NDCs, these units could be sold to overseas buyers and would likely collect a premium given the related nature benefits. Landowners have been assumed as recognising NZD$39.5 billion (NPV 2023) in economic benefits from 2030 to 2080 from this sequestration.

RESTORING AND PROTECTING OUR NATURAL ASSETS SAFEGUARDS OUR ABILITY TO ENJOY AND EXPERIENCE NATURE AND SUPPORTS OUR SERVICES SECTORS

Preserving our ability to enjoy Aotearoa New Zealand's natural assets, such as our native bush, rivers, lakes and moana supports spend on recreation, accommodation and food, transport, and trade (retail and wholesale trade) both from locals and tourists. Further, conservation and restorative actions across all ecosystems (land, waters and seas) improves the health and perceptions of our environmental conditions and protects our international tourism industry from contractions that could take place if significant environmental degradation was to occur.[55]

Many of the sectors that benefit from our enjoyment and experience of nature are service-focussed and therefore labour-intensive, contributing towards greater long-term boosts in employment. An increase in international tourism additionally impacts on the supply chains of other sectors.

For example, an increase in food services may demand additional manufactured food products such as local meat and dairy, increasing demand in Aotearoa New Zealand's agricultural sectors. These supply chain impacts are presented in Figure 8.

NATURE PROVIDES RESILIENCY, BRAND ENHANCEMENT, COST SAVINGS AND REVENUE DIVERSIFICATION OPPORTUNITIES AS A TRANSITION PATHWAY FOR PRIMARY INDUSTRIES

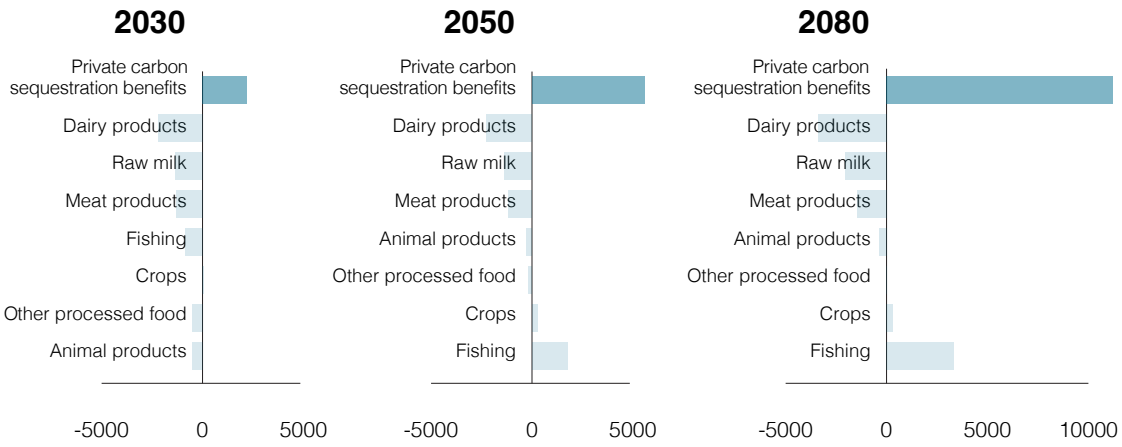
Aotearoa New Zealand's primary industries are expected to experience change and a range of economic impacts as a result of nature-positive action. These impacts support the growth of resilience and opportunities to diversify. Horticultural output was modelled as growing slightly, fisheries output was modelled as declining initially and then growing significantly, while livestock-related sectors were modelled as decreasing in traditional output out to 2080. The economic benefits associated with additional carbon sequestration achieved through sequestration and other actions would be shared with landowners and by 2080 this benefit is significantly larger than the reductions in output across the primary sectors.

Water conservation orders restricting water availability in some regions, and land conversion to support the restoration of wetlands and reduce nutrient runoff and sedimentation are modelled to result in a reduction in output for the dairy and livestock sectors over the modelling period. By 2080, the reduction in output against the no action scenario for the dairy products, meat products and animal products sectors are expected to be NZD$3.4 billion, NZD$1.4 billion and NZD$0.4 billion (2023), respectively.

Whilst this is a significant contraction and Aotearoa New Zealand's dairy and livestock sectors are modelled to produce lower volumes, the portions of these sectors that remain are expected to be compensated through higher prices and a more sustainable business model. Higher prices are enabled as a result of the actions taken protecting and growing Aotearoa New Zealand's 'green and clean' brand value. The restoration of rivers and lakes should reduce the risk of fluvial flooding and drought and achieving mammalian predator-free status should reduce the spread of disease within livestock populations and both actions support the sustainability of farm business models.

Further, insurance and natural disaster recovery costs are expected to reduce as a consequence of these actions and yields improved. New and diverse revenue streams would be supported through carbon or biodiversity crediting schemes if established, where farmers could collect revenue for native forestry planting on their land. The additional carbon sequestered through a number of identified actions has not been recognised in the model as providing direct benefits to agricultural sectors due to simplifications in the modelling approach. Instead, this benefit is treated as a direct positive impact on GNI. In reality, this value would be shared with landowners and by 2042 this benefit is larger than the reductions in output across the agricultural sectors as shown in Figure 9. By 2080 the primary industries sectors are experiencing net benefits of NZD$7.7 billion (NPV 2023) as a consequence of nature action.

Figure 9: Changing size of primary industries in Aotearoa New Zealand (output in real 2023 $ million)[56]



The fishing sector is also expected to experience initial reductions in output due to increases in marine protected areas displacing fisheries resulting in foregone revenue of NZD$0.8 billion (2023). However, by 2039 the fisheries and aquaculture sectors are modelled to experience positive economic impacts against the no action scenario as fish stocks and health increase because of habitat restoration actions taken earlier, as areas available for fishing begin to experience the 'halo effect' of marine protected areas and as a result of the protection of Aotearoa New Zealand's fishing sector's reputation as being sustainable.[57] By 2080 the fishing sector is experiencing an improvement on the no action scenario of NZD$3.5 billion (2023).

The horticulture sector experiences minor economic benefits against the no action scenario over the modelling period due to additional demand for food services and therefore food crops driven by the comparatively larger tourism numbers versus the no action scenario. The horticulture sector is expected to also benefit from the restoration of rivers and lakes through the reduced risk of fluvial flooding and drought, reducing insurance costs and natural disaster recovery costs. However, this benefit has not been recognised for this sector through our modelling and instead is included only as a benefit to the dairy and livestock sectors.

The actions identified did not directly impact on plantation forestry and therefore limited impacts on the forestry sector have been identified through our modelling. We note that native planting is a reoccurring action to support the achievement of Targets 2 and 3 and that there is an opportunity for our forestry sector, as well as all primary industries, to diversify their revenue through the sale of biodiversity and carbon credits as a consequence of native planting and wetland restoration, if these types of crediting mechanisms are developed.

Section four outlines in more detail the nature impacts and dependencies on key primary industries, along with actions that could be taken to overcome challenges and realise opportunities.

EXAMPLES OF THE CONSERVATISM OF THESE RESULTS

Assigning economic value to nature is complex due to a range of challenges which include:

- Nature provides a vast array of ecosystem services which are interconnected to other natural, economic and social systems, meaning that an impact on one system cascades and affects many others through first-, second- and third-order impacts.[58]
- Modelling nature requires knowledge of individual ecosystem relationships, as the value of an impact on one ecosystem can be completely different to another.
- Nature and biodiversity have tipping points; if an ecosystem service or habitat declines to reach a critical point, this can lead to exponential flow-on effects, such as the extinction of a species or an ecosystem no longer providing a useful service.[59]
- Nature and biodiversity provide subjective value to humans and cultures, who place different degrees of importance on different elements of nature and natural landmarks. Willingness-to-pay approaches can be used to quantify these types of values but can be challenging to conduct due to the levels of uncertainty involved.[60]
- Nature provides public value, for example clean air and drinking water, which is difficult for individuals to fully appreciate, understand and value.
- Besides niche examples, financial markets do not currently recognise the value of natural capital beyond the cash flows created when nature is used as an input to a product or service. Only when that nature-related input has reached a critical tipping point is nature's value more fully understood. This has led to systematic under protection and under-investment in nature, leading to its declining state.[61]

In this section we provide two case studies that support Target 4 and Target 6 and provide examples of how we have applied the principle of conservatism.

- Our modelling does not account for the value of nature to humans beyond the economic value it supports. Our Target 4 Case Study – Antipodean Albatross, shows the difficulty encountered in attempting to assign a value to a single species.
- Our modelling has not included the loss of economic value associated with collapsing ecosystems in our no action scenario. It assumes no loss in primary industry productivity in the no action scenario due to the complexities of identifying the extent of economic impact with nature decline and predicting cascading impacts and tipping points. Our Target 6 Case Study – Exotic Caulerpa shows the potential economic impact on primary industry productivity from an invasive species.

CASE STUDY

Target 4:

Halt Species Extinction, Protect Genetic Diversity, and Manage Human-Wildlife Conflicts

TARGET 4 AND THE ANTIPODEAN ALBATROSS

Ensure that there are urgent management actions to halt human induced extinction of known threatened species and for the recovery and conservation of species, in particular threatened species, to significantly reduce extinction risk, as well as to maintain and restore the genetic diversity within and between populations of native, wild and domesticated species to maintain their adaptive potential, including through in situ and ex situ conservation and sustainable management practices, and effectively manage human-wildlife interactions to minimise human-wildlife conflict for coexistence.

Species background

The Antipodean albatross or Toroa in te reo Māori (Diomedea antipodensis) is one of Aotearoa New Zealand's many endemic seabirds. There are two subspecies of this albatross, the larger and paler Diomedea antipodensis gibsoni, and the smaller and darker Diomedea antipodensis.[62]

The conservation status of the Antipodean albatross is 'Threatened – Nationally Critical,' which represents the highest level of risk of extinction.[63] The population of these large seabirds has declined dramatically over the past two decades and it is estimated that there are only 12,500 breeding pairs remaining.[64] They predominately breed on the Auckland, Antipodes, Campbell, Pitt and Chatham Islands, but spend the majority of their time covering long distances over deep waters from Australia to Chile, scavenging for fish and squid.[65]

The main threats to the Antipodean albatross are[66,67]:

- High death rate through fisheries bycatch
- Sea surface temperature change caused by global warming, which drives food scarcity
- Invasive predators and pests on Auckland Island
- Consumption of plastic pollution.

Actions

The two key actions identified to address the major threats to the Antipodean Albatross are:

1. *Implement mandatory cameras on board all offshore fishing vessels*
2. *Fast-track the Maukahuka project to make Auckland Island pest free.*

Total cost of action

The indicative cost of completing these two actions is estimated to be ~NZD$41 million per year (2023) for five years. Further information on how this cost was calculated can be found in Appendix D.

Benefits of taking action

The economic benefits associated with conservation of the Antipodean albatross, or any threatened species, are difficult to quantify as there is no alternative case to assess the impact of removing a species from an ecosystem until the extinction event occurs. The valuation of nature, and identifying tipping points, particularly for Target 4, is challenging due to the lack of evidence base to understand its impact on the wider ecosystem and the cascading impacts. Some studies have been able to quantify protection of species through non-market valuation techniques such as 'willingness-to-pay' studies. These studies ask individuals to reveal how much they would be willing to pay for the protection of a particular species. Willingness-to-pay studies have been conducted in Aotearoa New Zealand for a variety of species but not for the Antipodean albatross.[68,69] Nevertheless, willingness-to-pay studies typically show that the economic benefits associated with preventing extinction of a species, in this case the Antipodean albatross, outweigh the costs of implementation of actions.[70]

These studies do not consider tipping point values, so could potentially vastly underestimate value, should a species be critical for an ecosystem's broader health.

The value of protection is not limited to an individual's willingness to pay, but could also include benefits associated with ecosystems, tourism,[71] cultural significance as well as scientific significance. The suggested mandating of cameras on all offshore fishing vessels supports improved environmental outcomes, such as reduced protected species captures and better managed fish stocks, as a result of more informed management decisions and improved at-sea behaviour. For example, data from cameras on in-shore fishing vessels operating in Aotearoa New Zealand fitted and monitored by the Ministry for Primary Industries,[72] showed that albatross are accidentally caught and killed by vessels at a rate 350% higher than previously reported on.[73] This data supported the decision by Fisheries New Zealand to introduce "best practice" mitigation measures to reduce the risk to seabirds from fishing. It had previously been suggested that only marginal improvements would be adopted.[74]

The implementation of cameras on offshore vessels also supports the social license of Aotearoa New Zealand's fishing industry and enhances its brand value if appropriate action is taken as a result of surveillance findings. Implementing cameras on all offshore fishing vessels also provides more trusted fisheries data; greater transparency and trust both domestically and across international markets; and, safer, more practical and cost-effective monitoring of commercial fishing activity. Further, Aotearoa New Zealand's actions in protecting the species could have an amplified effect, encouraging other countries to adopt similar measures and increasing the overall benefit on ecosystems.

CASE STUDY

Target 6:

Reduce the Introduction of Invasive Alien Species by 50% and Minimise Their Impact

TARGET 6 AND EXOTIC CAULERPA

Eliminate, minimise, reduce and/or mitigate the impacts of invasive alien species on biodiversity and ecosystem services by identifying and managing pathways of the introduction of alien species, preventing the introduction and establishment of priority invasive alien species, reducing the rates of introduction and establishment of other known or potential invasive alien species by at least 50% by 2030, and eradicating or controlling invasive alien species, especially in priority sites, such as islands.

Species background

In 2021, two invasive species, Caulerpa brachypus and Caulerpa parvifolia were identified in Aotearoa New Zealand waters.[75] The species are closely related and appear identical. These species are seaweeds and are invasive in Aotearoa New Zealand.

Since the initial incursion on Aotea / Great Barrier Island, Caulerpa has spread to other areas of the North Island's East Coast,[76] even with relatively strict national biosecurity measures in place. It is unknown how these invasive species were first brought to Aotearoa New Zealand; however, since arrival Caulerpa has spread rapidly, forming large, thick monocultures underwater (up to 40m deep)[77] and in intertidal zones.

Caulerpa incursions globally have had significant impacts, as a result of the seaweed's ability to spread from small fragments and grow up to 3cm in length every day, efficiently forming dense mats on the seafloor that smother and displace native marine and intertidal flora and fauna. Exotic Caulerpa is able to survive in a wide range of temperatures and environmental conditions, meaning it can reach areas that other invasive marine plants may not tolerate.

This invasion presents an immediate and large threat to Aotearoa New Zealand's marine ecosystems. Aotearoa New Zealand's response so far has aimed to understand the distribution and extent of the invasion, how we might prevent its further spread and how we might remove it.

10%

REDUCTION IN FISH STOCK WOULD DECREASE FISHING OUTPUT BY NZD $4.9 BILLION

Ngāti Rehua, Ngatiwai ki Aotea and Ngāti Manuhiri have been critical in the response to date. Ngāti Manuhiri Settlement Trust has established Te Wero Nui and is working with Biosecurity New Zealand/MPI, NIWA and experts from California USA to strategise and develop an effective plan of action, raise awareness and initiate the removal process.[78] Despite efforts, the response so far has been ineffective at stopping Caulerpa's spread.[79,80,81,82] In early 2024, an independent strategic technical advisory group advised that eradication was not feasible in the short or medium term based on currently available tools and methods.[83]

Actions

The two key actions identified to supress Exotic Caulerpa in Aotearoa New Zealand are:

1 *Develop and establish suction dredging removal programmes through localised diver-operated teams and a widespread large-scale suction dredge*

2 *Develop a programme of biosecurity measures to stop regional and international spread of Caulerpa, including hull cleaning and monitoring of current sites of known Caulerpa.*

There are a number of challenges associated with these actions, including, but not limited to;

- Uncertainty of the effectiveness of the actions
- Uncertainty of the flow on trophic impacts of inaction
- Costs are highly dependent on when action is taken and how far it has spread.

Total cost of action

The indicative cost of undertaking the above actions is estimated to be ~NZD$177 million per year (2023) until the invasion is supressed, with some residual ongoing monitoring costs. Approximately NZD$7 million (2024) has been spent on and allocated to the invasion to date.[84] Further information on how these costs were calculated can be found in Appendix D.

Benefits of taking action

In the case of a widespread outbreak of Exotic Caulerpa, Aotearoa New Zealand's fisheries could be vulnerable to decline or collapse. Given eradication of Exotic Caulerpa has been deemed infeasible, it is assumed that it will continue to spread[85] and could have a large impact on our fisheries. This would impact recreational, subsistence and commercial fishing, our cultural connection to the ocean, tourism and the inherent value in our unique marine wildlife would also be impacted. The cost of inaction is therefore estimated to be of an order of magnitude larger than the cost of our identified actions.

Our commercial fisheries are valued at over NZD$4 billion (2017) annually.[86] The table below displays the economic costs to the Aotearoa New Zealand economy if the fishing industry contracted by a certain percentage, holding all else constant. Due to the lack of understanding of Caulerpa's potential impact, we cannot predict the reduction in our fish stocks if it is left to spread unchecked. However, in the Mediterranean Sea, where Caulerpa has extensively colonised certain regions[87], fish biomass declined between 42% and 57% over a six-year period.[88]

Table 5: Costs to the economy if commercial fishing output was to decrease from the baseline level (2080 NPV in NZD 2023)

	Assumed decrease in fish stocks			
Measure	1%	10%	30%	50%
Decrease in fishing output ($billion NPV)	0.5	4.9	14.8	24.7
Decrease in GDP ($billion NPV)	0.2	1.7	5.0	8.3
Decrease in GNI ($billion NPV)	0.4	3.9	11.5	19.1

Table 5 shows that a 10% reduction in fish stock would decrease fishing output by NZD$4.9 billion (2023) over the modelling period. If we assume that it takes 10 years to carry out our identified actions and that residual monitoring costs are zero, there will be a net benefit of NZD$3.13 billion (2023) against the no action scenario. The Hauraki Gulf, where the Caulerpa infestation is predominantly located, has been estimated to provide ecosystem services of NZD$292 million annually (2023) to cruise tourism, NZD$1.3 billion annually (2023) to ports and shipping and NZD$2.5 billion annually (2023) to recreation.[89] Because of a lack of understanding of Caulerpa's potential impact, we cannot predict the reduction in ecosystem services to the tourism industry.

An assumed reduction to these ecosystem services of 10% as a result of the Caulerpa outbreak would amount to a loss to the tourism industry of NZD$413 million annually (2023).

The costs of inaction on our cultural connection to the ocean, our recreational and subsistence fishing and to the inherent value of marine ecosystems has not been included in our quantification due to complexity and lack of data to support such a valuation.

04

PRIMARY SECTOR DEEP DIVE

Our modelling supports that Aotearoa New Zealand's primary industries will require some transformation to contribute towards the achievement of the GBF Targets.

In this section of the Report, we explore the significant impacts on, and dependencies of, these industries with respect to nature. We also examine the changes required within each industry, beyond the actions identified in our modelling, to support the achievement of the GBF Targets and the resulting opportunities available to the primary sector from achieving them. Additionally, we explore the risks the industries will increasingly face if our natural capital continues to deteriorate. These risks and opportunities go far beyond what has been quantified in our modelling of Targets 2 and 3. This qualitative analysis was supported by a literature review and focusses primarily on the production of primary goods and not the downstream value chain (e.g. processors and transport systems).

The Māori economy is heavily invested in the primary sector, with NZD$24 billion of the NZD$69 billion asset base found in agriculture, forestry and fishing.[90] Māori communities and businesses will therefore be disproportionately impacted and will suffer significant economic losses if nature continues to be degraded. It is therefore important that they are part of the process of defining these issues and deciding what actions to invest time, effort and resources into to address them. There is also a lot that can be learnt from Mātauranga Māori to guide our responses to nature-related challenges and opportunities. We have highlighted some examples of this but recognise many more exist.

LIVESTOCK

The livestock industry raises animals to produce food and fibre products for Aotearoa New Zealand and the export markets. We define the livestock industry to include both dry stock (sheep, beef and deer)[91] and dairy farming. Whilst both industries involve the raising of livestock for food and fibre products, they differ significantly in their interrelationships with biodiversity. Comparatively, dry stock farming tends to be less input intensive than dairy farming,[92] occurs over a greater land area[93] which generally includes more native vegetation[94] and operates across a larger variety of landscapes.[95]

Some of our products are dominated by exports, such as our dairy industry which sees over 95% of its products exported.[96] The industry is a critical part of the Māori economy, with 30% of sheep and beef production owned by Māori.[97] The industry is a key contributor to our regional economies and is worth NZD$38 billion (2023).[98,99,100]

Dependencies and impacts

As with all our primary sector industries, the livestock industry is deeply interconnected with nature. Its dependencies, impacts and interactions with nature affect every aspect of livestock farming and the environment in which it operates. For example, 25% of our total national vegetation is on sheep and beef farms.[101]

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The following table outlines the key dependencies and impact drivers between the livestock industry and nature. This highlights the balance that industry and nature need to strike so that each can continue to support each other over the long-term. Each dependency and impact driver have many biodiversity and operational outcomes. For example, historical land use change has reduced the area available to indigenous forests and species biodiversity within these ecosystems; however, completely reverting to original land-uses would impact the productivity of land currently used for livestock farming. The livestock industry also has a uniquely challenging greenhouse gas emissions profile.[102] Although this report does not directly explore the potential solutions to reducing these emissions, many of the proposed sector shifts will support climate action and work to address both Aotearoa New Zealand meeting its GBF Targets and its Paris Agreement commitments.

Table 8: The livestock industry's dependencies and impact drivers on nature

Dependencies	Impact drivers
Land use	
Livestock relies on suitable land to grow pasture and raise the livestock. Livestock farms rely on natural buffers such as planted vegetation for protection from floods and storms. Damage to infrastructure and animals is a key risk for the industry if these buffers are not fully functional.	Most land that is used for livestock once supported other native ecosystems and species, such as indigenous forest or wetlands.
Climate	
Livestock rely on specific climatic conditions to support pasture growth and animal wellbeing. A changing climate presents risks to increasing the frequency and severity of heat stressed animals, decreasing the ability to grow dominant pasture species and increasing rates of disease as vectors proliferate, impacting animal welfare and productivity.	Livestock produce methane, a GHG that contributes to climate change. Almost half of New Zealand's GHG emissions come from agriculture.

Dependencies	Impact drivers
Water	
Livestock relies on water as an input. Risks from this dependency include lowered yield during droughts, especially if unirrigated.	*Use:* Irrigation and abstraction are required for some dairy and dry stock farms to support pasture growth and milk production processes. These impact on water levels, flows and habitat area. *Nutrient pollution:* Over or inappropriate use of fertiliser leads to leaching and overland flow of nitrogen and phosphorous, into groundwater, rivers, lakes and eventually the marine environment. Effluent, when not disposed of correctly, can add nutrient pollution to groundwater, rivers, lakes and marine environments. *Sedimentation:* Eroding soils, stream crossings, milking sheds, silage and oxidation ponds can be areas where there is risk of contamination. This can cause issues such as algal blooms in downstream environments leading to lowered freshwater species. *Chemical contamination:* Pesticides and herbicides, used to control weeds and insect pests, can contaminate nearby waterways. This can increase the toxicity of those waterways and reduce the abundance of native species.
Soil	
Livestock rely on healthy soil in which its pasture grows to supply sufficient nutrients, water and habitat.	Stock trampling and pugging can degrade soil health, leading to compaction and increase sedimentation of downstream environments. This can lead to a reduction in soil biota such as protozoa and nematodes.
Disease and pests	
Livestock farms rely on natural disease and pest control mechanisms to protect their animals and pasture.	Not a key impact.

Possible implications of not achieving GBF Targets

Our analysis focusses on a scenario where Aotearoa New Zealand meets the GBF Targets, and the implications to the livestock industry in doing so. However, it is worth exploring the possible outcomes if these Targets are not met.

If we fail to halt and reverse biodiversity loss, key ecosystem services such as climate regulation, water availability and quality, and soil health – on which the livestock industry relies – may continue to deteriorate and become more volatile,[103] potentially reducing their ability to support the same level of output and quality.[104]

Freshwater quality and availability may continue to be highly constrained.[105] As droughts and floods become more common as the climate changes, the ability for the industry to rely on freshwater for irrigation and abstraction will decrease,[106] possibly impacting pasture growth and overall yield.[107]As a flow-on effect, soil structure and composition may become less capable of supporting pasture growth and livestock by reducing the ability of nutrients and water to travel through the soil.[108] The decreased resilience to droughts may also increase the need for, and cost of, supplementary feed for livestock.[109]

Due to climate change, there will likely be a greater occurrence of pests and diseases, as temperature and humidity increases.[110] If we don't diversify monocultured farms, this may lead to a greater and faster spread of these threats.[111,112,113]

Noting the increasing focus on sustainability in key export markets, Aotearoa New Zealand's products may lose access to premium buyers. This could occur as countries raise barriers to imports which don't meet their local expectations on nature management. Even where access is retained, the premium value for Aotearoa New Zealand products may no longer be available.[114]

Transition pathway to meet GBF Targets

The transformation required by the livestock industry to support Aotearoa New Zealand meeting the GBF Targets sees the industry optimising the use of on-farm fertiliser and pesticides, reducing the industry's reliance on irrigation, increasing riparian and shelterbelt planting, protecting waterways, changing feed inputs, and embracing mixed farming.

To support reduced nutrient pollution and sedimentation entering waterways, farmers fence off waterways, plant riparian vegetation and use fertiliser more precisely.[115] By better matching the nutrient demand of pasture and the load applied by farmers – through soil testing and precision application – these actions lead to decreased costs of fertiliser inputs and reduced leaching of nutrients into waterways. Livestock are excluded from waterways through the use of GPS collars and by planting riparian areas with natural vegetation.[116] This native vegetation acts as a natural buffer, reducing erosion, which in turn leads to a reduced amount of sediment, nutrients, and chemicals entering the waterways. It also protects the farm, livestock, and infrastructure from extreme weather events, such as floods.[117] Circular management techniques, such as optimising effluent, and the use of composted manures and vermicast for fertiliser, also support reduced nutrient loads entering waterways.[118]

To reduce the chemical contamination of waterways from pesticide, herbicide and fungicide use, farmers increasingly use novel chemicals, such as succinate dehydrogenase inhibitors and demethylation inhibitors.[119] These have high degrees of target specificity, low persistence in the environment and are less likely to be transported via surface and groundwater. Harmful chemicals are used sparingly, and not immediately before rain. Moreover, farmers increase the use of non-chemical methods for controlling weeds and pests, such as through mulching.[120]

Precision irrigation is utilised by farmers to reduce water usage.

The industry has diversified its use of land and includes areas of arable crops, orchards, native vegetation and agrivoltaics where appropriate. This integration of different land uses, as well as the use of diverse pastures and grazing management techniques, supports soil stability and health.[121] This improves soil life by adding natural fertiliser through intercropping and supports pasture growth through the presence of pollinators.[122,123,124] The use of diverse cover crops, shelter belts, pastures and forages is adopted by farmers to help to solve compaction and erosion. When multiple species across plant families are grown together, soil structure, soil carbon, water holding capacity and resilience to drought are all improved.

The industry also emits less greenhouse emissions, including through the use of feed additives and novel methane inhibitors. The gap between the productive capacity of the upper and lower quartiles of herds and livestock has decreased significantly.

Assurance schemes such as the New Zealand Farm Assurance Programme Plus (NZFAP Plus) are used to measure outcomes and improve performance.[125]

Opportunities from transition

The transformation of the livestock industry enhances the operational efficiency, resilience and business models of farms.

The reduction in irrigation, pesticide, herbicide, fungicide and fertiliser use to improve nature outcomes has the additional benefit of increasing the operational efficiency of farms through lowered input costs.[126] Operational resilience is achieved through more consistent yields as a result of the increased protection from natural disasters such as floods and droughts, and reduced invasion and spread of pests and diseases.

This increased protection is enabled through riparian and shelterbelt planting, which act as physical buffers against floods and storms and reduce stock losses from these.[127] Diverse land use types aid pest and disease management, also reducing stock losses.[128,129] Additionally, the greater resilience of farms to droughts, from improved soil structure from cover cropping,[130] reduces the need for and cost of destocking and use of supplementary feed.[131]

By taking nature-positive actions, the livestock industry protects its reputation as a sustainable producer, a key international competitive advantage. This is supported through the uptake of assurance schemes such as NZFAP Plus which have been developed based on the sustainability expectations and requirements of customers and markets. As consumers' environmental expectations continue to increase in our key export markets, this advantage will become more valuable.[132] Diversification opportunities will be afforded to entities taking action.
This includes through the sale of biodiversity credits, carbon credits, and ecosystem services. Our modelling supports that a NZD $39.5 billion (NPV 2023) opportunity exists to landowners from the sale of carbon credits, the majority of whom will be livestock farmers.[133]

The diversification of land use to include different agricultural products, as well as supporting soil health and stability, will increase revenue streams. An additional revenue creation or cost reduction opportunity for farmers is to include renewable energy generation infrastructure on farm. This will not only increase Aotearoa New Zealand's renewable energy generation capacity, reducing GHG emissions, but could provide benefit to livestock in the form of shade and shelter for example if solar panels were to be installed.[134]

There is an opportunity for Aotearoa New Zealand's livestock industry to collectively carry out research and development to enable further improvements to practices that support nature and brand value. For example, the development of novel pesticides, herbicides and fungicides can support farm yields whilst lowering impacts to native biodiversity.[135]

HORTICULTURE

The horticulture industry in Aotearoa New Zealand grows fruits, vegetables, grains, and flowers for the domestic and international markets. The export market has grown rapidly over the past two decades and the industry is worth over NZD$7 billion (2024).[136] For our analysis we have defined the horticulture industry as all fruit, vegetable, tree and vine crops, and arable farms. Whilst these farms tend to be located on flat or gently sloping lands with highly fertile soils, there are some key differences between arable and other crops. Arable systems typically include livestock, require less labour, have more mechanised operations, and involve the rotation and production of 'commodity crops'.[137]

Dependencies and impacts

The horticulture industry is deeply interconnected with nature, it relies on it for its key inputs: the land and soil on which farms and orchards are situated, the water and nutrients that crops require to grow, and a stable climate to facilitate this growth. In turn, the industry impacts nature, through its use of the land, changes to soil structure and quality, and impacts on water, carbon and nutrient cycles.

The following table outlines the key dependencies and impact drivers between the horticulture industry and nature. Each dependency and impact driver can have many biodiversity and operational outcomes. For example, nutrient pollution of waterways can lead to eutrophication – which in turn leads to algae blooms, lowered oxygen levels, and a reduced ability of the waterway to provide provisioning and cultural ecosystem benefits. Due to the large number of outcomes, we have restricted our analysis to the impact drivers and key consequences. As a result, the table below is not an exhaustive list.

Table 9: Horticulture's dependencies and impacts on nature

Dependencies	Impact drivers
Land	
Use: Horticulture relies on flat, fertile land to grow its crops.	The land that is used for horticulture was once a native ecosystem, often indigenous forest or wetlands.
Flood and storm protection: Horticulture relies on natural buffers such as planted vegetation to protect their farms from floods and storms. Damage to infrastructure and crops is a key risk for the industry if these buffers are not fully functional.	
Climate	
Horticulture relies on specific climactic conditions for different crop types to survive and thrive. A changing climate presents risks and opportunities to the country, as some crops may no longer be viable in some areas but may become viable in new areas.	The addition of nitrogen fertiliser to soils emits nitrous oxide, a GHG that contributes to climate change. Although not a direct impact, the transportation of the products also emits carbon dioxide.
Water	
Horticulture relies on a consistent flow of high-quality water as an input. Risks from this dependency include lowered yield during droughts.	*Use:* Irrigation is required in some parts of the country to support crop growth; in other parts, irrigation and abstraction are used to enhance crop growth. These impact on water levels, flows and habitat area. *Nutrient pollution:* Over or inappropriate use of fertiliser leads to leaching of nitrogen and phosphorous out of the soil, into groundwater, rivers, lakes and eventually the marine environment. Repeated harvesting increases surface runoff, also accelerating nutrient pollution. This can cause loss of habitat and species. *Chemical contamination:* Pesticides and herbicides, used to control weeds and insect pests, can contaminate nearby waterways causing among other things local loss of fish and invertebrate species.

Dependencies	Impact drivers
Soil	
Horticulture relies on the soil in which its crops grow to supply sufficient nutrients, water and habitat.	Horticultural practises such as tillage, harvesting, fertiliser and pesticide/herbicide use impact the soil structure and chemical composition.
Pollination	
Horticulture relies on pollinators to reproduce, set seed and increase yields.	Land use change and intensification can decrease the abundance of pollinators.
Disease and pests	
Horticulture farms rely on natural disease and pest control mechanisms to protect their crops.	Large monocultures increase the abundance of pests and reduce the resilience of crops to disease.

Possible implications of not achieving GBF Targets

Our analysis focusses on a scenario where Aotearoa New Zealand meets the GBF Targets, and the implications to the horticulture industry if it does. However, it is worth exploring the possible outcomes if these Targets are not met.

If we fail to halt and reverse biodiversity loss, growing conditions in Aotearoa New Zealand may deteriorate due to negative impacts on ecosystem services. Yields could decrease and input requirements – and therefore costs – would increase, adversely impacting the profitability of farms and their long-term viability. In some parts of the country, growing may no longer be possible. This will play out due to potentially lowered availability and quality of water, degraded soil, reduced protection from disruption and less abundance and diversity of pollinators.

The industry may become less resilient to natural disasters, pests and plagues. This would be caused by the continued use of monocultures, which increase the prevalence of pests and the requirement for chemical and nutrient defences to mitigate the faster spread of pests through an area.[138] A lack of natural vegetation protecting and supporting crops also lowers resilience to natural disasters such as floods. This may make yields more variable and uncertain, increase expenditure on insurance premiums and maintenance, degrade produce quality, and increase the stress felt by farmers.

Yields may also suffer due to negative impacts on other ecosystem services, including on direct physical inputs such as water, and on enablers of the production process such as pollination and soil quality. As soil structure and composition continue to degrade through erosion and overfertilisation, crop yields could fall.[139,140] This may lead to lowered profit margins across the industry.

As customer preferences continue to trend towards sustainably produced food, Aotearoa New Zealand's products may lose access to key markets and premium returns. [141]

Transition pathway to meet GBF Targets

A nature-positive transformation sees the industry reduce the use of fertilisers and irrigation, increase riparian planting, adopt new sowing technologies and methods, and change farm management techniques.

To support reduced nutrient pollution into waterways resulting from fertiliser use, farmers minimise time between harvesting and sowing the next crops. Farmers apply smaller amounts of fertiliser during autumn and winter when plants are not growing and avoid application before expected rainfall. Fertiliser is applied in split dressings, and farmers avoid excessive irrigation after application. Farmers change fertiliser types, use biochar and other 'Green Manures' instead of artificial fertiliser.[142] This change has been shown to be effective at providing the nutrients required by crops in Aotearoa New Zealand whilst reducing the impact of nutrient pollution on waterways.[143] By conducting soil testing and foliage analysis, farmers are able to gain a more granular understanding of their crop nutrient requirements, allowing them to match nutrient demands and application. Land and vegetation management is used to reduce runoff, for example, through riparian planting and maintenance of buffer zones between waterbodies and orchards.

To support reduced chemical contamination of waterways resulting from pesticide, herbicide and fungicide use, farmers use novel chemicals, such as succinate dehydrogenase inhibitors and demethylation inhibitors, with high degrees of target specificity, low persistence in the environment, and a lower likelihood to be transported via surface and groundwater.[144] These chemicals are used sparingly and, and not immediately before rain. Their use supports direct drilling and minimum tillage practises by helping control weeds. Moreover, farmers have increased the use of non-chemical methods for controlling weeds and pests, such as through mulching.

Precision irrigation is being used by famers to reduce water usage. Other technologies, such as advanced greenhouse farming – which includes sensors, data analytics and automated systems – lower the input requirements of the industry.[145]

To support the retention of stable and high-quality soil, farmers employ crop rotations, use cover cropping and intercropping, and have increased riparian and shelter belt planting and minimised tillage. Crop rotation is the systematic change of crops between harvests to improve soil quality and avoid the build-up of local pests. Cover cropping involves planting crops not intended for harvest between regular crop production cycles. This practice can improve soil structure and composition and prevent erosion and sedimentation into nearby waterways. Intercropping is the practice of planting two or more crops in close proximity. It improves microbial diversity, nutrient pollution, and yields.[146] Direct drilling reduces the need to cultivate soil and improves soil structure and soil biology.

Nature-based solutions: Watercress

Initial results from a study conducted by NIWA show that watercress can remove nutrients from waterways. In the trial, conducted in the Rotorua district by NIWA scientists, water from a local stream was fed through troughs planted with watercress at two flow rates. At a low flow rate the watercress absorbed up to 40% of the nitrate and phosphate from the water. At a higher flow rate nutrient levels were reduced by up to 15%.

This is an example of how we can use nature to solve for nature issues and illustrates that there can be monetizable benefits related to nature action. In this case both the removal of nutrient pollution could be sold as a service and the watercress sold as stock feed or for human consumption.

Opportunities from transition

Operational efficiency and resilience, as well as business model enhancements are opportunities afforded to the horticulture industry as a result of taking action towards the GBF targets.

Lowered input costs and therefore increased operational efficiency are enabled through the use of precision irrigation and the reduced volumes of fertiliser, herbicide, fungicide and pesticide required as a result of adopting farm and orchard practices that support biodiversity.[147] Yields become more consistent as soil quality and stability improves through use of intercropping and cover crops.[148,149] Riparian and shelter belt planting provide physical barriers against strong winds associated with increasingly frequent and severe storms as a result of climate change helping to reduce damage and natural disaster recovery costs.[150]

Pest and disease invasions and spread are reduced through the use of intercropping,[151] a key threat to some parts of our horticultural industry.[152]

By taking nature-positive actions, the horticultural industry will protect its reputation as a sustainable producer, and enable the industry to continue to access international markets and receive price premiums on its products. As consumers' environmental expectations continue to increase in our key export markets, this advantage will become more valuable.[153] The sale of biodiversity credits, carbon credits, and ecosystem services, as well as the diversification of land use to include different agricultural products and/or renewable energy generation infrastructure will increase revenue streams and reduce risk.[154] For example, biodiversity credits may be awarded to farmers who support native biodiversity through increasing habitat space by planting native species. These biodiversity credits could then be sold through to a company wanting to become nature-positive, or through a compliance scheme requiring them to do so. This diversification towards integrated farming, improves yield productivity, food security and biodiversity outcomes.[155]

As with our livestock sector, there is an opportunity for Aotearoa New Zealand's horticultural industry to work collaboratively to develop innovative practices and/or technology that can support nature while improving efficiency and resilience and protecting and enhancing brand.

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FISHERIES AND AQUACULTURE

Aotearoa New Zealand has the fourth largest ocean territory in the world, with the marine environment adding NZD$7 billion (2017) to our economy annually and employing 30,000 people.[156] Beyond the economic benefits, our oceans are a crucial source of national and cultural identity for many New Zealanders, and are a valuable source of physical, spiritual and mental wellbeing. Many New Zealanders feed their families directly or indirectly through the use of ocean resources. Customary fishing has historically been, and continues to be, an important source of economic and cultural wealth to Māori.[157] The fisheries and aquaculture industry is a key part of the Māori economy, with 47% of all commercial quota by value held by iwi.[158] The fisheries and aquaculture industry includes all wild caught commercial fisheries, and farmed mussels, oysters and salmon. The industry is worth NZD$5.2 billion (2022).[159]

Dependencies and impacts

The long-term prosperity of the fisheries and aquaculture industry is directly linked to the health and resilience of our ocean. The harvesting of wild caught fish and shellfish is a direct use of the provisioning of ecosystem services. Aquaculture farms also rely on a healthy, stable marine environment to grow their products.

The following table outlines the key impact drivers of the industry and its dependency on nature. Each impact driver and dependency has many biodiversity and operational outcomes. For example, high levels of bycatch of vulnerable or threatened species leads to population declines of the species caught, which, in turn, has cascading effects throughout the ecosystem. This, in turn, can negatively impact commercial fish stocks and lower sustainable yields. Due to the large number of outcomes, we have restricted our analysis to the impact drivers and key consequences. As a result, the table below is not an exhaustive list.

Table 10: Fisheries and aquaculture's dependencies and impacts on nature

Dependencies	Impact drivers
Provisioning	
Fishing directly harvests wild stocks of fish and shellfish	Overfishing and bycatch reduce populations of marine life. As climate change drives changes in the geographical distribution of fish stocks, fishers may be motivated to overfish now to offset future losses in revenue.
Habitat	
Commercial fishing stocks rely on nursery habitats for protection and food for juveniles, supporting the long-term population of the stock.	Bottom trawling and other bottom-impacting fishing methods remove and damage sea life, reduce habitat integrity, and sometimes irreversibly alter the structure of the seafloor. Additionally, commercial fishers contribute significantly to marine plastic pollution as a result of abandoned, lost or discarded fishing gear.This can result in the physical and chemical degradation of marine habitats.
Water	
Aquaculture farms and fish stocks rely on a continuous flow of water that is free from excess nutrients, sediments and pollutants such as pesticides	*Flow and clarity:* Aquaculture farms incorporate large structures such as fish cages and oyster racks which create obstructions in the water column and can alter currents and water flow and therefore impact on the way sediments deposit and accumulate. This can decrease water clarity and have negative impacts on species living on or around the seabed. *Nutrient pollution:* Aquaculture farms release nutrients such as faeces, fish food and live shellfish resulting in eutrophication. *Chemical contamination:* Aquaculture farms release chemical contaminants, for example from pharmaceutical products, anti-fouling paints and fish food, and these can be detrimental to aquatic life.
Climate	
Marine heatwaves pose a significant risk to our marine ecosystems and the industries which rely on them by lowering oxygen levels, making water more acidic and lowering water quality.Additionally, aquaculture farms and fishing vessels rely on calm conditions to grow and harvest their products.	Bottom trawling and other fishing activities can disturb the seafloor, releasing stored carbon that is released to the atmosphere. Additionally, and although not a direct impact, greenhouse gas emissions are generated in the burning of fuel when vessels travel to fishing grounds and during the transportation of the products.

Possible implications of not achieving GBF Targets

Our analysis focuses on a scenario where Aotearoa New Zealand meets the GBF Targets, and the implications to the fisheries and aquaculture industry in doing so. However, it is also worth exploring the possible outcomes to the industry if these Targets are not met.

If we fail to halt and reverse biodiversity loss, Aotearoa's marine environment may degrade due to continued use of bottom trawling and dredging, overfishing, increased marine plastic pollution, and climate impacts such as increased water temperature and acidity. The spread of invasive species, such as Exotic Caulerpa, may cause the loss of marine ecosystems and native species. The abundance of fish stocks could significantly decline, diminishing the ability of the marine environment to provide the provision and regulatory services on which our fishing industry relies. These services include coastal protection, moderation of extreme weather events and pollution control.[160]

Vessels may be required to spend longer at sea, travel further and fish at greater depths to obtain a sufficient catch, resulting in increased fuel and crew costs. Oceanic temperature increases around Aotearoa New Zealand increase the frequency and intensity of storms and therefore the risks associated with deep ocean fishing.[161]

Land-based activities such as nutrification and sedimentation combined with climate impacts such as ocean acidification and temperature increase may diminish species growth rates and the overall productivity of our aquaculture industry. Acute marine heatwaves could kill fish stocks and increase the volatility in the yields of operators.[162] Maintenance costs may increase due to an increase in climate-related coastal storms. Sea level rise may require widespread infrastructural changes to farms and capital expenditure.

As with our land-based industries, in the absence of nature-positive transformations, Aotearoa New Zealand's fishing and aquaculture industries may lose market share to other parts of the world that have successfully adopted nature positive practices. However, even more concerning will be the industry's reduced ability to provide protein to our own population, not only through commercial fisheries and aquaculture but through subsistence and customary fishing, and shellfish harvest. Work to reverse environmental degradation and enable the restoration of kai moana populations may be extensive, expensive and potentially unsuccessful.

Transition pathway to meet GBF Targets

In a world where Aotearoa New Zealand has reversed biodiversity loss, the fisheries and aquaculture industry has transformed. This transformation sees the industry having changed several current practises, including shifting away from bottom trawling and dredging, operating within a more informed and responsive quota management system, and with aquaculture farms that are appropriate in location and size.

Fisheries no longer use indiscriminate bottom-impacting methods, instead using techniques such as purse seine and longlining which reduce impacts on marine habitats and bycatch rates. Purse seine fishing is the use of vertical nets, which are released around schools of fish without touching the seafloor and can lower the rates of bycatch. However, fish aggregating devices (FADs) to attract fish for purse seine fishing are not used as these increase rates of bycatch.[163] Pelagic longlining targets midwater fish using baited hooks attached to a main line. Best practice seabird bycatch mitigation measures – including the use of hook-shielding devices, weighted branch lines, tori lines and setting lines at night – have been implemented across the industry, reducing bycatch rates to negligible levels and safeguarding our vulnerable seabird populations.[164]

The quota management system has become nuanced and responsive to fisheries and climate data, protecting commercially caught fish stocks from overfishing. This responsiveness is driven by more complete, granular, and accurate data on our fish stocks and a clear, evidence-directed relationship between the health of a particular stock and the total commercial catch allowed.[165] Customary fisheries management practices such as rahui are employed more frequently in response to a fish stock showing signs of stress.

Shellfish farms are following best practice guidelines, including operating above muddy habitats, being appropriately stocked, and not having multiple farms concentrated in a single bay.[166] Fish farms are located in deep, well-flushed areas, which decreases the impact of organic material on the seafloor, provides the farms with greater resilience to marine heatwaves, and reduces their impact on water flow. All types of aquaculture operate with a more informed view of the baseline water quality and the impacts of their operations on marine ecosystems and species.[167] This has been achieved by greater monitoring, testing, and mapping of the marine environment prior to the approval and construction of aquaculture farms. Aquacultural use of antibiotics, vaccines and steroids and other growth enhancers have been reduced to minimum levels required to support the overall health of fish and shellfish stocks.

Fishers are taking greater action to reduce marine plastic pollution from abandoned, lost or discarded fishing gear. This includes through research and redesign of fishing nets and other fishing gear to use alternatives to plastic, reusing and repairing fishing gear as much as possible, identifying innovative future use of fishing gear that is no longer repairable, and putting in place recovery strategies for discarded gear.[168]

The transformation in the fisheries and aquaculture industry has been supported by land-based industries, which have decreased their pollution of fresh waterways and the marine environment.

Opportunities from the transition

The transformation of the fisheries and aquaculture industries supported by government action enhances the operational efficiency, resilience and business models of aquaculture farms and fishers.

Aquacultural farm reductions in the use of antibiotics, vaccines, steroids and other growth enhancer to support the overall health of fish and shellfish stocks improves their operational efficiency by reducing input costs.[169] For fishers, healthy fish stocks mean vessel fleets spend less time at sea and travel shorter distances to obtain a sufficient catch, thereby reducing fuel and crew costs.[170]

Operational resilience is achieved by the aquacultural industry through more consistent yields: a result of more sustainable fish stocks and a healthy marine environment. By using spatial planning to avoid the concentration of aquaculture farms in single bays and lowering the density of fish in aquaculture farms, the spread of disease is reduced, increasing consistency of yields.[171,172] Action taken by our government to put in place Marine Protected Areas (MPAs) that exclude any harvesting activity from 30% of our oceans support healthy, sustainable fish stocks, provide safe havens for all marine life, and increase the available catch in surrounding waters.[173] Our modelling indicates that if these MPAs are implemented now, positive economic impacts will occur from 2039 onwards.

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Nature-positive action taken by these industries and supported by government regulation and assurance programmes, for example through the monitoring of fishing fleets with cameras, convey trust in sustainable management to nature-conscious consumers. This protects the aquaculture and fishing industries reputations as sustainable producers. The sale of biodiversity credits, blue carbon credits, and ecosystem services, will increase revenue streams and reduce risk through diversification. Creative reuse or repurposing of fishing gear waste could provide additional opportunities for revenue or support reduced costs.[174]

FORESTRY

Plantation forestry, defined as the planting and cultivation of trees for timber and non-timber products, is a large industry in Aotearoa New Zealand, covering 2.1 million hectares and worth NZD$6.6 billion (2024).[175,176] The industry is currently dominated by exotic monoculture plantations of pinus radiata (Radiata pine), with Douglas fir and various cypress and eucalypt species also grown for timber.[177] Harvesting of native forests is minimal and highly regulated.[178] In recent years, the inclusion of forests in the NZ ETS has accelerated afforestation rates.[179] Māori own 48% of commercial forests in Aotearoa New Zealand, making it a key industry to iwi and hapū.[180]

Dependencies and impacts

Forests regulate carbon, water and soil cycles.[181] Since human arrival, forest coverage, which once accounted for more than 80% of Aotearoa's land area, has halved.[182] The forestry industry is deeply connected to the natural environment, both relying upon and providing multiple ecosystem services.

The following table outlines the key impact drivers of the industry and its dependency on nature. Each impact driver and dependency has many biodiversity and operational outcomes. For example, the spread of 'wilding conifers' beyond forest boundaries reduces the size and integrity of other native ecosystems. This can affect the abundance and diversity of native wildlife, increase wildfire risk, negatively impact the water cycle, and reduce grazing land for pastural farming.[183] Due to the large number of outcomes, we have restricted our analysis to the impact drivers and key consequences. As a result, the table below is not an exhaustive list.

Table 11: Forestry's dependencies and impacts on nature

Dependencies	Impact drivers
Land	
Forestry relies on land to grow its trees.	Plantation forestry operates on land that was once indigenous forest and lowers the biodiversity of the area. Monoculture plantations can disrupt water cycles and soil fertility and increase the adverse effects of wildfires and pests and diseases.
Water	
Forestry relies on a consistent flow of high-quality water as an input. Risks from this dependency include lowered yield during droughts.	*Woody waste and sedimentation:* Woody waste (slash) and sedimentation produced from planation forests can damage downstream waterways, vegetation and the coastal marine environment. *Nutrient pollution:* Fertiliser use on plantations leads to nutrient pollution of downstream waterways. *Chemical contamination:* Chemical contamination of waterways can occur from direct spraying of, for example, herbicides and pesticides, and spills.
Climate regulation	
Plantation forests rely on a stable climate to regulate wildfire and storm risks.	Forests have the ability to sequester carbon, reducing the impacts of climate change.
Disease and pests	
The forestry industry relies on natural disease and pest control mechanisms to protect their forests.	When seeds from exotic forests self-spread beyond the plantation, they can significantly alter, and impact other habitats and the species make up. Exotic plantations can also increase the presence of pests.
Soil quality and stability	
Forestry relies on soil to provide the nutrients, water and habitat for the forests to grow. Key functions of the sold include the decomposition and fixing qualities which enable nitrogen fixing, nitrification and mineralisation of dead organic material, soil stability and managing the microbes and water levels.	Increased soil degradation and erosion from compaction, exposure and mechanical damage as a result of harvest. This can increase the risk of landslides and sedimentation in waterways.

Possible implications of not achieving GBF Targets

Our analysis focusses on a scenario where Aotearoa New Zealand meets the GBF Targets, and the implications to the forestry industry if it does. However, it is worth exploring the possible outcomes to the industry if these Targets are not met.

If we fail to halt and reverse biodiversity loss, soil stability may continue to suffer due to compaction, exposure, and mechanical damage from harvesting. Furthermore, continued mono-cropping depletes soil nutrients, diminishing the soil's capacity to support forest growth. This increases the risk of tree loss and other damage resulting from storms[184] and wildfires,[185] which will increase in frequency and severity as a result of climate change.[186]

Pests and disease continue to threaten our forests, with plantation monoculture forests typically being more vulnerable than natural forests.[187] If these risks materialise it could lead to large degradation of Aotearoa New Zealand's forests and economic losses for their owners.[188, 189]

Our plantation forests may continue to impact the environment, including through the spread of exotic species beyond plantation boundaries, which can disrupt natural habitats and alter the composition of native species. Nutrient and chemical pollution from production forests, as well as woody waste and sedimentation, may cause significant damage to nearby waterways.[190] Whilst these impacts are felt primarily by industries other than forestry, there may be flow-on legal and social licence implications for the forestry industry.[191]

Transition pathway to meet GBF Targets

In a world where New Zealand has reversed biodiversity loss, the forestry industry has transformed and expanded. This transformation sees the industry having changed forestry types and practises, to include more native trees and continuous coverage forestry (CCF). The expansion occurs both within the traditional forestry industry and across the rest of the primary sector, as land use is optimised, and more mixed land-use occurs.

Native trees make up a greater proportion of plantation forestry, especially on highly erodible land and riparian zones.[192] This supports biodiversity of other species and reduces sedimentation, nutrient, and chemical pollution entering downstream waterways.

CCF enhances resilience in our forestry industry and mitigates environmental impacts, leading to improved water quality, increased biodiversity, and reduced erosion. It achieves these benefits by favouring mixed-species and uneven-aged planting over large-scale clear-felling.[193]

Woody biomass is retrieved from forests and sold for use in biofuels and other products, reducing damage caused to downstream ecosystems following storm events and creating additional revenue streams.[194] Advanced woody residue recovery systems and technologies are deployed at scale to facilitate this retrieval.[195]

Other changes to forestry practices include a reduction in the use of fertiliser and herbicides, resulting in lowered pollution of waterways and a greater ability to control and suppress wilding conifers. This increases both biodiversity and the availability of productive land in Aotearoa New Zealand.[196]

Opportunities from the transition

The transformation of the forestry industry enhances the operational efficiency, resilience and business model of the industry.

The reduction in pesticide, herbicide and fungicide use increases the operational efficiency through lowered input costs.[197] Operational resilience is achieved through more consistent yields: a result of lowered impacts from pests and diseases, droughts, floods and wildfires. Pests and disease are less able to spread through genetically diverse and complex landscapes than monoculture plantations.[198] Native forests are less susceptible to wildfires,[199] and continuous forest coverage increases resilience to droughts and floods through increasing the water storage potential of the forest.[200,201]

By taking nature-positive actions, the forestry industry protects its reputation as a sustainable producer, a key international competitive advantage. As consumers' environmental expectations continue to increase in our key export markets, this advantage will become more valuable.[202] The sale of biodiversity credits, carbon credits, ecosystem services, and waste products for feedstocks to biofuels will increase revenue streams. For example, Genesis Energy is exploring the use of biomass in its Huntly Power Station to provide dispatchable renewable electricity.[203] The feedstock for this biomass will likely come from forestry operators, and Genesis is exploring the viability of a local supply chain.[204]

05

CLOSING THE INVESTMENT GAP

THE CASE FOR INVESTING IN NATURE

Historically, our economic system has failed to adequately value and invest in nature, both globally and locally.[205,206] Our financial systems that underpin our economies do not currently account for nature in a meaningful way; for example, natural capital is not included in government accounts.[207]

This means we do not meaningfully incentivise preserving and restoring nature and we do not adequately penalise nature-harmful activities.[208] As such, a large investment gap currently exists between the current levels of investment in nature and what is needed to achieve the GBF Targets.

Our analysis shows that achieving Target 2 and Target 3 by 2030 is estimated to generate significant net positive economic value to Aotearoa New Zealand of NZ$272 billion (2023 dollars) from 2025 to 2080. This outcome includes the costs of implementing actions. However, because of the limitations in our current economic system, it is challenging to attract capital into biodiversity outcomes.

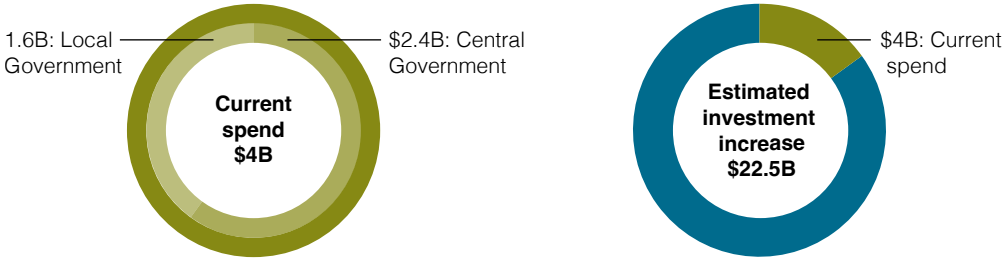
Increasing the flow of resources towards nature-positive actions is one of the most challenging and important issues in addressing the biodiversity crisis and the longer we wait the more costly the action will become, and the more likely irreversible damage will occur.[209]

There will also inevitably be a lag between mobilising finance, undertaking activities and having the desired effect on biodiversity. This increases the pressure to act quickly.

Investment into nature by investors outside the public sector and philanthropy is challenged by a lack of mechanisms that produce sufficient financial returns to be comparable to other investments and therefore be attractive. However, as this modelling shows, nature action does generate financial returns and with the right enabling structures and financial mechanisms, should be investable.

This section of the Report examines the nature financing gap and investigates ways we can overcome it.

The Nature Financing Gap



THE NATURE FINANCING GAP

Based on our research, NZD$4 billion (2024) is currently spent per year on biodiversity in Aotearoa New Zealand. The majority of this comes from central government (~NZD$2.4 billion (2024) per year[210]), and local government (~NZD$1.6 billion (2022) per year),[211] with a small proportion coming from philanthropy (~NZD$25 million (2018) per year).[212] This calculation excludes investments made by private landowners, iwi and corporations investing directly into nature.[213]

This spend is largely through the Department of Conservation (DOC), which manages approximately one third of Aotearoa New Zealand's land mass, a significant marine area, and all our native species. Other significant Government investment in nature has historically been ad hoc and is typically time-limited and ring-fenced to specific projects – for example, the Jobs for Nature programme and Predator Free 2050 initiative. These are good initiatives, but the insecurity of funding is a barrier to delivering sustained progress on reversing biodiversity loss.

We have estimated that approximately NZD$26.5 billion (2024) is needed annually to meet the 23 GBF Targets in Aotearoa New Zealand. For this estimation a 'top-down' approach was employed, relying on global estimates from international literature,[214,215] which was scaled proportionally to Aotearoa New Zealand.[216]

New Zealand's current biodiversity investment gap:

Using this high-level approach, we estimate Aotearoa New Zealand's investment into nature needs to increase by ~6.5 times or NZD$22.5 billion (2024) per annum to achieve all of the GBF Targets.

We have also estimated investment needs to achieve individual GBF Targets in Aotearoa New Zealand. For Targets 2 and 3 the estimate is based on actions identified for incorporation into our modelling (see Section 2). Appendix A outlines our approach for Targets 4 and 6.

Comparison of the top-down and bottom-up estimates is not possible due to the different modelling approaches. All the estimate approaches used here contain significant assumptions and have high degrees of uncertainty. However, we can see from this analysis that investment is required to meet each Target and the estimated level of investment required to meet Target 4 is significantly greater than the other Targets and is also significant compared to an estimate of the total investment needed in Aotearoa New Zealand (NZD$8.1 billion or 30.5% of the estimated NZD$26.5 billion per annum requirement). This large estimate reflects that Aotearoa New Zealand has many native species now threatened with extinction[217,218] and that successfully supporting species recovery requires specific and significant investment.[219]

Table 6: Estimates of investment required to meet the GBF Targets in Aotearoa New Zealand, NZD 2023

GBF Target	Estimated annual investment to meet specific GBF Targets
Target 2: Restore 30% of all Degraded Ecosystems	NZD$1.6 billion
Target 3: Conserve 30% of Land, Waters and Seas	NZD$0.9 billion
Target 4: Halt Species Extinction, Protect Genetic Diversity, and Manage Human-Wildlife Conflicts	NZD$8.1 billion
Target 6: Reduce the Introduction of Invasive Alien Species by 50% and Minimise Their Impact	NZD$1.0 billion
Total investment estimated to be required annually to meet the Targets considered in this Report	NZD$11.6 billion

BARRIERS TO INVESTMENT

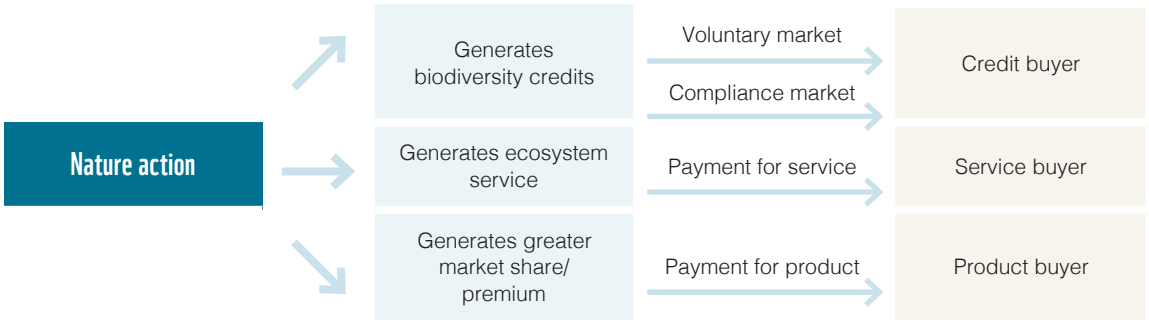
Our economic modelling and the limitations to valuing nature, highlight the barriers to investing in biodiversity and nature. We have summarised these in Table 7. For each barrier we have identified potential opportunities which could increase nature-focused investment beyond grants from government and philanthropy.

Table 7 Barriers to investment and opportunities

Description	Opportunities
Transparency: *Lack of data and measures to identify nature-related impacts*	
As this Report highlights, the value of nature is poorly recognised in financial terms. We have limited information about our reliance on nature and on how our actions impact nature. This makes it challenging to then quantify how significant nature is and how damaging or restorative our actions are on nature and how this supports our broader economy.	Below are examples of mechanisms developed to overcome this barrier and encourage better transparency and data: • *Nature-based compliance reporting and measurement:* Development of a biodiversity measurement approach will be required to support the reporting of nature-related risks and opportunities to investors and to underpin biodiversity credits and ecosystem service payments. Frameworks such as TNFD set out a robust framework for companies to report their impacts and reliance on nature. This provides greater transparency on nature-related costs and benefits, which will incentivise investment. • *Nature-Positive standards:* These are consumer focused standards that set nature-related requirements for products and brands to meet in order to be labelled as nature-positive and be attractive to the premium market segment. These standards incentivise company nature action with the aim of increasing brand value.
Diffuse: Financial cost and benefits are experienced by different parties	
Our modelling shows there could be significant financial benefits to the Aotearoa New Zealand economy as a whole from taking nature-positive actions. However, some sectors are expected to be worse off and some better off. In many cases, those that receive financial benefits will not be those that take the nature-related action. This causes financing challenges as parties would need to share costs and benefits to make action desirable and investable.	Below are examples of mechanisms developed to overcome this barrier and encourage investment where multiple stakeholders are involved: • *Ecosystem service payments:* Recipients of the financial benefits pay those required to take the action. • *Biodiversity/carbon crediting:* Credits are generated and sold be those taking the action to compensate them for the project costs. • *Multistakeholder transactions:* Transactions can be arranged that involve several parties with different terms for each party. These are generally blended financing models with more bespoke and complex structures that allow for different interests to work together to finance a project with shared outcomes.

Description	Opportunities
Elongated: Payback periods are longer than other investment types	
The modelling shows the most significant costs are experienced in the short-term and were related to project implementation. Financial benefits commenced in later periods and then tended to increase over time. Although, over a long period (10+ years) the investment returns may look attractive, over shorter periods (3-5 years) (more aligned to traditional investment mandates) they may not.	Below are examples of mechanisms developed to overcome this barrier and encourage investment in longer-term outcomes: • Government financing vehicles: Globally, governments have set-up financing vehicles (such as green banks) that will accept longer payback periods from investments or take higher risks (e.g., first loss provisions). These vehicles aim to encourage private investment by improving the risk/return profile to be comparable with other investment types. • Discounting lending products: Banks and insurers can offer discounted lending products to incentivise investment in these actions. These discounts are driven by a perceived risk reduction or brand improvement of the borrower as a result of nature action. The incentive can be more substantial if backed by a government borrowing rate or some level of government first loss provision, or if supported by capital adequacy frameworks that allow banks to hold less collateral against these types of loans.
Novel: Companies focussed on nature action are generally SMEs or Māori entities that face difficulty obtaining finance	
Entities carrying out nature restoration and preservation activities are often small, sole traders or Māori entities. Small entities often have limited credit history which makes it difficult for these entities to obtain finance. The investment size required from these SMEs also tend to fall below the minimum investment size for larger and institutional investors. Many Māori landholdings are inalienable, meaning the land cannot be sold, and therefore cannot be used as security for finance. Additionally, the treaty settlements process requires an iwi to establish a post-settlement governance entity, the form of which has been dictated and changed over time resulting in a landscape of legal structures that banking teams find difficult to navigate.	Below are examples of mechanisms developed to overcome this barrier and encourage investment in new, smaller and/or Māori entities: • *Project aggregation:* Pooling nature projects with different credit ratings and risk/return profiles can reduce portfolio risks and increase the overall portfolio size. This can transform the investment characteristics of an individual SME project to that of an investable aggregated portfolio (a portfolio returning between 5 and 15% annually in the long term). • *Investment structures and approaches that are cognisant of Māori land and organisational structures:* Banks could put in place Māori banking teams and/or other investment structures such as credit terms to support iwi to better access capital toward the nature outcomes that they are focused on.

Figure 10: Mechanisms to support monetisation of nature action



OPPORTUNITIES TO OVERCOME INVESTMENT BARRIERS

As outlined in Table 7 above, we have identified a number of opportunities to overcome the barriers identified and increase investment into nature. We have grouped these investment mechanisms under business model pathways, government action pathways and finance sector pathways and explored these pathways in this Section.

Business model pathways

We have identified three main business model pathways through which nature action can be monetised and attract additional investment (as shown in Figure 10):

- Biodiversity or carbon credits generated by nature action could be sold either through a voluntary market or through a compliance market, for example if the New Zealand Emissions Trading Scheme (NZ ETS) were to be expanded to include nature-based sequestration solutions.
- Ecosystem services payment structures could be invested in by entities and government who benefit from the service enabled by the action. Entities whose business models rely heavily on nature will benefit from the ecosystem services, such as enhancing the resilience of their business or improving productivity.
- Nature reporting and consumer product standards can generate greater market share and increase price as consumers seek out nature positive products. To support communication of nature action to the market and enable the increase in market share and premium price, reporting or consumer standards should be adopted.

Biodiversity and carbon credits

Biodiversity credits recognise in a consistent way projects and activities that protect or enhance biodiversity. Biodiversity credit systems enable individuals and companies to invest in projects that contribute to protecting, restoring and enhancing biodiversity and mobilises investment to support landholders or project owners with taking nature-positive action.[220]

At a voluntary level there are many examples of biodiversity credit platforms both in Aotearoa New Zealand and globally that could be replicated and grown further:

- ICR: The International Carbon Registry (ICR) announced in 2024 their pilot Biodiversity Program. Projects will be registered and will issue biodiversity credits publicly on the ICR platform.[221]
- Australian Nature Repair Market: In Australia, the Nature Repair Act 2023 has established a framework for a voluntary biodiversity market. The scheme will incentivise actions to restore and protect the environment by creating a marketplace where individuals and organisations can undertake nature repair projects to generate a tradable credit. This market is expected to open in 2025 and will allow for alignment with the Australian Carbon Credit Unit (ACCU) Scheme.[222]
- Toha Network: In Aotearoa New Zealand, the Toha Network have developed a token network, whereby their platform facilitates the voluntary buying of MAHI tokens to support specific project's conservation work. [223]

Nature-based solutions could also be included within the NZ ETS, allowing for the integration of biodiversity credits with carbon credits. This would enable the carbon sequestered through a nature-related project to generate revenue.

There are examples of carbon crediting schemes and emissions trading schemes including nature-related methods, such as:

- The American Carbon Registry (ACR) has developed a wetland restoration methodology, meaning wetland conservation projects are able to generate offsets that can be sold on California's state-wide, compliance carbon market.[224]
- The ACCU Scheme includes methods for forestry, agricultural and vegetation project activities that enable eligible projects to earn Australian carbon credit units (ACCUs). For example, reforestation and activities that enable carbon to be stored in soil could generate units when the ACCU method requirements are met.[225,226]

We note that for a biodiversity credit scheme to operate biodiversity measurement approaches are required and these have been outlined in Section 5.3.1.3.

Ecosystem service and outcomes payments

Ecosystem service payments are a voluntary transaction where payments are made based on the delivery of environmental outcomes. This approach is used in environmental projects where investors, who rely on an ecosystem service, agree to pay for specific ecosystem service outcomes rather than simply investing in an activity or inputs. Generally, the investor will expect a financial benefit to their business from the improvement in the ecosystem service, which is why this approach is financially desirable.

In a 2021 OECD report,[227] ecosystem service payments were identified as the nature-based financial mechanism that generated the most revenue.[228]

Some examples of ecosystem service payments are outlined below:

- In Oregon in the US, farmers are paid for shade services provided to cool water discharged from a wastewater treatment plant through the restoration of trees and shrubs on riverbanks.[229]
- Nestle-Vittel and Danone-Evian, two of the largest water companies in the world domiciled in France, have developed ecosystem service payment schemes in their water source areas to pay farmers who adopt sustainable agricultural practices that avoid water pollution.
- In the United States, the New York City water utility pays farmers to reduce pollution in the Catskill basin.
- The operators of Guri hydro dam (the world's third largest based in Venezuela) pay for conservation and surveillance activities in the adjacent Canaima National Park to reduce the risk of deforestation, which could result in soil erosion and siltation of the dam's reservoir.[230]
- A common ecosystem service payment approach used globally is asking tourists to pay a fee to visit nature-based attractions

Nature reporting and consumer product standards

For biodiversity credit markets to function and ecosystem service payments to be viable, appropriate biodiversity measurement approaches will be required. As above, nature action can generate greater market share and increase price as consumers seek out nature positive products. However, consumers will need to understand the actions taken and trust that any claims made, or metrics provided are accurate. Described below are a number of enabling actions that could be taken to enable these business model pathways to function and support increased investment into nature.

Development of a biodiversity measurement approach

There are a number of frameworks that exist to support measurement of biodiversity and nature outcomes such as the Global Biodiversity Score, Biodiversity Credit Alliance Taskforce, IUCN Species Threat Abatement Restoration (STAR) Metric, UK Biodiversity Net Gain metric and the Natural England Biodiversity Metric 4.0.[231] These frameworks incorporate some or all of the following measures:

- Species richness: Quantifies the number of different species in an ecosystem.
- Species abundance: Measures the population sizes of different species within an ecosystem.
- Species threat: Measures the risk of extinction of a species.
- Species evenness: Measures the commonness or rarity of a species within an ecosystem relative to other species.
- Ecosystem integrity: Provides a measure for the overall health, functioning and resilience of an ecosystem.

The development of an approach to using these frameworks will support project proponents to report on the outcomes and impacts of their nature-focused projects and therefore increase investment into these project types. This development would underpin an effective biodiversity market and support ecosystem service payments. A framework could be developed at the government-level or by the private sector with support of relevant not-for-profits. A government developed or endorsed framework would support market consistency and understanding and likely have more impact.

At the entity level, approaches are being developed to incorporate the measurement of nature in investment decisions. Tahito is an indigenous ethical investor that applies ancestral Māori knowledge to determine a set of key principles that guides its investment behaviours and decisions. Some of these principles include Whanaungatanga tō ao – understanding the interconnectedness of the world; commercial, social, environmental and cultural, Whakapapa tō mana – understanding that business is interdependent and relies on its total environment to succeed.[232]

Nature-based compliance reporting

Nature-based reporting supports ecosystem service payments and greater market share/premium revenue mechanisms, by providing a framework for businesses to understand and disclose their nature-related risks, impacts, dependencies and opportunities. To support high quality and comparable disclosures, this reporting should be mandatory for some large organisations. This enabling action aligns closely to Target 15 – Businesses Assess, Disclose and Reduce Biodiversity-Related Risks and Negative Impacts of the GBF:[233]

The Taskforce on Nature-related Financial Disclosures (TNFD), which is the current global leading nature-based disclosure framework, could be used. The TNFD recommendations are structured around governance, strategy risk management and metrics & targets. This structure is, consistent with the Task Force on Climate-related Financial Disclosures (TCFD) and the International Sustainability Standards Board (ISSB).[234]

The TNFD is still maturing, with only 400 organisations having adopted it globally,[235] and nature reporting not yet being mandated in any jurisdiction.[236] However, if nature reporting was made mandatory for large private entities, it would drive nature positive outcomes by:

- Developing the internal processes within entities to not only report on but understand and act on nature-related risks and opportunities, impacts and dependencies
- Enabling investors and other stakeholders to understand the nature-related risks and opportunities of an entity to support informed capital-allocation decisions
- Promoting investments into nature positive organisations and activities and away from nature harmful ones
- Providing a framework to encourage development of nature-related metrics or a measurement approach which will support increased nature-related investments.

Nature-positive labelling system

The creation of an Aotearoa New Zealand-specific nature-positive labelling system could support entities to make credible claims about their products or activities. EcoChoice Aotearoa (The Ecolabelling Trust New Zealand), an independently governed non-profit organisation, is responsible for creating third-party certifications and ecolabels for some of Aotearoa New Zealand's products and services and could support the development of such a system. Nature-positive labelling could drive heightened corporate awareness of the reliance on nature and could act as a catalyst for increasing investment demand from businesses and consumers seeking to align with sustainable and environmentally responsible practices. Additionally with export markets increasingly focussed on environmental sustainability, this will support Aotearoa New Zealand exports.

Government action

There is a role for government to build supporting infrastructure and stimulate investment into nature. Specific actions are outlined below.

Process for assessing the credibility of biodiversity or nature-based carbon sequestration crediting methods

To support the development of credible markets, biodiversity and nature-based sequestration methods should align to international expectations of credits and have rigorous evaluation approaches that focus on integrity. The infrastructure for this process can be led by government to show their support of these markets and to provide independence from method developers and vested interests. Methods approved through such a process can then feed into voluntary or compliance markets. This type of structure is used in Australia and is being bolstered after the independent review of the ACCU scheme, which set out improvements to the governance and review process of the Clean Energy Regulator, an independent statutory authority who oversees method development and the integrity of carbon and future nature markets in Australia. ACCU methods must now meet legislated Offsets Integrity Standards and result in emission reductions that are real and in addition to business-as-usual operations.

Determine if nature-based methods could be included into the New Zealand ETS

Nature based sequestration (beyond post-1990s forestry) could be included into the NZ ETS and product NZUs, which would then link these projects to a compliance market and provide access to additional market demand. Linking these types of biodiversity credits to an established compliance market provides immediate infrastructure, price history and credit demand, which will take a longer time to establish through voluntary biodiversity markets. However, adding new sources of supply into the NZ ETS would also impact the supply and demand characteristics of the market and careful evaluation would be required to minimise disruption to the markets price stability.

Determine mandatory reporting requirements on nature-related impact

Currently, there are no mandatory requirements to report on nature-related impacts of business operations in Aotearoa New Zealand, which means businesses have less clarity on their relationships and impacts on nature Nature-related reporting could be embedded within the established New Zealand Climate Standards (NZ CS).[237] The Taskforce for Nature-related Financial Disclosures (TNFD) aligns with the pillars of the NZ CS reporting standards and certain parts of this reporting standard, such as the identification of risks and opportunities and reporting on metrics & targets could be broadened to cover nature-related impacts. Other sections of the NZ CS might already be appropriate for encompassing nature-related information, meaning the increased compliance burden of broadening this standard could be kept low.

Development of a sustainable finance strategy and taxonomy that links to nature-positive consumer standards

The Aotearoa New Zealand government announced in July 2024 the development of a sustainable finance strategy and associated taxonomy.[238] Developing a sustainable finance strategy that links with the long-term strategic objectives and economic growth opportunties of Aotearoa New Zealand will highlight where nature-related solutions can be strategically important and prioritised through government support. The associated sustainable finance taxonomy is a set of agreed definitions for what constitutes sustainable economic activity. This taxonomy will initially prioritise climate mitigation but climate resiliency and biodiversity could also be prioritised.[239] The inclusion of biodiversity and ecosystem protection within the taxonomies environmental objectives is expected to support the mobilisation of private sector investment into biodiversity and nature and the taxonomy can be used to support the branding of nature-positive products and provide a platform to continue to market Aotearoa New Zealand exports as high-quality, premium products.

Develop a blended finance,[240] scalable investment vehicle or mechanisms for nature-related projects

The modelling showed that nature-related action has significant long-term financial returns to Aotearoa New Zealand. However, due to the challenges highlighted above, there are barriers to attracting traditional investors to these projects. The Government could establish an investment fund or a blended finance investment mechanism which targets nature-related projects which will support significant long-term financial returns to Aotearoa New Zealand.

This fund or mechanism should be scalable and be focussed on crowding-in capital by becoming a cornerstone investor, who takes a higher risk tranche of the investment (such as longer-term payback periods, first loss provisions or outcomes payment structures). This would then attract traditional investors into a more commercially structured investment tranche. This is similar to the role of the New Zealand Green Investment Finance (NZ GIF), but with higher levels of risk than the NZ GIFs mandate allows. This type of government support can also be provided directly through government lending programmes.

Examples of this can be seen globally through government blue bond programmes (e.g. Indonesia's blue bond, which provided finance for coastal protection, sustainable management of fisheries and aquaculture, marine biodiversity conservation and mangrove rehabilitation[241]), government outcomes payment mechanisms (e.g. Costa Rica's payments for forest protection[242]) or government investment funds (e.g. ARENA in Australia which targets renewable energy in Australia). This type of government support can also assist in aggregating nature-related projects and investors.

Aggregating allows diversification of project characteristics such as payback timeframes, risk structures and outcomes and therefore reduces overall investment risk. This way, the higher-risk projects are balanced by more stable, income-generating activities within the investment bundle, increasing the attractiveness of such investments. It also enables the bundling of projects into investable market-size packages increasing the attractiveness to a wider range of investors.

Financial Institutions action

There is a role for financial institutions to support investment into nature. Specific actions are outlined below.

Development of specialised financial products

To assist SME and Māori enterprises carrying out nature action, banks and other financial institutions could develop specialised financial products or support the aggregation of projects to address financial barriers.

To address the barrier that the majority of companies focussed on nature action are SMEs with limited credit history and investment sizes that tend to fall below the minimum investment size for larger and institutional investors, financial sector players could support access to capital through aggregation of these projects. Pooling nature projects with different credit ratings and risk/return profiles could reduce portfolio risks and increase the overall portfolio size.

This could transform the investment characteristics of an individual SME project to that of an investable aggregated portfolio (a portfolio returning between 5 and 15% annually in the long term).

Many Māori landholdings are inalienable, meaning the land cannot be sold, and therefore cannot be used as security for finance. Additionally, the treaty settlements process requires an iwi to establish a post-settlement governance entity, the form of which has been dictated and changed over time resulting in a landscape of legal structures that banking teams find difficult to navigate.

To support Māori entities taking nature action, banks could further develop Māori banking teams and put in place other investment structures such as credit terms, to support iwi to better access capital towards the nature outcomes that they are focussed on. An example, although not nature specific, is the BNZ framework that will allow mortgage lending on land communally owned by Ngāti Whātua Ōrākei at standard home loan interest rates for hapū members that meet BNZ's normal home lending criteria.[243]

Discounted lending products

To overcome the elongated payback periods associated with nature investment, banks and insurers could offer discounted lending products to incentivise investment in nature action. These discounts are enabled through the risk reduction and/or brand improvement resulting from nature action taken by the borrower. The incentive can be more substantial if backed by a government borrowing rate or some level of government first loss provision, or if supported by capital adequacy frameworks that allow banks to hold less collateral against these types of loans. An example of this is the loan guarantee scheme under the North Island Weather Events Response and Recovery fund programme which provided relief to entities seeking commercial lending that had been affected by the Auckland Anniversary Weekend floods or Cyclone Gabrielle. 80% of credit risk on covered loans was carried by the Crown allowing banks to reduce interest rates.[244]

WE ALL HAVE A ROLE TO PLAY

We've outlined in this Report the criticality of nature to our economy – and survival – and that nature is in trouble. We've identified a significant gap in both action being taken to support Aotearoa New Zealand to meet our obligations under the GBF and the finance that is available to enable this. Through our modelling and primary sector analysis we've identified specific actions to support the transformation to a nature-positive Aotearoa New Zealand and we've highlighted ways that business, government and the finance sector can support in unlocking the finance that will be required. We've also shown that protecting and restoring nature makes economic sense.

Ko au Te Taiao, ko Te Taiao ko au (I am nature, and nature is me). We all have a role to play to protect and restore Aotearoa New Zealand. We hope this research will accelerate action towards a nature-positive future for Aotearoa New Zealand and bring us together to more effectively tackle the growing crisis of nature loss.

APPENDICES

A. NATURE FINANCING GAP CALCULATIONS

Table 12 outlines the approach taken to determine the current investment in nature and biodiversity, the total investment required to meet the GBF Targets in Aotearoa New Zealand and the gap between these two numbers.

Table 12: Nature Financing Gap Calculation Methods

Calculation	Assumptions	Key Sources
Current investment in biodiversity		
Current spend = central government spend + local government spend + philanthropic spend	Central government expenditure into biodiversity includes all expenditure on the environment except climate change mitigation and adaptation and proportionate spend on improving institutions which manage human interventions in the environment. Local government expenditure on biodiversity includes all local government spending on the environment. Philanthropic spend has not changed meaningfully since 2018.	Central government: https://pce.parliament.nz/publications/estimate-of-environmental-expenditure-2023-24/ Local government: https://www.stats.govt.nz/information-releases/environmental-economic-accounts-data-to-2022/ Philanthropic: https://static1.squarespace.com/static/608a1a95d5087f40f9c2e366/t/6170561168036225f10f62fa/1634752022165/PNZ_JBWere_NZ-Support-Report.pdf
Total investment required to reach GBF Targets in Aotearoa New Zealand		
Investment needed = Global investment needed x proportion needed in New Zealand Proportion needed in Aotearoa New Zealand = number of species threatened in Aotearoa New Zealand / number of species threatened globally	Number of threatened species is an appropriate proxy for investment needed to achieve GBF Target.	Global investment needed: Financing Nature: Closing the Global Biodiversity Financing Gap – Paulson Institute Global investment needed: State of Finance for Nature 2023 | UNEP – UN Environment Programme Aotearoa New Zealand threatened species: New Zealand's latest National Report under the Convention on Biological Diversity (doc.govt.nz) Global threatened species: IUCN Red List of Threatened Species

Calculation	Assumptions	Key Sources
Investment needed to reach GBF Target 2		
Costs to achieve Target 2 (See Appendix C for more on the calculation metho)		
Investment needed to reach GBF Target 3		
Costs to achieve Target 3 (See Appendix C for more on the calculation metho)		
Investment needed to reach GBF Target 4		
Investment needed = cost to save one species from extinction x number of species facing extinction in Aotearoa New Zealand	There will be minimal cost efficiencies realised from saving all species from extinction (i.e., saving one species will not reduce the cost of saving another). Species facing extinction include species that are threatened or at risk.	Aotearoa New Zealand species facing extinction: New Zealand's latest National Report under the Convention on Biological Diversity (doc.govt.nz) Cost to save one species: ESA_recovery_costs_2019 (defenders-cci.org) Cost to save one species: Conservation triage or injurious neglect in endangered species recovery | PNAS Cost to save one species: To save an entire species, all you need is $1. 3 million a year | ScienceDaily
Investment needed to reach GBF Target 6		
Investment needed = Investment needed to achieve Predator Free 2050 + investment needed to supress Exotic Caulerpa (see Appendix C)	Costs to supress invasive species limited to predators as defined by PF2050 and Exotic Caulerpa.	Investment needed to achieve Predator Free 2050: PF2050-Limited-Annual-Report-2023.pdf

B. OVERVIEW OF CGE MODELLING

Computable General Equilibrium (CGE) models are a class of economic model developed originally out of Input Output (IO) models providing a causal, full system and theory driven framework for the assessment of a wide range of policy, project and economic condition assessments. As noted by Dixon in the Handbook of Computable General Equilibrium Modelling:

"CGE models are used in almost every part of the world to generate insights into the effects of policies and other shocks in the areas of trade, taxation, public expenditure, social security, demography, immigration, technology, labour markets, environment, resources, infrastructure and major-project expenditures, natural and man-made disasters, and financial crises. CGE modelling is the only practical way of quantifying these effects on industries, occupations, regions and socioeconomic groups."

The CGE model used in this analysis is a member of the Global Trade Analysis Project (GTAP)/Global Trade and Environmental Model (GTEM) family of CGE models which have a long history in the public and private sectors to assess the economic impact of projects and policies. The GTAP database is the primary data source for the model. It is the most detailed, comprehensive and widely used database of its type in the world, used by over 700 researchers worldwide. The database contains information on inter industry flows, trade, taxes and behavioural variables.

The CGE model is based on an underlying input-output or social accounting matrix, which is a standard representation of the national accounting frameworks applied by central statistical agencies globally and forms the basis for calculating well known macroeconomic variables such as gross domestic product. This foundational data describes how economies are linked through production, consumption, trade and investment flows.

Overlaying this system of national accounts are a set of standard behavioural structures that simulate real world decision making and are validated by established academic literature, providing the basis for forecasting responses to policy changes. For policy analysis, this incorporation of behavioural structures provides an advantage over traditional econometric approaches, particularly where historical examples or analogues of the policy being evaluated is not well represented in historical data (for example climate change policy).

The below points highlight some of the key features of the CGE model:

- Direct linkages between industries and countries through purchases and sales of each other's goods and services.
- Inter industry linkages through purchases and sales of each other's goods and services.
- International linkages through the imports and exports of goods and services.
- Capacity constraints in primary factor markets, representing the finite availability of capital, labour, land and the natural resource (This is not accounted for in IO models).
- Behavioural mechanisms such as the responses to price changes.

The below summaries highlight the microeconomic theory which the model is founded upon.

Income

- The model contains a 'regional consumer' that receives all income from factor payments (labour, capital, land, and natural resources), taxes and net foreign income from borrowing (lending).
- Income is allocated across household consumption, government consumption and savings so as to maximise a Cobb-Douglas utility function.

Consumption

- Household consumption for composite goods is determined by minimising expenditure via a CDE (Constant Differences of Elasticities) expenditure function. For most regions, households can source consumption goods only from domestic and imported sources. In all cases, the choice of commodities by source is determined by a CRESH (Constant Ratios of Elasticities Substitution, Homothetic) utility function.
- Government consumption for composite goods, and goods from different sources (domestic, imported and interstate), is determined by maximising utility via a Cobb-Douglas utility function.
- Production
- Producers supply goods by combining aggregate intermediate inputs and primary factors in fixed proportions (the Leontief assumption). Composite intermediate inputs are also combined in fixed proportions, whereas individual primary factors are combined using a CES production function.
- Producers are cost minimisers, and in doing so choose between domestic, imported and interstate intermediate inputs via a CRESH production function.
- The supply of labour is positively influenced by movements in the real wage rate governed by an elasticity of supply. A labour supply elasticity of 0.3 is uniformly adopted for this analysis.

Investment

- All savings generated in each region are used to purchase bonds whose price movements reflect movements in the price of creating capital.
- Investment takes place in a global market and allows for different regions to have different rates of return that reflect different risk profiles and policy impediments to investment. A global investor ranks countries as investment destinations based on two factors: global investment and rates of return in a given region compared with global rates of return.
- Once aggregate investment is determined in each region, the regional investor constructs capital goods by combining composite investment goods in fixed proportions and minimises costs by choosing between domestic and imported sources for these goods via a CRESH production function.

Prices

- Prices are determined via market-clearing conditions that require sectoral output (supply) to equal the amount sold (demand) to final users (households and government), intermediate users (firms and investors), foreigners (international exports), and other Australian regions (interstate exports).
- For internationally traded goods (imports and exports), the Armington assumption is applied whereby the same goods produced in different countries are treated as imperfect substitutes. But in relative terms imported goods from different regions are treated as closer substitutes than domestically produced goods and imported composites.

Economic model specifications

Table 13 outlines the model's industry disaggregation for this project, alongside the corresponding GTAP sectors. Many sectors are specified because of critical interconnections across many other parts of the economy, including energy, water and waste, and transportation. Other sectors are separated to enable the assessment of the impact of economic "shocks" specific to this assessment. For example, agricultural industries are represented across four sectors (crops, animal products, raw milk and forestry and fishing), since certain actions target each of these sectors separately.

Table: 13 CGE model sector breakdown

CGE sector	GTAP sector
Crops	1-8
Animal products	9-10
Raw milk	11
Forestry and fishing	13-14
Coal	15
Oil	16
Gas	17, 47
Other mining	18
Meat products	19-20
Dairy products	22
Other processed food	21, 23-26
Petroleum and coal products	32
Other manufacturing	27-31, 33-45
Electricity generation	46
Water and waste services	48
Construction	49
Trade	50
Accommodation and food services	51
Transport	52-55
Recreation	61
Insurance	58
Government services	62-63
Health services	64
Other services	56-57, 59-60, 65

Economic model inputs

Four types of "shocks" are used in this model to convert the selected actions into economic activities in the CGE model, as described below:

- Output: an increase in output represents sector growth, beyond baseline levels.
- Productivity: productivity enhancements represent avoided costs for many of the actions, where the same level of output is produced at a lower cost, compared to the baseline.
- Exports: Target 3 Action 2 has a positive impact on agriculture exports. An increase in exports is expected to have the flow-on impact of an increase in output in the same sector.
- Gross national income: carbon savings benefit the entire Aotearoa New Zealand economy by reducing the amount of carbon credits purchased to reach national targets. This national saving is modelled through an increase in gross national income.

Table 14 describes the approach to modelling each cost and benefit by assigning each of these to one of the modelling mechanisms listed above. The costs and benefits are then consolidated into seven combined shocks which feed directly into the model. Each increase or reduction is measured relative to the baseline. As such, avoided costs are measured as additional to the baseline, even if the outcome does not describe an increase in the total level of output in the policy. The assumptions underpinning each input are described in Appendix C.

Table 14: CGE model shocks overview

Cost/benefit	CGE model shock	Timing
Target 2		
Action 1: Re-wet 667,477ha of degraded wetlands and peatlands		
Cost 1: Creating the wetlands and peatlands	Out of model assessment	2025-2029
Cost 2: Purchasing land for conversion	Reduction in total agriculture output	2025-2029
Cost 3: Maintaining and monitoring the wetlands and peatlands	Out of model assessment	2030-2058
Benefit 1: Carbon sequestration	Increase in gross national income	2030-2079
Benefit 2: Protection from flooding and coastal inundation	Increase in productivity of insurance sector	2031-2080
Benefit 3: Increased fishing yield from habitat restoration	Increase in fishing output	2031-2080
Action 2: Implement localised restoration programmes to improve the water quality in 30% of Aotearoa New Zealand's rivers and lakes, by achieving an applicable water quality rating of Band A.		
Cost 1: Implementing the river restoration projects	Out of model assessment	2025-2029
Cost 2: Implementing the lake restoration projects	Out of model assessment	2025-2029
Cost 3: Maintaining and monitoring the waterways	Out of model assessment	2030-2080
Benefit 1: Reduced water treatment	Increase in productivity of water sector	2031-2080
Benefit 2: Contribution to protecting the tourism industry	Increase in tourism output	2025-2080
Benefit 3: Protection from flooding and drought	Increase in productivity of total agriculture sector	2031-2080

Cost/benefit	CGE model shock	Timing
Action 3: Reduce nutrient runoff and sedimentation pollution into coastal marine ecosystems, by planting native trees on riparian zones, reducing the use of synthetic fertiliser and planting highly erodible land.		
Cost 1: Riparian planting programmes	Out of model assessment	2025--2029
Cost 2: Native planting programmes on erosion prone land	Out of model assessment	2025-2029
Benefit 1: Contribution to protecting the tourism industry	Increase in tourism output	2031-2080
Benefit 2: Increase in fishing yield from habitat restoration	Increase in tourism output	2025-2080
Benefit 3: Carbon sequestration	Increase in gross national income	2030-2079

Target 3

Action 1: Achieve full mammalian predator-free status in all terrestrial protected areas		
Cost 1: Initial pest eradication	Out of model assessment	2025-2029
Cost 2: Maintenance and monitoring	Out of model assessment	2030-2039
Benefit 1: Contribution to protecting the tourism industry	Increase in tourism output	2025-2080
Action 2: Implement water conservation orders on 30% of New Zealand's rivers and lakes		
Cost 1: Reduced agricultural yield	Decrease in raw milk output	2030-2080
Cost 2: Establishment costs of orders	Out of model assessment	2025-2029
Cost 3: Consenting costs of orders	Out of model assessment	2025-2029
Benefit 1: Reduced water treatment	Increase in productivity of water sector	2030-2080
Benefit 2: Improved reputational resilience in agricultural sector	Increase in total agriculture exports	2026-2080
Benefit 3: Contribution to protecting the tourism industry	Increase in tourism output	2025-2080
Benefit 4: Safer swimming conditions	Increase in productivity of healthcare sector	2030-2080

Cost/benefit	CGE model shock	Timing
Action 3: Create marine protected areas to grant the maximum level of protection (as enabled through legislation) to 30% of New Zealand's Exclusive Economic Zone and Territorial Seas		
Cost 1: Displaced fisheries and foregone revenue	Decrease in fishing output	2030-2049
Cost 2: Monitoring and enforcement of the MPAs	Out of model assessment	2030-2080
Cost 3: Establishing the MPAs	Out of model assessment	2025-2029
Benefit 1: Improved reputational resilience in the fisheries sector	Increase in total fishing exports	2026-2080
Benefit 2: Contribution to protecting the tourism industry	Increase in tourism output	2025-2080
Benefit 3: Increase in fishing yield	Increase in fishing output	2031-2080

C. MODEL INPUTS

The tables below outline the calculations used to develop impacts which were used as 'shock' inputs to the CGE model. The approaches developed relied on the existence of publicly available literature, and assumptions were made around the timing of the costs and benefits. Literature and case studies that are based in New Zealand were given priority, but where this was not available international literature was utilised. Adjustments for currency conversions and inflation were made to any monetary figures so that our results were reported in real 2023 NZD. As multiple actions resulted in a benefit to the international tourism industry, this has been presented alone. All other impact pathways are grouped by the action that they relate to.

Table 15: Tourism Benefit, from achieving Targets 2 and 3

Impact calculation	Key assumptions	Key Data Sources
Benefit (Avoided cost)		
Protection of the international tourism industry		
Benefit = Current size of international tourism industry in New Zealand * % decrease in length of stay in New Zealand if international tourists' visitors have 'worsened environmental perceptions' of New Zealand	The combined effect of reaching Targets 2 and 3 would result in the international community not viewing New Zealand as environmentally degraded, and that without the actions they would. 1:1 ratio of length of time spent in country: money spent in country. 2020 was used to value the size of the current international tourism industry to eliminate effects from COVID-19.	Current size of international tourism industry in New Zealand: Tourism satellite account: Year ended March 2023 | Stats NZ % decrease in international tourist length of stay: clean-green-aug01-final.pdf (environment.govt.nz)

Table 16: Target 2, Action 1

Impact calculation	Key assumptions	Key Data Sources
Cost		
Creating the wetlands and peatlands		
Cost of Restoration = Area of restoration (ha) x Cost per area of restoration ($/ha) Area of restoration = 30% x pre-human coverage – existing coverage	Cost per area of restoration taken from case studies.	Pre-human and existing coverage: Pre-human wetlands » Maps » Our Environment (scinfo.org.nz) https://www.stats.govt.nz/indicators/wetland-area/ Case studies: Wetlands Opuatia Wetland restoration | Waikato Regional Council Paper_Tanner_2015.pdf (massey.ac.nz) Northland's Underwood Wetland reversing habitat loss – NZ Herald Peatlands https://sefari.scot/sites/default/files/documents/Peat%20Cost%20Report%202022_Glenk%20et%20al.pdf
Cost = Area to be purchased (ha) x Cost per area purchased ($/ha) Area to be purchased = Area of restoration x % of pre-human coverage land owned privately	Purchase price of land is reflective of the economic cost of lost productive yield of that land. Cost of land conversion for publicly owned land not considered.	Cost per area purchased: New Zealand: median farm prices by region 2024 | Statista % of pre-human coverage land owned privately: New Zealand's wetlands remain at risk on private land | Forest and Bird
Cost = Ongoing maintenance and monitoring costs ($/ha) x Area of restoration (ha)	Ongoing costs from case studies	Ongoing maintenance and monitoring costs: The Dollars and Sense of Wetland Preservation (freshoutlookfoundation.org)

Impact calculation	Key assumptions	Key Data Sources
Benefit = Sequestration (t CO2 e) x Monetary benefit of sequestration ($/ t CO2e) Sequestration = Sequestration rate (t CO2 e / ha) x Area of restoration (ha)	Monetary benefit of sequestration based on marginal cost to achieve New Zealand climate commitments. Sequestration rate depends on wetland type and comes from case studies.	Sequestration rate mangroves: Indus Delta DBC-1 Monitoring Report.pdf – Google Drive Sequestration rate wetlands excluding mangroves: Indus Delta DBC-1 Monitoring Report.pdf – Google Drive https://www.environment.sa.gov.au/news-hub/news/articles/2022/10/states-first-blue-carbon-restoration-site-launched-today-north-of-adelaide Sequestration rate peatlands: Peatland Protection and Rewetting | Project Drawdown Cost of carbon: Monetised benefits and costs manual – v1.7.1 July 2024 (nzta.govt.nz)
Benefit = Cost of flood savings per area ($/ha) x Area of restoration (ha)	Cost of flood savings per area from case studies	Cost of flood savings per area: The value of coastal wetlands for storm protection in Australia – ScienceDirect
Benefit = Benefit to fisheries per area of mangroves restored ($/ha) x Area of restoration (ha)	Benefit to fisheries per area of mangroves restored from case studies	Benefits to fisheries of mangroves: oieau.fr/eaudoc/system/files/33226.pdf

Table 17: Target 2, Action 2

Impact calculation	Assumptions	Key Data Sources
Cost *Implementing the river restoration projects*		
Cost of Restoration = Length of restoration (km) x Cost per length of restoration ($/km) Length of restoration = 30% x total length of rivers in NZ – length of rivers that have median MCI scores indicative of pristine conditions	Cost per length of restoration from average across case studies	Total length of New Zealand Rivers: How New Zealand rivers are formed – Te Ara Encyclopedia of New Zealand Length of rivers that have median MCI scores indicative of pristine conditions: River water quality: macroinvertebrate community index | Stats NZ Case studies: Te_Hoiere_Project_IBC_Summary.pdf (tehoiere.org.nz) Ngā Awa programme report 2020/2021 (doc.govt.nz) Public Waterways and Ecosystem Restoration Fund | Ministry for the Environmen
Cost *Implementing the lake restoration projects*		
Cost of Restoration = Lake area of restoration (km2) x Cost per area of restoration ($/km2) Lake area of restoration = 30% x total surface area of lakes in NZ– area with trophic level index (TLI) of good or very good	Cost per area of restoration from case studies	Total surface area of lakes in New Zealand: Lakes (teara.govt.nz) Total surface area of lakes in New Zealand with TLI of good or very good: Lake water quality | Stats NZ Case studies: Major step in restoration of Lake Horowhenua | Beehive.govt.nz Lake Kimihia restoration | Waikato Regional Council

Impact calculation	Assumptions	Key Data Sources
Cost *Maintaining and monitoring the waterways*		
NA	Costs assumed to be the same as the estimated costs of 'Water measuring and reporting-related costs including telemetry systems' of MfE's 'Action for healthy waterways'	Maintenance and monitoring costs: Action for healthy waterways information on benefits and costs (environment.govt.nz)
Benefit (Added benefit) *Reduced water treatment*		
Cost savings = 30% x current spending on drinking water treatment in NZ Current spending on drinking water treatment = Drinking water rates in New Zealand (per household) x number of households in New Zealand x 40%	Assumes that 40% of the cost of drinking water in New Zealand is attributable to treatment. Assumes action lowers drinking water costs on average by 30%.	Drinking water rates: Big decision 2: How we pay for drinking water supply | Your Say Selwyn Number of households in New Zealand: Dwelling and household estimates: December 2023 quarter | Stats NZ
Benefit (Added benefit) *Protection from flooding and drought*		
Benefit = Average annual cost arising from droughts and floods in NZ x 3%	Assumes action would decrease flood and drought expense by 3%.	Average annual cost arising from droughts and floods in New Zealand: Climate change attribution and the economic costs of extreme weather events: a study on damages from extreme rainfall and drought | Climatic Change (springer.com)

Table 18: Target 2, Action 3

Impact calculation	Assumptions	Key Data Sources
Cost *Riparian planting programmes*		
Cost = Cost of planting ($/km) x length to be planted (kms) Length to be planted = 30% x total river length in New Zealand – length of rivers already planted	Cost per km of planting from case studies. Assumes Auckland region is representative of New Zealand with respect to length of rivers already planted.	Cost of planting: Ministry for Primary Industries Stock Exclusion Costs Report (mpi.govt.nz) Total river length in New Zealand: How New Zealand rivers are formed – Te Ara Encyclopedia of New Zealand Length of rivers already planted: Riparian Facts – Streamside Planting Guide (aucklandcouncil.govt.nz)
Cost *Native planting programmes on erosion prone land*		
Cost = Area of erosion prone land (km2) x Cost of native planting on erosion prone land ($/km2)	Erosion prone land considered is land classified as: High landslide risk – delivery to stream, moderate earthflow risk, severe earthflow risk, gully risk.	Area of erosion prone land: MfE Data Service Cost of native planting on erosion prone land: Review of Actual Forest Restoration Costs 2021 (mpi.govt.nz)
Benefit (Added benefit) *Increase in fishing yield from habitat restoration*		
Benefits = Size of rock lobster industry ($) x 25%	Reduced coastal sedimentation will increase the stock of rock lobsters (crayfish) in New Zealand by 25%.	Size of rock lobster industry: Economic Review of the Seafood industry
Benefit (Added benefit) *Carbon sequestration*		
Benefit = Sequestration (t CO_2 e) x Monetary benefit of sequestration ($/ t CO_2e) Sequestration = Sequestration rate (t CO_2 e / ha) x Area of erosion prone land (ha)	Monetary benefit of sequestration based on marginal cost to achieve New Zealand climate commitments. Sequestration from natives planted on riparian zone excluded.	Sequestration rate of native forests: Climate Change (Forestry) Regulations 2022 (SL 2022/266) (as at 28 June 2024) Schedule 4 Default tables of carbon stock per hectare for post-1989 forest land – New Zealand Legislation Monetary benefit of sequestration: Monetised benefits and costs manual – v1.7.1 July 2024 (nzta.govt.nz)

Table 19: Target 3, Action 1

Impact calculation	Assumptions	Key Data Sources
Cost *Initial pest eradication*		
Cost = Size of protected area (ha) – Size of areas where predators are already supressed x Cost of eradication ($/ha)	Cost of eradication per unit area from case studies	Size of protected area: https://ourenvironment.scinfo.org.nz/maps-and-tools/app Size of supressed areas: Predator Free 2050 biennial progress report (doc.govt.nz) Cost of eradication: From case studies found in this report – Annual Report Archive – Predator Free 2050 Limited: Predator Free 2050 Limited (pf2050.co.nz)
Cost *Maintenance and monitoring*		
Cost = Size of protected area (ha) x Cost per area to monitor and maintain ($/ha)	Cost of monitoring and maintenance from case studies	Cost per area to monitor and maintain: Starters-guide-to-Predator-Control-on-Farms.pdf (predatorfreenz.org) What will it cost? – Predator Free NZ Trust

Table 20: Target 3, Action 2

Impact calculation	Assumptions	Key Data Sources
Cost *Reduced agricultural yield*		
Cost = Dairy industry revenue x % reduction in farm revenue from lowered irrigation resulting from WCO	Assumes % reduction in farm revenue from lowered irrigation resulting from WCO is the same as that for the Te Waikoropupū Springs and associated water bodies WCO. Assumed 30% of dairy industry is affected by WCOs. Excluded impacts to other agricultural sectors.	% reduction in farm revenue from lowered irrigation resulting from WCO: Statement of primary evidence of Michael Copeland on behalf of Upper Takaka irrigators inc. and others.
Cost *Establishment costs of orders*		
Cost = number of regional councils x cost per council per WCO	WCO implementation is NZ$10 million, regional plan amendment is NZ$14 million.	Number of regional councils: Councils in Aotearoa – LGNZ
Cost *Consenting costs of orders*		
Cost to change consents = 30% x number of consents in New Zealand x cost per consent	Cost per consent change is NZ$20,000. Assumed 30% of consents are impacted.	Number of consents in New Zealand in relation to water takes: Total consents for consumptive use of water in New Zealand – Figure.NZ
Benefit (Added benefit) *Reduced water treatment*		
Benefit = Avoided cost of having to build and operate a system to remove excess nitrates from drinking water sources in Canterbury.	If current practices continue, nitrate will have to be treated in the water supply. Only considering the Canterbury region.	Avoided cost: New study measures harmful cost of nitrate in drinking water | WSP

Impact calculation	Assumptions	Key Data Sources
Benefit (Added benefit) *Improved reputational resilience in agricultural sector*		
Benefit = Annual revenue of dairy industry x % of avoided reduction of annual revenue	Conservatively, only half of the benefit was modelled. International customers will view ANZ as 'environmentally degraded' if action not taken, and achieving this Target will completely reverse this. Only considering the dairy industry.	% of avoided reduction of annual revenue: environment.govt.nz/assets/Publications/Files/clean-green-aug01-final.pdf
Benefit (Added benefit) *Safer swimming conditions*		
Benefit = Avoided cost of healthcare associated with drinking and swimming in unsafe water	The package of freshwater reforms from MfE report has a similar effect on swimming risk as these actions.	Avoided cost of healthcare associated with drinking and swimming in unsafe water: Action for healthy waterways information on benefits and costs (environment.govt.nz)

Table 21: Target 3, Action 3

Impact calculation	Assumptions	Key Data Sources
Cost *Displaced fisheries and foregone revenue*		
Cost = Annual revenue of fisheries x reduction factor Reduction factor dependent on where fish is caught, and how much of this area will be covered by an MPA.	Only top ten fisheries by value included, which account for 80% of ANZ commercial fishery output.	NZ.Stat Metadata Viewer (stats.govt.nz) Fisheries New Zealand environment.govt.nz/assets/Publications/RIS-for-kermadec-ocean-sanctuary-bill_0_0.pdf
Cost *Establishing the MPAs*		
Cost = Cost per unit area to monitor and enforce x size of MPA x reduction factor (due to efficiency gains) Cost per unit area to monitor and enforce = Cost per unit area to monitor and enforce current MPAs in New Zealand (coastal marine reserves). Size of new MPA = 30% of New Zealand's EEZ and Territorial seas	There will be efficiencies given the distance and isolation of the two proposed marine reserves resulting in a reduction factor of 95% for MPAs in the EEZ and of 50% for MPAs in the territorial seas.	Cost per unit area to monitor and enforce: The costs of protecting the big blue – EcoLincNZ (lincolnecology.org.nz) EEZ size: EEZ discussion paper_FINAL (environment.govt.nz) Territorial sea size: Areas • Environment Guide

Impact calculation	Assumptions	Key Data Sources
Cost *Monitoring and enforcement of the MPAs*		
Cost = (Pre-establishment costs per MPA + Establishment costs per MPA) x number of new MPAs Number of new MPAs in territorial seas = 30% of New Zealand's Territorial seas / average size of existing MPAs Number of new MPAs in EEZ = 2	Assumes new MPAs in territorial seas will be the same size as existing MPAs and that two additional MPAs will be established in the EEZ	Pre-establishment and establishment costs: Evaluation of impacts in terms of social, economic and biological from two marine reserves creation in New Zealand (researchgate.net)
Benefit (Added benefit) *Increase in fishing yield*		
Benefit = Current total revenue of fishing industry x % increase in fish stocks from MPA	Case study provided the % increase in fish stocks. 1:1 increase in fish stocks to commercial fishing yields.	% increase in fish stocks from MPA case study: Projecting contributions of marine protected areas to rebuild fish stocks under climate change | npj Ocean Sustainability (nature.com)
Benefit (Added benefit) *Improved reputational resilience in fishing sector*		
Benefit = Annual revenue of fishing industry x % of avoided reduction of annual revenue	Conservatively, only half of the benefit was modelled. International customers will view New Zealand as 'environmentally degraded' if action not taken, and achieving this Target will completely reverse this. International customers will act in the same way with respect to purchasing products from the fishing sector versus purchasing products from the dairy sector if they view New Zealand as 'environmentally degraded.'	% of avoided reduction of annual revenue: environment.govt.nz/assets/Publications/Files/clean-green-aug01-final.pdf

D. CASE STUDY CALCULATIONS

Table 22 outlines the approach taken to estimate costs associated with the case studies developed for Targets 4 and 6 of the GBF.

Table 22: Target 4 and 6 case studies – approach taken for estimates

Calculation	Assumptions	Key Data Sources
Develop and establish localised and widespread suction dredging removal programmes through diver-operated teams (localised) and a large-scale suction dredge (widespread). (Target 4 Case Study)		
Cost = Cost to remove per unit area ($/ha) x current known coverage (ha)	Current known coverage is the current extent of spread of Caulerpa. Used Central Estimate from MPI's cost estimations.	Current known coverage: Aotea Caulerpa removal trial (mpi.govt.nz) NZ's 'most unwanted species' invading Hauraki Gulf (newsroom.co.nz) https://www.rnz.co.nz/news/ldr/491853/bay-of-islands-anchoring-ban-now-in-place-to-fight-caulerpa-spread Cost to remove per unit area: https://www.mpi.govt.nz/dmsdocument/61711-Aotea-Caulerpa-removal-trial
Develop a programme of biosecurity measures to stop regional and international spread of Caulerpa, including hull cleaning and monitoring of current sites of known Caulerpa. (Target 4 Case Study)		
Cost = Cost to implement hull cleaning program + cost to monitor current sites Cost to implement hull cleaning program = Cost per regional council x number of regional councils in NZ	Assumed monitoring current sites would cost a total of NZ$20 million. Cost per regional council to implement hull cleaning program taken from Northland Case Study.	Cost per regional council (to implement hull cleaning programme): A benefit-cost model for regional marine biosecurity pathway management (nrc.govt.nz) Number of regional councils in NZ: Councils in Aotearoa – LGNZ

Calculation	Assumptions	Key Data Sources
Cost of implementing mandatory cameras on all ANZ offshore fishing vessels. (Target 6 Case Study)		
Cost = cost per vessel x number of offshore fishing vessels in ANZ without cameras	Assumes cost per vessel to be similar to onshore camera fit out costs.	Cost per vessel: On-board cameras for commercial fishing vessels | NZ Government (mpi.govt.nz) Number of offshore fishing vessels without cameras: https://www.mpi.govt.nz/dmsdocument/56572-Draft-Fisheries-Industry-Transformation-Plan
Cost to implement the Maukahuka Project to eradicate pigs, mice and cats from Auckland Island. (Target 6 Case Study)		
Used DOC's Maukahuka Pest Free Auckland Island Technical feasibility study report findings.	Assumes preferred option best reflects costs.	Cost to implement: Maukahuka Pest Free Auckland Island – Technical feasibility study report (doc.govt.nz)

GLOSSARY

Ecological Concept	Definition
Biodiversity	The variety of all living species on earth.
Natural capital	The stocks of natural assets which include the geology, soil, air, water and living species.
Conservation	The protection and restoration of natural environments and the species that live in them.
Restoration	The process of assisting or accelerating the recovery of an ecosystem that has been degraded, damaged, or destroyed.
Protection	The prevention of negative changes to ecosystems.
Protected area	An area which is designated or regulated and managed to achieve specific conservation objectives.
Ecosystem services	The benefits natural environments offer to humans, including provisions, cultural, supporting and regulating services.
Tipping point	A condition of an ecosystem when changes to the ecosystem lead to sudden and often irreversible shifts in the state of the ecosystem.
Natural assets	The components of the natural environment which can be used, directly or indirectly, by humans.
Predator free area	An area which has no invasive animal species.
Territorial sea	An area of water not exceeding 12 nautical miles in width which is measured seaward from the territorial sea baseline
Economic exclusive zone	An area of sea beyond and adjacent to the territorial sea. The outer limit of the exclusive economic zone cannot exceed 200 nautical miles from the territorial sea baseline.
Nationally Determined Contribution (NDC)	National plans to reach climate mitigation and adaptation targets under the Paris Agreement.

Economic Concept	Definition
Gross Domestic Product (GDP)	The total value of goods and services produced in the economy.
Nature finance gap	The difference between the amount of money invested into nature and the amount required
Economic value	The worth of, or benefit provided from, a good or service.
Computable general equilibrium model (CGE)	An economic model which uses actual economic data and sets of equations to estimate the changes to an economy from a change in policy or an investment decision.
Gross National Income (GNI)	The total income generated domestically and internationally by residents of a country.
Output	The value of goods and services produced by all economic sectors, including both value-add and non-value-add components.
Full time equivalent (FTE)	The equivalent to one employee working full time for a year.
Net present value (NPV)	The difference between the present value of all the positive and negative cashflows of an investment.
Payback period	The amount of time taken for an investment to reach breakeven point in terms of NPV.

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