Department of Conservation climate change adaptation action plan

Te Papa Atawhai he whakamahere hātepe urutau mō te huringa āhuarangi

2020/21 – 2024/25

Department of Conservation
Te Papa Atawhai

New Zealand Government

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Front cover image: Upper Waimakariri River. *Source: Department of Conservation.*

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New Zealand's changing climate is affecting nearly every aspect of the Department of Conservation's (DOC's) responsibilities. This Climate Change Adaptation Action Plan (CCAAP) outlines the actions DOC will take to reduce the risks posed by our changing climate between 2020/21 and 2024/25.

The CCAAP draws on international best practices to establish a long-term strategy for climate change research, monitoring and action across all of DOC's functions (starting with the first 5-year increment). This will guide DOC's internal strategic planning, prioritisation and operations to allow its four intermediate objectives and nine stretch goals to be met in the face of climate change and will also help to ensure that DOC is connected to and can inform national climate change efforts, such as the National Adaptation Plan (NAP) under the Climate Change Response (Zero Carbon) Amendment Act 2019.

The CCAAP acknowledges that effective engagement with tangata whenua enhances the conservation of natural resources and cultural heritage. Under section 4 of the Conservation Act 1987, DOC has a statutory responsibility to ensure that the Act is interpreted and administered as to give effect to the principles of the Treaty of Waitangi. By working with our Treaty partners to understand the impacts of climate change on natural and cultural resources and taonga/treasures on public conservation lands and waters, the CCAAP seeks to enable mātauranga/knowledge opportunities that will allow whānau, hapū and iwi to exercise their responsibilities as kaitiaki/guardians.

Climate change is a significant risk for DOC that already affects every aspect of its work. Direct effects include damage to infrastructure or habitat caused by a rising sea level and more frequent storm and flood events, while indirect effects involve the shifting of habitats and species distributions, including the movement of potentially invasive species into areas that are currently unsuitable, as a result of changing temperature and precipitation patterns. In the outdoor recreation context, changing climate conditions will affect tourism distribution patterns and visitor risks in many locations, prompting various visitor management issues. As the climate continues to change over the coming decades, we expect ongoing atmospheric and ocean warming, elevated fire risks, more storm surges, more extreme precipitation events, longer droughts, ocean acidification, continued sea-level rise and new land-use demands, such as from adaptations to water shortages or carbon sequestration efforts (e.g. tree planting).

DOC is currently investigating how climate change will affect its responsibilities, including changes in the elevational distribution of invasive rats due to increasing temperatures and coastal flooding risks to infrastructure from sea-level rise. However, a more comprehensive and integrated approach to climate change adaptation research and implementation is needed.

This CCAAP identifies the steps DOC needs to take over the next 5 years to:

- Identify and rectify important climate change information gaps
- Develop and implement:
  - Consistent risk assessments on priority species, habitats, regions and assets
  - A suite of opportunities to reduce impacts
  - The required adaptation actions to address those risks, including time frames and resource requirements
  - Monitoring and reporting systems to know if the actions are being successful
- Establish an internal governance and management structure for the implementation

1. Introduction | He kupu whakataki

New Zealand's climate is changing and will continue to do so for the foreseeable future, matching global trends. These changes are having significant known effects on New Zealand's natural and cultural heritage, as well as its visitor and recreation resources. However, there are still many information gaps around the impacts of climate change on the New Zealand environment. Examples of the impacts that may occur include some species no longer existing in the wild, mammalian pests and weeds becoming more prevalent in alpine areas, and iconic visitor destinations such as the glaciers on the West Coast no longer being accessible. These changes will affect every aspect of the Department of Conservation's (DOC's) responsibilities.

Regardless of our present and future efforts to limit the causes of climate change by reducing greenhouse gas concentrations in the atmosphere (also known as climate change mitigation), we will experience some ongoing physical impacts related to climate change (e.g. sea-level rise, increasing temperatures, retreating glaciers). Therefore, a two-pronged approach is needed that incorporates both climate change mitigation and climate change adaptation, whereby the impacts of climate change are reduced whilst we become more resilient to the challenges it brings.

DOC is undertaking a range of measures to become leaders in low-carbon conservation management with a view to climate change mitigation and wider sustainability outcomes, while this Climate Change Adaptation Action Plan (CCAAP) considers the adaptation side of the approach. However, it should be noted that the two sides are fundamentally interrelated and DOC's work towards both will be constantly connected – for instance, some adaptation solutions will also provide mitigation outcomes (e.g. restoring coastal wetlands).

Ongoing work in the climate change adaptation space will be undertaken by the wider DOC community in collaboration with our Treaty partners and other stakeholders to make DOC's business, New Zealand's conservation estate, and the natural and historic values that we hold in high regard more resilient to climate change.

A present and future threat | He whakawehi o te wā me te āpōpō

Significant climate change is already occurring in New Zealand. Over the past 100 years, New Zealand's average annual air temperature has increased by almost 1°C and many high-temperature records have been broken in recent years compared with fewer low-temperature records. The majority (93%) of the heat that has been trapped through the production of greenhouse gases since the Industrial Revolution has been absorbed by the oceans, resulting in sea surface temperatures (SSTs) in New Zealand waters increasing by an average of 0.12°C in the past 40 years (Fig. 1). Rising ocean temperatures have also been associated with ice melt, which has resulted in the sea level rising 1.3–2.1 mm per year since 1900, with an accelerated rate in the past two decades. Indeed, the glacier ice volume in New Zealand decreased by 38% from 1962 to 2018, with an average of 0.41 km^3 of glacier ice being lost annually (Salinger et al. 2019), which is enough water to fill 164 000 Olympic swimming pools each year.

Climate change modelling shows a future for New Zealand that is generally warmer with amplified rainfall patterns (i.e. the dry parts may become drier and the wet parts are likely to get wetter). There are also likely to be more extreme daily and seasonal variations in both temperature and rainfall.

Haupapa / Tasman Glacier. *Source: NIWA.*

The magnitude of these future changes to our climate will depend on the action we take as a global community to reduce greenhouse gas concentrations in the atmosphere over the next few decades. Human greenhouse gas emissions have mainly stemmed from the burning of fossil fuels, such as oil and gas, since the beginning of the Industrial Revolution in the mid-1700s. Higher concentrations of these gases increase the heat held in the atmosphere, driving atmospheric warming and other climatic changes.

The Intergovernmental Panel on Climate Change (IPCC) has set out a range of possible futures for our climate through the consideration of different scenarios. The lower IPCC scenario involves strong mitigation and emissions reduction action being taken globally, while the highest representative concentration pathway (RCP 8.5) is based on the continuation of increasing emissions (i.e. 'business as usual'). In 2018, global carbon dioxide emissions were estimated to have increased by 2% globally, indicating that the middle or higher IPCC concentration pathways are more plausible at the present time (Figueres et al. 2018).

There are many projected changes for New Zealand throughout the 21st century, as outlined in Box 1 (also see MfE 2018b: table 1). Under the highest scenario (RCP 8.5), average annual air temperatures in New Zealand are projected to increase by up to 1.0°C by the mid-21st century and 3.0°C by the late century (Fig. 2), while SSTs in the New Zealand region are projected to increase by 1.0°C and 2.5°C, respectively, compared with temperatures in the 1990s (Law et al. 2018). Over these time periods, higher temperatures will generally be experienced throughout the year but the largest increases are projected for summer and autumn, while annual precipitation will increase in the west and south of the country and decrease in the north and east (Fig. 3).

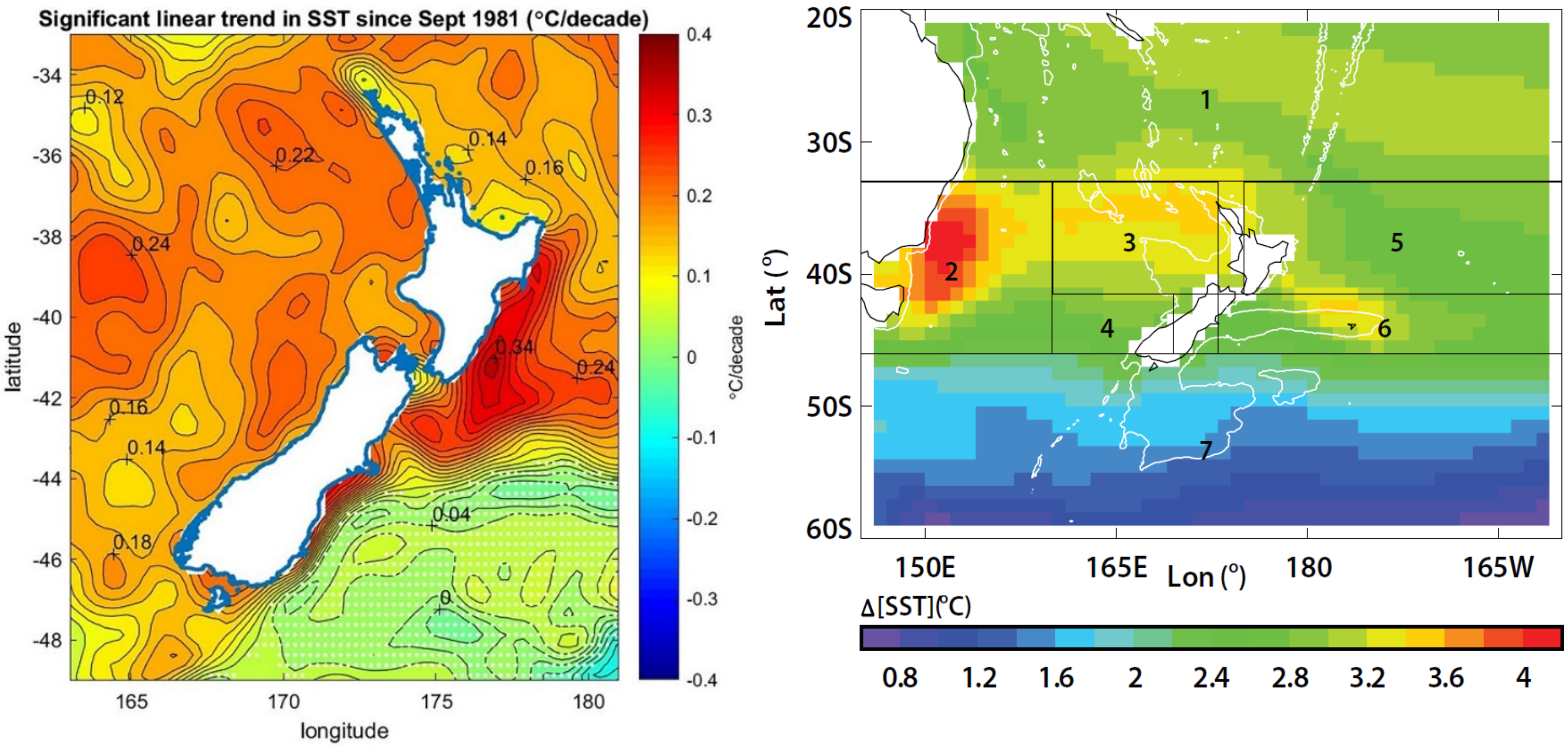


Figure 1. Linear trend in the sea surface temperature (SST) in the New Zealand region between 1981 and 2017 (source: Sutton & Bowen 2019) (left).Projected increase in SST by the late 21st century compared with the 1990s under the highest greenhouse gas concentration scenario RCP 8.5 (source: Law et al. 2017) (right).

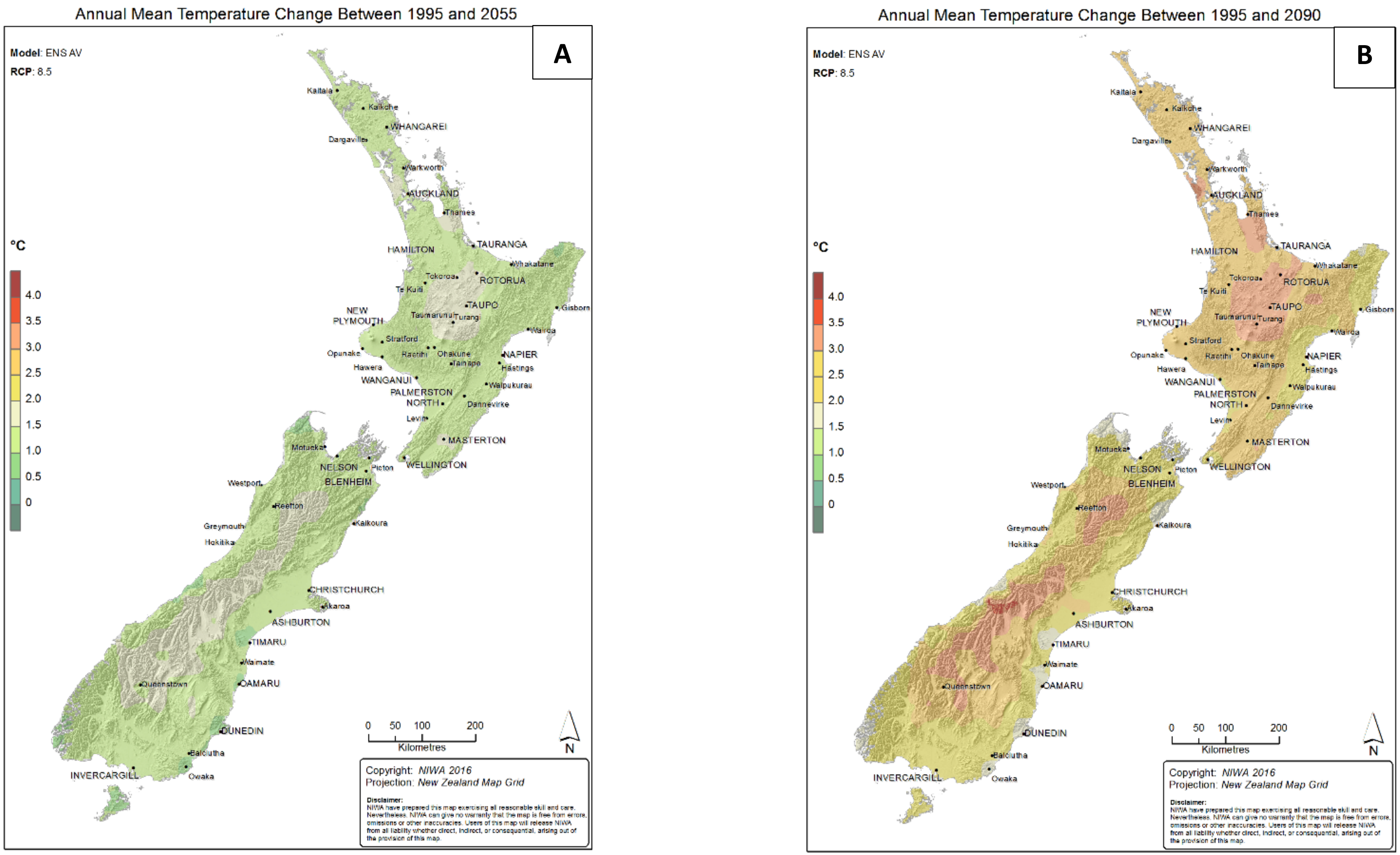


Figure 2. Projected annual mean temperature changes for New Zealand between A. 1995 and 2055 and B. 1995 and 2090 under the highest Intergovernmental Panel on Climate Change (IPCC) greenhouse gas concentration scenario (RCP 8.5). All regions are expected to undergo further warming, with the most warming (relative to the historic climate) occurring at higher elevations. Source: Our Future Climate New Zealand (http://ofcnz.niwa.co.nz).

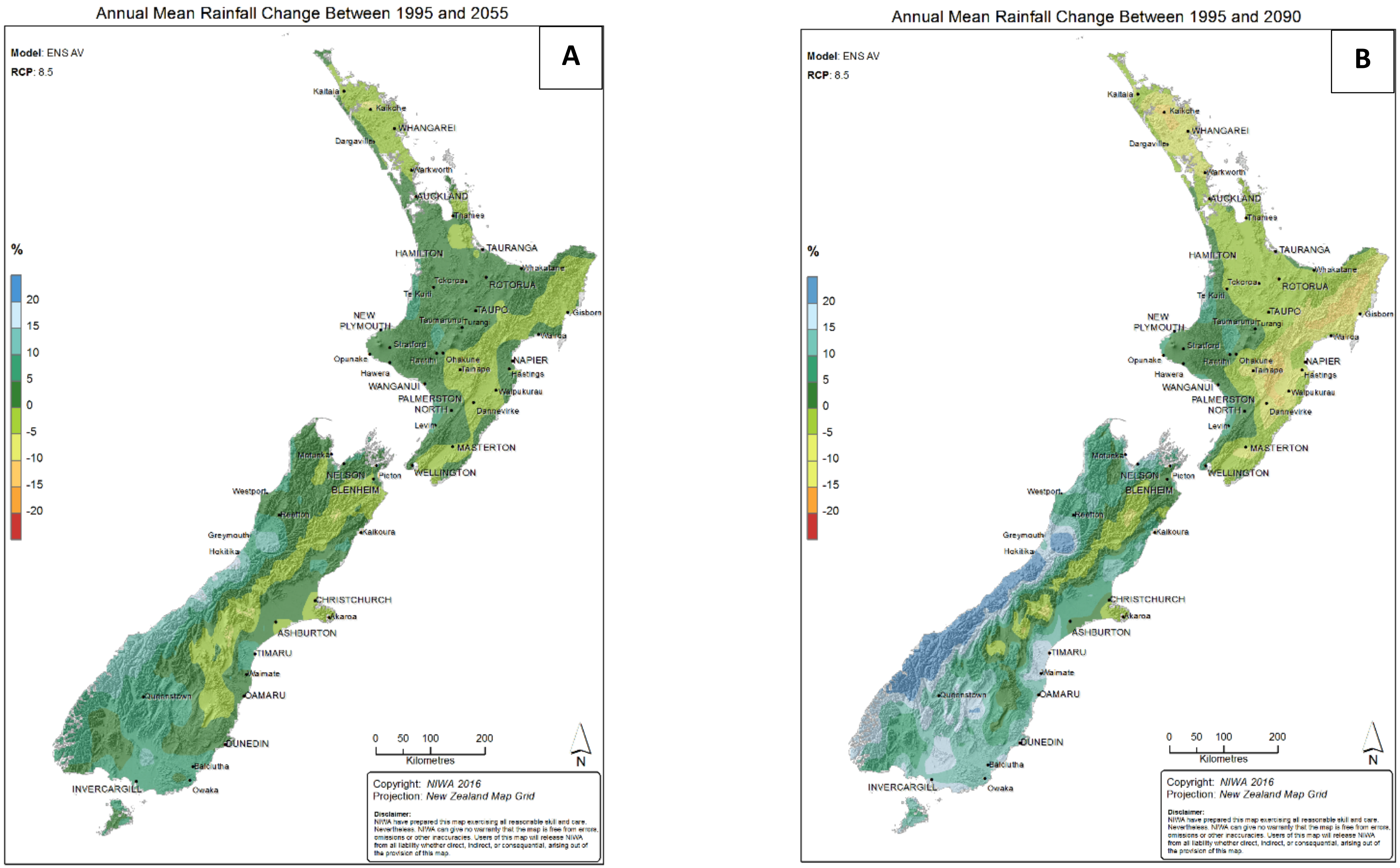


Figure 3. Projected annual mean rainfall changes for New Zealand between A. 1995 and 2055 and B. 1995 and 2090 under the highest Intergovernmental Panel on Climate Change (IPCC) greenhouse gas concentration scenario (RCP 8.5). Significant increases in total annual rainfall are projected for the west and south of the South Island, while reductions in rainfall are projected for eastern and northern areas, particularly in the North Island. Source: Our Future Climate New Zealand (http://ofcnz.niwa.co.nz).

Box 1 Predicted changes to New Zealand's climate

Under the highest atmospheric greenhouse gas representative concentration pathway (RCP 8.5), a person born in New Zealand today could experience the following changes.

By the time they are 21 years old (around 2040):

- A doubling of the time spent in drought each year in the east and north of the country (Clark et al. 2011)
- A halving of the number of cold nights (minimum temperature of 0°C or lower)
- A doubling of the number of hot days (over 25°C) per year on average
- A 400% increase in the number of days with a 'very high' or 'extreme' fire risk in some areas (Pearce et al. 2010)

By the time they are 65 years old (around 2090):

- 90% fewer cold nights
- 60 more hot days on average per year (a 300% increase)
- A 35% increase in the intensity of 1-hour-long extreme rain events with a 100-year return period
- Over 30 fewer snow days per year in high-altitude regions and the southern South Island
- A 700% increase in the number of days with a 'very high' or 'extreme' fire risk in some areas

By the time they die (around 2100):

- A 10% increase in the average wind speed and the occurrence of stronger, more damaging ex-tropical cyclones in some parts of the country
- A 0.5–1 m higher sea level (possibly more)
- Acidification of the seas around New Zealand by an average of 0.3 pH units (from 8.1 to 7.8) (Law et al. 2018), representing the lowest global pH value and fastest rate of pH change in over 25 million years
- Up to 3°C higher SSTs in some parts of the country (Rickard et al. 2015)

Compiled from MfE (2018).

It is difficult to predict the effects of a changing climate on the full range of DOC's interests and responsibilities. Comparatively, it is easier to predict how rising seas will affect low-lying infrastructure (Tait 2019) than to determine how climate change will affect biodiversity or visitor safety, and even less is known about how future changes may affect the oceans around New Zealand (Willis et al. 2007). Predicting the impacts of climate change on ecological systems is especially problematic due to a lack of long-term data on the causative factors that affect the distributions and abundances of most New Zealand species and ecosystems and the difficulty in assessing their resilience and adaptation potential, and any such predictions are further confounded by the past and ongoing effects of invasive species and habitat loss (Christie 2014). Some researchers have predicted that there will be major losses of terrestrial biodiversity as a result of climate change (Halloy & Mark 2003), while others have predicted that few impacts will be seen in the short term, such as over the next few decades (McGlone & Walker 2011), but that 'a more obvious response to climate change from biodiversity seems likely in the long run' (Christie 2014) (Box 2). Some have also predicted that marine species will be more at risk of local extinctions due to their narrower thermal tolerances (Pinsky et al. 2019).

Given the scale and complexity of this issue and the lack of long-term data, this CCAAP will provide adaptive actions to reduce climate change impacts in an environment of deep uncertainty. This will be enabled by taking a 'no regrets' precautionary approach to risk identification and assessment, as well as establishing measuring and reporting frameworks, and using dynamic adaptive planning tools. Therefore, projections associated with high-emission scenario RCP 8.5 will be considered for the purpose of initial risk screening, which will also enable a wider range of impacts to be evaluated.

Box 2 Predicted changes to New Zealand's landscape and biodiversity

The same New Zealander that is born today could witness the following changes in their lifetime:

- Some seabird and seal species may no longer exist on the New Zealand mainland, only persisting on the subantarctic islands to the south.
- Native coastal habitats, such as mangrove forests, may be increasingly rare as they are squeezed between rising sea levels and developed rural or urban land.
- Threatened species populations in beech forest and the subalpine zone may no longer survive in the wild due to increased numbers of invasive predators at higher altitudes.
- Plant flowering and bird nesting may occur earlier due to the warmer winters, which may cause mismatched food webs and other unforeseen outcomes.
- The upper red tussock slopes of Mount Tongariro may be extensively covered by heather (*Calluna vulgaris*), an invasive weed that is currently restricted by the climate (Julie Disleppe, Victoria University of Wellington, pers. comm.).
- Road access to some popular visitor destinations may be at risk of closure due to increased storm damage from more intense storms and the costs and viability of ongoing repairs.


A flood-damaged bridge in Arthur's Pass. *Source: DOC.*

- Important visitor attractions may change – for example, some of New Zealand's highest mountains may no longer have permanent snow year-round and it may no longer be possible to visit Fox Glacier/Te Moeka o Tuawe and Franz Josef Glacier/Kā Roimata o Hine Hukatere on the West Coast by foot.
- Coastal tracks and popular coastal campsites where generations of New Zealanders holiday, such as Tōtaranui in Abel Tasman National Park, may experience more frequent damage and closures due to sea-level rise and increased storm damage.
- Foothill rivers on the east coast of the South Island, such as the Ashley River/Rakahuri and Selwyn River/Waikirikiri, may run dry more frequently and for longer periods of time due to increased drought and water abstraction pressure from agriculture or forestry (Collins & Zammit 2016).
- Subtropical fish species that currently only visit New Zealand waters as vagrants during the summer, such as groper and sunfish, may become established in northern New Zealand, and other fish species may move further south to cooler waters (Law et al. 2016), as occurred during the marine heatwave of 2017–2018, when kingfish (*Scomberomorus cavalla*), which is a northern fish species, was seen near Dunedin.

Purpose | Ko te aronga

The purpose of the CCAAP is:

> **To guide DOC's strategic planning and management activities for increased resilience to climate change impacts.**

DOC is by no means unique in having its operations and responsibilities affected by climate change, and nor is it alone as it adapts to these ongoing and exacerbating impacts. To be successful, both mitigation (reducing greenhouse gas concentrations) and adaptation (responding to the impacts of climate change) will be required at a global scale to reduce the impacts of climate change on our natural ecosystems, societies, cultures and economies. Furthermore, all knowledge, insights and perspectives will be needed to find our way forward.

DOC has created this CCAAP to inform, prepare and guide our responses to climate-related changes and to give effect to the principles of the Treaty of Waitangi under section 4 of the Conservation Act, capturing the advice of our Treaty partners, internal experts and key external stakeholders.

DOC's vision is that 'New Zealand is the greatest living space on Earth' and its purpose is 'to work with others to increase the value of conservation for New Zealanders'. Most of DOC's intermediate outcomes (e.g. 'The diversity of New Zealand's natural heritage is maintained and restored') and stretch goals (e.g. '90% of our threatened species across New Zealand's ecosystems are managed to enhance their populations') are or will be affected by climate change (Appendix 1).

The CCAAP builds on existing adaptation planning by DOC, including existing ideas to protect our terrestrial native biodiversity from the impacts of climate change (e.g. Christie 2014), a previous review of marine issues (Willis et al. 2007) and ongoing sustainability planning. This is the first comprehensive assessment of the required activities across all of DOC's functions and includes actions for natural and historic heritage, visitor, recreational, and policy and partnerships elements, as well as biodiversity. It is intended that the CCAAP will inform all aspects of DOC's work, including statutory documents, national policy statements, internal strategies and prioritisation tools (Fig. 4).

The following outcomes are sought by the CCAAP:

1. DOC alongside its Treaty partners and other stakeholders has identified, prioritised and significantly addressed and communicated information gaps pertaining to achieving its purpose.
2. Prioritised research and consistent detailed risk assessments are completed to identify the exposure, consequence and vulnerability of DOC's areas of management to climate change impacts.
3. DOC has implemented consistent and integrated internal policies and actions to ensure that its responsibilities (e.g. biodiversity, heritage and recreation) are resilient to climate change impacts both now and into the future.
4. Policies and actions are regularly reviewed and maintained to remain relevant in a changing environment and as new information emerges.
5. The CCAAP is implemented in a way that gives full effect to the principles of the Treaty of Waitangi under section 4 of the Conservation Act.

6. DOC's efforts inform the development of the National Adaptation Plan (NAP), as part of the Climate Change Response (Zero Carbon) Amendment Act 2019, bringing conservation values to the forefront.
7. DOC has consistently reported implementation of the CCAAP and successes in addressing information deficiencies to inform adaptive action.

The CCAAP will be reviewed at regular intervals and revised every fifth year. The present report outlines priority activities during the 2020/21 – 2024/25 fiscal years.

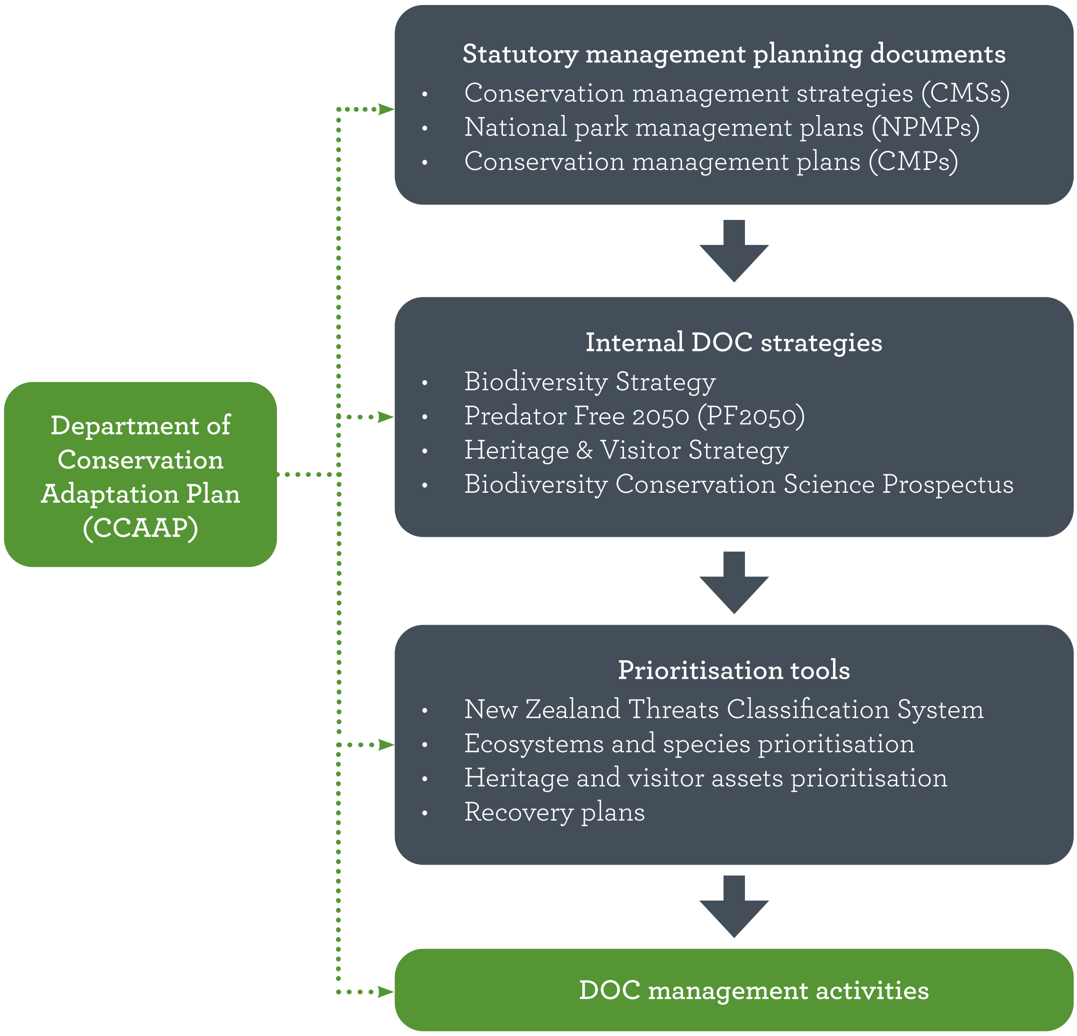


Figure 4. How the Climate Change Adaptation Action Plan (CCAAP) fits into the Department of Conservation's (DOC's) statutory management planning, strategies, prioritisation and delivery.

2. Treaty partnership | Ko te hononga Tiriti

Oamaru coastline. *Source: NIWA*

The partnership between iwi/hapū and the Crown that was established under the Treaty of Waitangi forms the basis for working together and underpins the CCAAP. Understanding and integrating te ao Māori / the Māori world view of the interconnectedness of people and nature is an essential component of the CCAAP. Climate change will affect all Māori, particularly given the special relationship Māori have with their ancestral lands, waters, sites, wāhi tapu / sacred sites and taonga / treasures as tangata whenua and kaitiaki/guardians.

The knowledge and experience of our Treaty partners will be integral to the development and implementation of the CCAAP. Some iwi have already developed and started to implement comprehensive iwi-led climate change adaptation and mitigation strategies or have long-established climate change criteria and priorities within iwi management plans. Therefore, this knowledge and experience will be of significant value to ensuring that the implementation of the CCAAP supports and complements these iwi-led initiatives.

Section 4 of the Conservation Act 1987 requires DOC to 'give effect to the principles' of the Treaty of Waitangi in its work. To meet this requirement, DOC applies the following Treaty principles[1] in the work it does, which will also guide the development and implementation of the CCAAP:

[1] www.doc.govt.nz/get-involved/apply-for-permits/iwi-consultation/principles-of-the-treaty-of-waitangi-and-doc/

- **Partnership – mutual good faith and reasonableness**

  The Crown and Māori must act towards each other reasonably and in good faith. These mutual duties of reasonableness and good faith describe the nature of the relationship between the Crown and Māori and are the core of what has been described as the Treaty partnership. This principle is about how the Crown should behave towards Māori and Māori towards the Crown.

- **Informed decision-making**

  Both the Crown and Māori need to be well informed of the other's interests and views. When exercising the right to govern, Crown decision makers need to be fully informed, while Māori need to provide complete information to contribute to the decision-making process. This is closely connected to the principles of good faith and active protection. Consultation and engagement are means to achieve informed decision-making.

- **Active protection**

  The Crown must actively protect Māori interests retained under the Treaty as part of the promises around the right to govern. This includes the promise to protect tino rangatiratanga / self-government, taonga and mana whenua / territorial rights to economic development. Active protection requires informed decision-making and judgement about what is reasonable in the circumstances.

- **Redress and reconciliation**

  The Treaty relationship should include processes to address differences of view between the Crown and Māori. The Crown must preserve capacity to provide redress for proven grievances as a result of failing to uphold the promises made in the Treaty, and Māori and the Crown should demonstrate reconciliation as these grievances are addressed.

The CCAAP has been developed with the knowledge that further discussion will be required about the impacts the specific adaptation actions described will have on Māori and that ongoing collaboration with our Treaty partners is essential. Furthermore, the activities arising from the CCAAP will be implemented in partnership with our Treaty partners.

3. Informing national efforts | Hei whakamōhio atu i ngā whakamahere hātepe o te motu

The impacts caused by climate change are broad and complex, so the CCAAP serves as an overarching document that builds on and affects many other ongoing efforts (Fig. 5). It will link to the development of the updated New Zealand Biodiversity Strategy, Predator Free 2050, the National Policy Statement on Indigenous Biodiversity, the Biodiversity Conservation Science Prospectus, the Tourism Strategy and DOC's strategic planning efforts. The CCAAP also builds on existing health and safety risk management systems (e.g. evacuation procedures for low-lying campgrounds), the New Zealand Coastal Policy Statement 2010, the Ministry for the Environment's climate change adaptation guidance (MfE 2018), the Ministry for the Environment's coastal hazards and climate change guidance for local government (MfE 2017), and the Conservation and Environment Science Roadmap (MfE & DOC 2017). Future revisions also have the potential to be influenced by the Wai 262 claim.[2]

The Climate Change Response (Zero Carbon) Amendment Act 2019 sets reduction targets for carbon dioxide, methane and nitrous oxide and requires the development of a National Climate Change Risk Assessment (NCCRA) and NAP. The CCAAP is expected to inform both of these national documents.

The actions listed in the CCAAP are likely to align with the priorities of a multitude of other external agencies and organisations with interests in the natural environment. Therefore, the CCAAP will be implemented using a collaborative approach, whereby partnerships and cooperation with other stakeholders will be sought where alignment exists.

[2] www.waitangitribunal.govt.nz/news/ko-aotearoa-tenei-report-on-the-wai-262-claim-released/

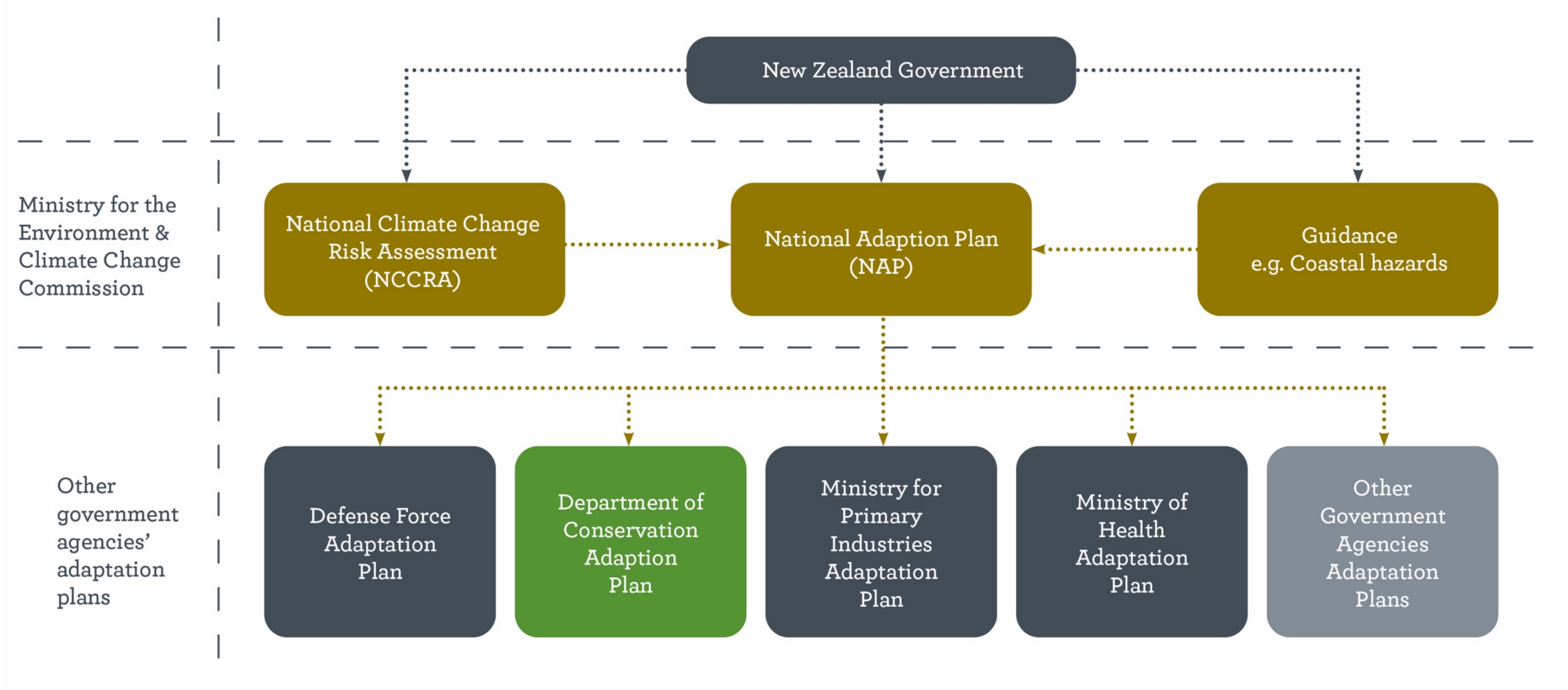


Figure 5. How the Climate Change Adaptation Action Plan (CCAAP) fits into ongoing climate change efforts at the national level.

Living Standards Framework for wellbeing | He Ara Waiora

In the Treasury's Living Standards Framework,[3] natural capital surrounds all other capitals (Fig. 6), indicating that the wellbeing of New Zealanders is highly dependent on sustaining natural capital or ecosystem services, which provide resources, moderate the climate, absorb pollutants, cycle nutrients and provide resilience to extreme weather events. The ecosystem services delivered by indigenous biodiversity and natural ecosystems not only provide for many of our basic needs and health but are also at the core of New Zealand's cultural and social identity (Roberts et al. 2015).

The principles of this connection between healthy ecosystems and wellbeing is mirrored in DOC's Healthy Nature Healthy People programme.

In the context of the CCAAP, the Living Standards Framework stresses the need to ensure that we adapt our management of the natural environment to remain resilient to the impacts of climate change for the benefit of the wellbeing of New Zealanders.

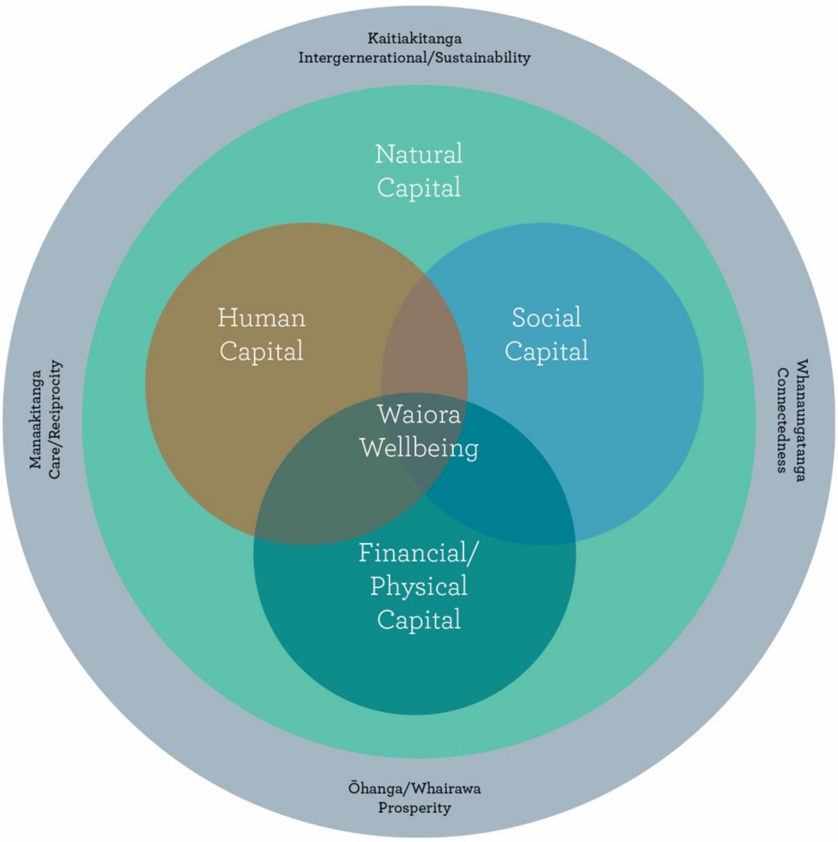


Figure 6. The Treasury's Living Standards Framework for wellbeing and the He Ara Waiora framework.

[3] https://treasury.govt.nz/information-and-services/nz-economy/higher-living-standards/our-living-standards-framework

National and international reporting | Ko ngā pūrongorongo ki te motu, ki te ao

The CCAAP will be most effective if it is directly linked to DOC's intermediate outcomes and associated stretch goals and the United Nations' Sustainable Development Goals and is reported on in DOC's Annual Report to allow progress to be measured annually and provide a clear chain of accountability.

The CCAAP will also assist New Zealand in meeting some of the international obligations it has committed to. As a signatory to several international agreements (e.g. the Convention on Biological Diversity,[4] the Ramsar Convention on Wetlands[5] and the Convention on the Conservation of Migratory Species[6]), New Zealand has committed to make efforts to preserve its biodiversity against all threats.

Previous work on climate change | Ko ngā mahi huringa āhuarangi o mua a

The CCAAP builds on previous climate change work by DOC, particularly in the following research areas:

- A proposed framework for the conservation of terrestrial native biodiversity in New Zealand (Christie 2014)
- The impacts of climate change on native biodiversity (McGlone & Walker 2011)
- Freshwater conservation under a changing climate (Robertson et al. 2016)
- Climate change and the New Zealand marine environment (Willis et al. 2007)
- How climate change responses by land managers could benefit biodiversity (Green 2014)
- The impacts and implications of climate change on Waituna Lagoon, Southland (Tait & Pearce 2019)
- A risk-exposure assessment of DOC coastal locations to flooding from the sea (Tait 2019)
- Coastal hazards and climate change adaptation planning for recreational, historic and property assets (Field 2019)


Wellington south coast. *Source: NIWA.*

[4] www.doc.govt.nz/about-us/international-agreements/convention-on-biological-diversity/
[5] www.doc.govt.nz/about-us/international-agreements/ramsar-convention-on-wetlands/
[6] www.doc.govt.nz/about-us/international-agreements/migratory-species/

4. Action plan framework | He anga whakamahere hātepe

How the plan was developed | He pehea te whanaketanga o te mahere

1. A writing team was established that included DOC practitioners and experts.
2. The concept was discussed by the Senior Leadership Team (SLT) in December 2018, resulting in a task assignment.
3. The first iteration of the CCAAP was produced through a collaborative process between the writing team, numerous DOC staff and some external focus groups.
4. A Technical Advisory Group (TAG) consisting of approximately ten representatives from different DOC groups provided guidance and feedback during the formation of the CCAAP. This TAG will continue to guide the implementation of the CCAAP through the 5-year cycles.
5. Approximately 40 DOC staff members from different groups took part in 'action table workshops' in May 2019 to shape the details of the action tables presented in the following sections.
6. The Eastern South Island Regional Management Team (RMT) was engaged as a focus group, which discussed the CCAAP in its various stages to assess its validity and utility.
7. Te ao Māori climate change practitioners were also involved in the process to share lessons learned and discuss future collaboration.

What feedback did we receive | He aha ngā whakahokinga kōrero?

We consistently heard that:

- Difficult and consistent climate change adaptation issues are affecting all of DOC's work programmes and these cannot be addressed by any single group/unit in isolation. Therefore, for DOC to successfully adapt to climate change, a team effort is essential.

  To address this and ensure that the CCAAP is effectively implemented in a coordinated and consistent manner, we recommend that:
  - A cross-functional team of advisors is maintained to oversee the implementation of the CCAAP. This should be led by a dedicated full-time employee to ensure the success of the team and the CCAAP.
  - Several overarching/governance actions are developed that oversee the remaining actions.

- One of the first steps should be to consider the relevance of information DOC already has and still needs and to then assess the risks it faces from climate change. A standardised risk assessment process[7] should then be conducted to assess species, habitats, heritage sites, and recreational and visitor risk elements in a prioritised way.
- Additional resources are likely to be required to implement some of the highest priority actions. Determining the resources required is identified as a task in this action plan.

[7] This risk assessment should be consistent with the National Climate Change Risk Assessment.

How to interpret the action tables | Me pēhea te whakamāori i ngā ripanga hātepe

The tables presented in the following sections outline the adaptation actions that DOC should take between 2020 and 2024 to reduce the risks and improve its resilience to climate change and describe how the CCAAP will be implemented.

The action tables are arranged in six different categories, each of which corresponds to a different area of DOC's business:

- Governance and Strategic
- Evaluation and Reporting
- Terrestrial Biodiversity
- Aquatic Biodiversity
- Heritage, Visitors and Infrastructure
- Planning, Permissions and Land

Action categories

Governance and Strategic actions will guide the implementation of the CCAAP across DOC. These actions are designed to ensure that the CCAAP is effectively implemented in a way that:

- Secures adequate resourcing
- Integrates climate change actions in DOC's project management and risk assessment frameworks
- Ensures that DOC is actively engaged in and directly informing relevant national discussions
- Gives full effect to the principles of the Treaty of Waitangi under section 4 of the Conservation Act
- Helps everyone within DOC and key external stakeholders to understand the need for and purpose of the CCAAP

Evaluation and Reporting actions identify the ways in which climate change adaptation will be assessed by DOC. This will be done through:

- Existing and new reporting mechanisms
- Monitoring schemes to report progress for the adaptation actions
- Consistent climate change risk assessment processes and tools

Terrestrial Biodiversity (i.e. Threats and Terrestrial Science Units), Aquatic Biodiversity, Heritage, Visitors and Infrastructure, and Planning, Permissions and Land actions represent the specific steps that these groups or units need to take. These include:

- Identifying information gaps
- Undertaking risk assessments
- Updating existing planning and prioritisation systems
- Implementing adaptation actions

Owners have been assigned to the actions in all of these areas according to the type of action required.

Action stakeholders

One or more stakeholders have been allocated to each action according to the DOC unit or functional group that is responsible for that action. In some cases, multiple groups make up the teams that are responsible for a particular action, in which case a single point of accountability will be identified for implementation (Table 1).

Reporting and revision – structure and frequency

Progress reports on the implementation of the CCAAP will be produced annually and reported in DOC's Annual Report. A red-amber-green (RAG) assessment will regularly be conducted and published for each action to provide a quick indication of progress. It is expected that the CCAAP will be revised at least every 5 years in accordance with the NAP associated with the Climate Change Response (Zero Carbon) Amendment Act 2019.

Living document status

The CCAAP will be published and implemented as a 'living document'. This will enable new information to be considered and help inform the direction over the 5-year period and will also ensure flexibility to allow any changes in national priorities, internal structure or planning systems to be adhered to.

Progress against each CCAAP action, the relevant external context (team/unit structures, changes in planning or delivery systems, etc.) and new information relating to climate change will be reviewed annually. Should this new or changing context be deemed significant to the scope or intent of the CCAAP, an update process will be conducted.

Table 1. Abbreviations for the groups and units referred to in the action tables.

KKA Kahui Kaupapa Atawhai	**BG** Biodiversity Group	**PVG** Policy & Visitors Group	**OG** Operations Group	**CSG** Corporate Services Group	**PEG** People & Engagement Group	**PG** Partnerships Group
	PSU Planning & Support Unit	**PU** Policy Unit	**OPU** Operations Planning Unit	**BAU** Business Assurance Unit	**HSU** Health & Safety Unit	**PS** Partnerships Unit
	TU Threats Unit	**HVU** Heritage & Visitors Unit	**PPLU** Planning, Permissions & Land Unit	**BSS** Business Shared Service	**MCT** Media and Communications Team	**IPT** International Partnerships Team
	TSU Terrestrial Science Unit		**NOU** National Operations Unit	**FU** Finance Unit		**NSU** Partnerships National Support Unit
	AU Aquatic Unit			**OMU** Outcomes Management Unit		**TR** Tenure Review

Action timelines

The timeline indicates the year in which the action is to be completed. For example, actions with a 'By when' date of 2022 should be completed by 30 June 2022 (i.e. the end of DOC's financial year) (see Table 2). It should be noted that some actions cannot be implemented until other actions have been completed (see section 3.3.7).

Table 2. Delivery dates for the adaptation actions.

Delivery time frame	2022	2024	2025+
Financial year	2020/21 + 2021/22	2022/23 + 2023/24	2024/25 onwards

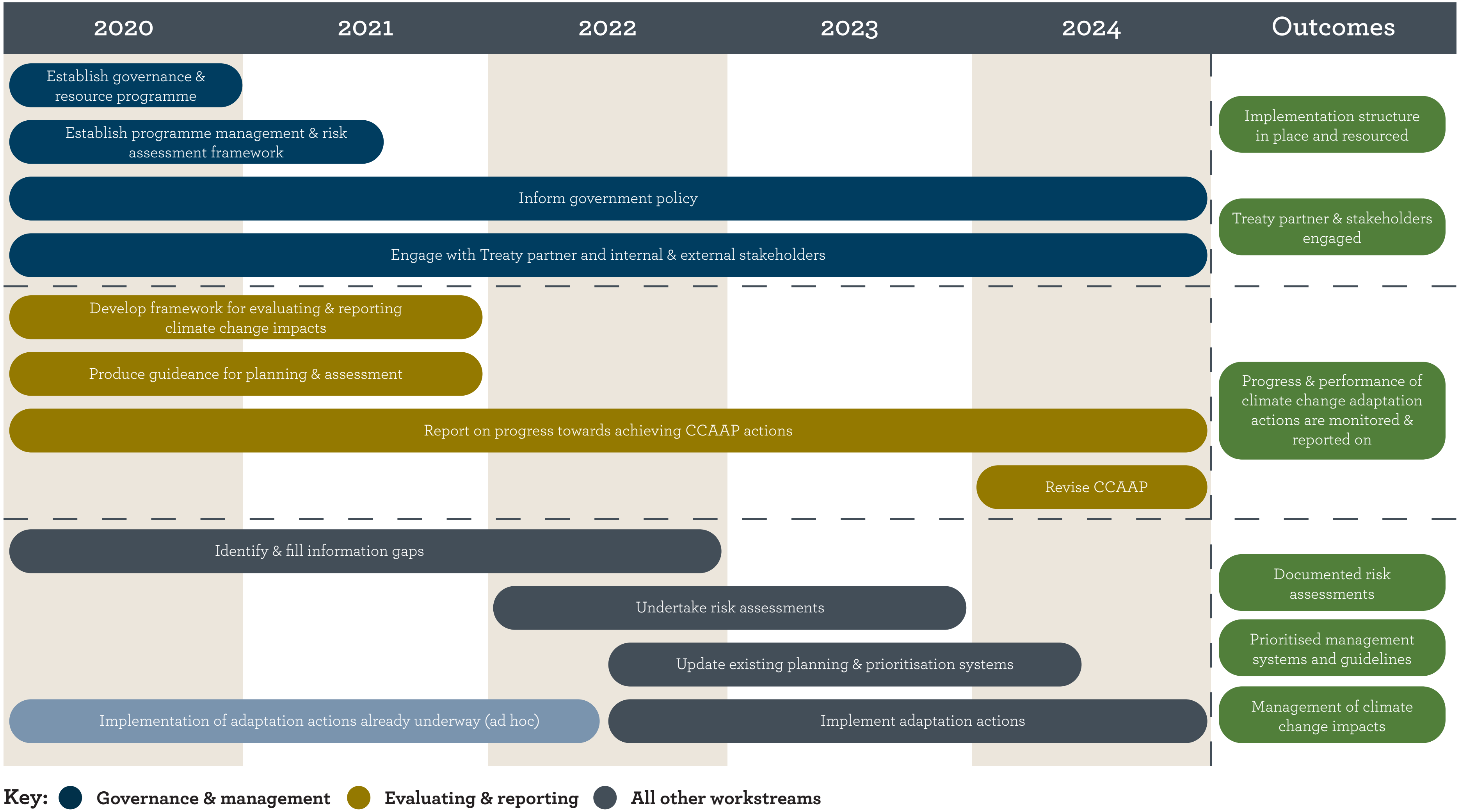
Resourcing the adaptation actions

Some actions may be achieved through the reprioritisation of existing resources, while others will require new, additional resources to enable implementation. These budget decisions will be made by the Senior Responsible Owner associated with the particular action or series of actions.

Identifying critical pathways and dependencies of actions

Some actions have dependencies, meaning that other actions in the tables need to be completed before they can be implemented. The 'critical pathways' for implementing these actions by year and by outcome are shown in Table 3. Further guidance to assist with prioritising the implementation of any sub-actions is provided in Appendix 2.

Table 3. Critical pathways in the Climate Change Adaptation Action Plan (CCAAP).



5. Governance and Strategic | Ko Mana Whakahaere me Ahunga Rautaki

This is the Department of Conservation's first climate change adaptation action plan. It provides a blueprint for managing the impacts of climate change on New Zealand's biodiversity, cultural heritage and visitor experiences that are managed by DOC.

Governance and Strategic actions will guide the implementation of the CCAAP across DOC's diverse portfolio. This will include establishing the governance structure (see Fig. 7 for a proposed overview) and the resources required to successfully implement the CCAAP and integrate the adaptive actions into standard practice.

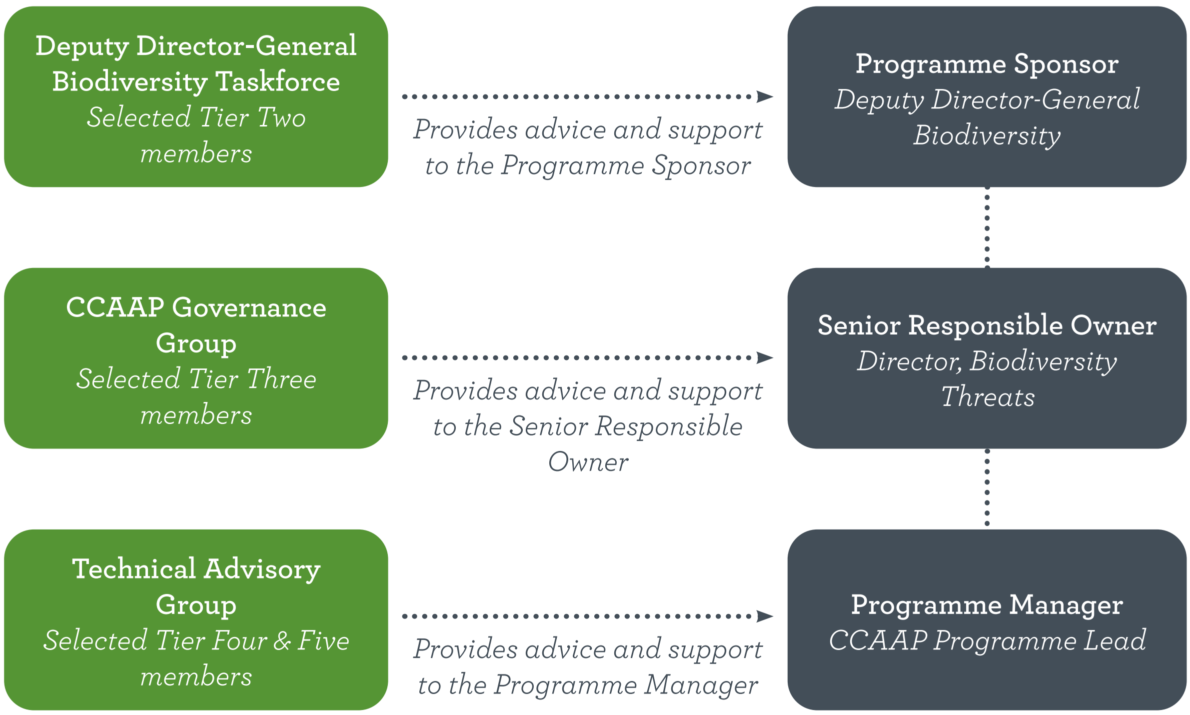


Figure 7. Proposed governance structure of the Climate Change Adaptation Action Plan (CCAAP).

Case study 1: Researching taonga tipu in Tongariro National Park

The incorporation of mātauranga Māori / traditional knowledge is an important aspect of climate change adaptation in New Zealand. Consequently, co-design is a significant element of climate change adaptation research.


Mount Tongariro. *Source: NIWA.*

Tongariro National Park is a United Nations Educational, Scientific and Cultural Organization (UNESCO) world heritage site for both its cultural and natural heritage values. However, it is currently subject to the dual pressures of a changing climate and the invasion of European heather (*Calluna vulgaris*). Matāuranga Māori from Ngāti Rangi identified five taonga tipu / sacred plants in Tongariro National Park that are at risk from these pressures.

The distributions of these indigenous plants and European heather were surveyed along elevational and invasion gradients, and this information was then related to current climate gradients and compared with future climate change projections.[8]

The results indicated that ongoing climate change will cause European heather to expand its range upslope to higher elevations and occur at higher densities. This, in turn, will reduce the distributions of three of the identified taonga tipu species. It was also predicted that there would be no increase in suitable habitat for the taonga tipu under climate change. Therefore, the compounding pressure of climate change is likely to reduce the ranges of these taonga tipu and may even increase the likelihood that populations of these plants will disappear.

Alpine sites such as Tongariro National Park are subject to the problems of decreasing real estate as the climate warms – that is, the size of the area that is available for occupation by indigenous plants shrinks as they move up the mountain until eventually they can go no higher. This is especially problematic for isolated mountain tops like Mount Tongariro, where indigenous plants literally have nowhere else to go. The indigenous plants that are most exposed to this effect are those which are vulnerable to both climate change and weed invasion. Consequently, these interacting drivers of global change require consideration for the successful kaitiakitanga/guardianship of our taonga tipu.

[8] Unpublished research by J.R. Deslippe and J. Giejsztowt of Victoria University of Wellington in 2019.

Governance and Strategic actions | Ko ngā hātepe mana whakahaere me te ahunga rautaki

The key Governance and Strategic actions and their associated accountabilities and delivery time frames are shown in Table 4.

Table 4. Action table for the Climate Change Adaptation Action Plan (CCAAP) Governance and Strategic actions. See Table 1 for a list of the abbreviations for the units and groups.

ACTIONS		DOC Teams – unit (group)	Delivery time frame		
			2022	2024	2025
G1	**Resources to support implementation of the CCAAP**				
G1a	Refocus the existing cross-functional CCAAP Technical Advisory Group (TAG) to support the implementation of the CCAAP. Clarify the roles and responsibilities of the TAG.	**TU (BG)**	✓		
G1b	Establish a new Climate Adaptation Lead position to implement the CCAAP and oversee the TAG.	**TU (BG)**	✓		
G1c	Continue and secure resources for a part-time secondment from NIWA to support the Department of Conservation's (DOC's) capability and capacity for meeting climate change monitoring and research needs.	**PSU (BG)**	✓		
G1d	Continue with the existing science lead to write a science strategy, provide overview across all of the climate change impacts research and collaborate with external research providers.	**TU (BG)**	✓		
G1e	Continue with the existing Policy Unit key contact to represent DOC's interests in the National Adaptation Plan (NAP), National Climate Change Risk Assessment (NCCRA) and other national initiatives.	**PU (PVG)**	✓	✓	✓
G1f	Assess and secure the resources needed to implement the CCAAP and seek organisational commitment, including: • To enable research • To augment monitoring • For business as usual costs (e.g. extra costs for science support) • For new projects	**TU (BG)**, PSU (BG), HVU (PVG), OG	✓		
G1g	Prioritise identified adaptation actions and identify channels for funding.	All groups		✓	✓

ACTIONS		DOC Teams – unit (group)	Delivery time frame		
			2022	2024	2025
G2	**Programme management and risk assessment**				
G2a	Put the CCAAP and its actions into DOC's Programme Management framework. Include: • Monitoring requirements • Reporting mechanisms • Management thresholds	**TU (BG)**	✓		
G2b	Adapt DOC's risk assessment processes and project management tools to include climate change in a manner that works across functional groups and is consistent with the NCCRA framework.	**BAU (CSG)**	✓		
G3	**Inform government policy**				
G3a	If the opportunity arises, identify whether climate change criteria need to be included in the Conservation General Policy and National Park General Policy and what these criteria are.	**PU (PVG)**	✓	✓	✓
G3b	Identify climate change issues in DOC-led national policy statements and strategies, including the: • New Zealand Biodiversity Strategy • National Policy Statement on Indigenous Biodiversity • New Zealand Coastal Policy Statement	**PU (PVG)**	✓	✓	✓
G3c	Work with the Ministry for the Environment (MfE) and other government agencies to ensure climate change issues are included in government policy not led by DOC (e.g. biodiversity in the National Policy Statement for Freshwater Management and National Environmental Standards for Plantation Forestry).	**PU (PVG)**	✓	✓	✓
G3d	Work with MfE and other agencies to improve the integration of resilience to climate change impacts in central government decision-making.	**PU (PVG)** / all groups	✓		
G3e	Work with the Ministry of Foreign Affairs and Trade (MFAT) to contribute to biodiversity resilience to climate change in the Pacific as required.	**IPT (PG)**, TSU (BG)	✓		

ACTIONS		DOC Teams – unit (group)	Delivery time frame		
			2022	2024	2025
G3f	Investigate whether consideration of climate change needs and options should be included in briefing and advice paper templates and revise these if the opportunity arises.	**Ministerial Services**, BAU (CSG)	✓		
G3g	Influence the Nature Heritage Fund to include new criteria that take climate change into consideration, e.g. the purchase of strategic lands for species translocation or where coastal habitats / species are at risk due to increased flooding.	**NSU (PG)**	✓		
G3h	Provide guidance for the effective implementation of DOC-led policies that include climate change issues.	**PU (PVG)**	✓	✓	✓
G3i	Work with MfE and other government agencies to ensure that 'nature-based solutions' to improve biodiversity and climate change resilience are included in the climate change adaptation plans of other land-use sectors.	**PU (PVG)**, TU (BG)	✓	✓	✓
G4	**Engage with Treaty partners and external stakeholders**				
G4a	Implement the CCAAP in a way that gives full effect to the principles of the Treaty of Waitangi under section 4 of the Conservation Act 1987.	All groups	✓	✓	✓
G4b	In collaboration with our Treaty partners develop guidance for task assignments related to quality expectations and acceptance criteria to ensure that our Treaty partners are involved in the planning and delivery of adaptation actions so that the principles of the Treaty of Waitangi are given effect to throughout the implementation of the CCAAP.	**TU (BG)**, KKA, OG	✓		
G4c	Enable mātauranga opportunities that will enable whānau, hapū and iwi to exercise kaitiaki of natural and cultural resources in response to climate change.	All groups	✓	✓	✓
G4d	Engage with our Treaty partners to identify which natural and cultural resources, sites and other taonga on public conservation lands and waters need to be considered in the implementation of CCAAP workstreams.	**TU (BG)**, KKA, OG	✓		
G4e	Develop and implement an internal and external communications strategy for the CCAAP to increase the profile of climate change adaptation in DOC.	**MCT (PEG)**, TU (BG)	✓		
G4f	Create and update key climate change messages for use by all of DOC.	**MCT (PEG)**, TU (BG)	✓	✓	✓

6. Evaluation and Reporting | Ko Aromātai me Pūrongorongo

The CCAAP is underpinned by evaluating and reporting, so that we know where management is needed and its effectiveness. Therefore, annual progress reports will be produced over the life of this plan.

Red tussock (*Chionochloa rubra*) grasslands. *Source: DOC.*

Measuring climate change impacts and adaptation effectiveness are complex tasks. Indicators will be developed to show progress towards achieving the actions included in this plan and a RAG assessment will also be provided for each. We will work towards improving our approach to evaluating and reporting over time.

Progress on some of these actions will be reported on in the DOC Annual Report. Some of these actions will also be reported as required under the Zero Carbon Bill.

Monitoring is key to understanding how climate change is affecting what we value and where the greatest impacts will be. Some of the changes we can expect include:

- The shifting of species' ranges southwards and to higher elevations following the distribution of essential food sources or habitat conditions
- The earlier or more frequent timing of events such as breeding or flowering
- Sea-level rise and storm damage, which will change landscapes and most likely cross ecological thresholds, leading to changes in habitat viability for some species

Investment in monitoring will help us to manage and, in some instances, reduce risk. While we will be able to use existing information and monitoring schemes, we also need to invest in gathering new and finer scale information. Baseline information is needed so we can compare changes over time. The use of emerging technologies such as remote sensing will allow us to gather and map large-scale changes over time more easily. We could also work with te ao Māori experts/practitioners to include mātauranga Māori in data gathering, monitoring and evaluation.

Case study 2: Remote sensing of beech forest flowering

Remote sensing will allow us to detect changes that occur at a large spatial scale, such as the occurrence of beech flowering or drought-induced forest mortality, and link these to climate change.

Flowering mountain beech (*Fuscoscpora cliffortioides*). Source: DOC.

Beech is a dominant tree species in roughly two-thirds of New Zealand's protected native forests. Unlike many plant species, beech trees flower en masse, but this only occurs roughly every 4 years. This is known as mast flowering and is partially dependent on inter-annual variations in climatic conditions.

Beech flowers cross-pollinate other trees, resulting in large amounts of beech seed being produced. This seed provides a surplus of food and drives native bird and invertebrate breeding cycles. However, with the introduction of invasive predators by European settlers, this seed now also drives mammalian predator–prey cycles, in which our native species are the prey (DOC 2014). As a result, many native species are now extinct or severely threatened within these forests. Consequently, investment in predator control is significant, particularly in mast years.

Climate change could alter the pattern of mast seeding in two ways. Firstly, flowering could occur earlier in spring than is currently the case due to increased temperatures. This could create a disconnect with the birds and invertebrates that rely on the availability of this food and potentially spur earlier predator irruptions, which would require control operations to begin earlier in the year. Secondly, as mast flowering is partially driven by the ambient temperature during the previous 2 years, increased weather variability as a result of climate change could change the frequency of masts that are synchronised over larger parts of the landscape. However, the relationship between climate change and mast seeding events is not yet clear.

Historically, it has not been possible to undertake monitoring at a landscape level to investigate when beech trees start to flower. Instead, a network of collection funnels has been used to collect seed later in autumn. While extremely useful, this network does not tell us when and where flowering started or its intensity. However, remote sensing now makes it possible to obtain landscape-scale imagery from either fixed-wing aircraft or satellites. These images are processed to provide a time-stamped georeferenced image of beech tree flowering (Fig. 8). This also means it is now possible to determine how climate affects the timing of the onset of flowering, as well as the relationship between flowering intensity, climate and seed production.

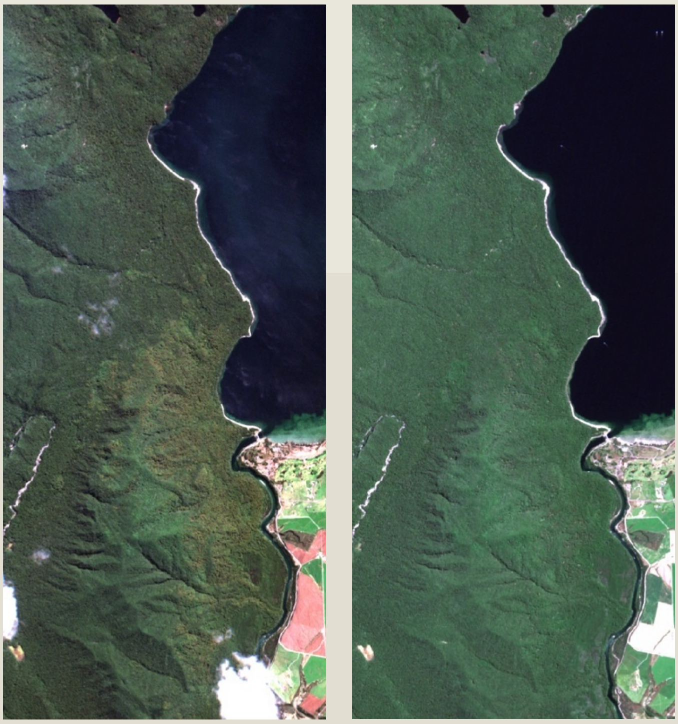


Figure 8: Remotely sensed images of a beech forest when flowering (left) and not flowering (right). *Source: DOC.*

Remote sensing imagery can also be used monitor tree mortality in forests. Many beech forests are in dry eastern areas, which are expected to become warmer and sometimes drier under climate change. Consequently, tree stress and mortality could become more prevalent, leading to changes in the forest dynamics. Knowledge of when and where forests are being affected would allow us to manage other pressures where possible to aid forest regeneration.

Beech forest in the Hawdon River valley. *Source: DOC.*

Adaptation measures that originate from this type of monitoring include:

- Researching how changes in the timing of flowering affect seed production and the productivity of both native species and pest mammal species.
- Investigating whether additional native species management actions are needed.
- Considering whether the timing of invasive predator operations needs to change to inform planning around resources and staff time.
- Considering whether drought-affected beech forests should be a priority for browsing herbivore control to reduce tree mortality from other sources and increase tree recruitment.

Red beech (*Fuscospora fusca*) forest canopy. Source: DOC

Evaluation and Reporting actions | Ko ngā hātepe aromātai me te pūrongorongo

The key Evaluation and Reporting actions and their associated accountabilities and delivery time frames are shown in Table 5.

Table 5. Action table for the Climate Change Adaptation Action Plan (CCAAP) Evaluation and Reporting actions. See Table 1 for a list of the abbreviations for the units and groups.

ACTIONS		DOC Teams – unit (group)	Delivery time frame		
			2022	2024	2025
ER1	**Report on progress towards achieving the CCAAP actions**				
ER1a	Develop and maintain a dashboard to report on progress against each action in the CCAAP on an annual basis. Use a red-amber-green (RAG) assessment approach.	**TU (BG)**	✓	✓	✓
ER1b	Report on progress against implemented actions and collate key indicators/measures.	**TU (BG),** PSU (BG)	✓		
ER1c	Report on progress for actions identified as mandatory and within the time frame under the National Adaptation Plan (NAP) and National Climate Change Risk Assessment (NCCRA).	**TU (BG)**	✓	✓	✓
ER1d	Include CCAAP indictors/measures in DOC statutory documents such as the Annual Report, Four-year Plan, Long-term Investment Plan and other applicable reporting mechanisms.	**OMU (CSG)**	✓	✓	✓
ER1e	Revise the financial reporting system to make annual assessments of the actual costs of extreme weather events on DOC plant, property, assets and equipment.	**FU (CSG)**	✓		
ER1f	Revise the CCAAP in advance of the NAP revisions or if a change in the risk threshold prompts a partial or full review. This should occur no later than every 5 years.	**TU (BG)**			✓
ER2	**Develop a framework for evaluating and reporting on climate change impacts**				
ER2a	Undertake a gap analysis of current monitoring programmes and research on climate change impacts. Confirm which long-term monitoring needs to be sustained (e.g. invasive pest monitoring, beech seed rain network).	**TU (BG),** PSU (BG), TSU (BG), AU (BG), HVU (PVG)		✓	

ACTIONS		DOC Teams – unit (group)	Delivery time frame		
			2022	2024	2025
ER2b	Extend the remote sensing monitoring of climate change related events. Work with other agencies as required. Examples include: • The timing of flowering • Tussock and beech masting • Drought-related tree mortality • Phytoplankton blooms	**PSU (BG),** TU (BG), TSU (BG), AU (BG)	✓	✓	✓
ER2c	Work with Treaty partners to extend the remote sensing monitoring of climate change related events of importance to te ao Māori.	**PSU (BG),** TU (BG), AU (BG), TSU (BG)	✓	✓	✓
ER2d	Continue and extend the existing collection of fine-scale climate, habitat and biodiversity information to support coarser scale regional models.	**TU (BG),** PSU (BG), AU	✓		
ER2e	Finalise the national climate data sharing memorandum of understanding (MOU) between the Department of Conservation (DOC) and NIWA.	**PSU (BG)**	✓		
ER2f	Make up-to-date climate change threshold data readily available on the DOC geographic information system (GIS) for coarse site risk assessments.	**PSU (BG),** TU (BG)	✓		
ER2g	Build an end-to-end process for predicting animal pest irruptions based on routine updates of mast species models (e.g. beech, tussock and rimu (*Dacrydium cupressinum*)) using NIWA climate data and the seed database.	**PSU (BG)**		✓	
ER3	**Produce guidance for planning and assessments**				
ER3a	Produce a science strategy to fill priority information gaps and coordinate internal research to address climate change impacts. Collaborate with other research agencies (i.e. Crown Research Institutes (CRIs) and universities) and Treaty partners to fill gaps and understand what work is being undertaken elsewhere in New Zealand.	**TU (BG),** PSU (BG)	✓	✓	
ER3b	Produce new guidance for undertaking climate change first-pass risk screening and detailed risk assessments for DOC value domains.	**TU (BG),** PSU (BG), HVU (PVG)	✓		
ER3c	Produce new guidance on dynamic adaptive pathways planning (DAPP) for adapting to climate change for: • Native ecosystems and species • Historic heritage, visitor experience and infrastructure	**TU (BG),** PSU (BG), OPU (OG), NOU (OG)	✓		

ACTIONS		DOC Teams – unit (group)	Delivery time frame		
			2022	2024	2025
ER3d	Include climate change considerations within DOC Emergency Management Systems Response and Recovery Plan templates.	**BAU (CSG),** TU (BG)	✓		

7. Terrestrial Biodiversity | Ko Rerenga Rauropi Whenua

Climate change will affect terrestrial biodiversity through warming air temperatures, an increased intensity of severe weather events and rising sea levels. However, a thriving biodiversity can also be part of the solution, providing resilience to some of the predicted impacts of climate change.

Climate change poses many risks to terrestrial biodiversity through changes to the timing of seasonal and annual events, range shifts, environmental degradation, an increased incidence of pests and disease, and drought and storm damage. To achieve better conservation outcomes in terrestrial environments, we need to better understand these potential risks and their impacts and devise ways to adapt to climate change.

For many of New Zealand's indigenous species and ecosystems, the potential impacts of climate change are currently unknown or poorly understood. For example, for New Zealand's endemic long-tailed bat (*Chalinolobus tuberculatus*), which roosts in tree hollows and enters torpor in winter to survive the cold temperatures, the risks of increasing winter temperatures are potentially two-fold: the bats may spend less time in torpor, waking more frequently at a time when there is insufficient prey to meet their energy costs, causing increased mortality; and invasive predators such as rats (*Rattus* spp.) and stoats (*Mustela erminea*) may be more likely to survive over winter, increasing the risk of predation. Migration or translocation of these species is not a desirable option. However, it is possible that these bats will be able to adapt to climate change by selecting roost cavities with different thermal characteristics.


The Hawdon River valley. *Source: DOC.*

Climate-induced changes are already evident in some regions. In Northland, drought conditions are becoming more prevalent and some species are already being affected. For example, DOC science technical advisor Rogan Colbourne has noticed kiwi struggling to probe for food when the ground is hard and dry, but notes that there is also an upside: 'On one hand, it's getting too dry to probe, but on the other hand, there may be more surface insects'. In the same region, droughts may also be affecting the survivability and recruitment of kauri snails (*Paryphanta* spp.) – mating in these snails appears to

Native snail (*Powelliphanta* sp.). *Source: DOC.*

be triggered by climatic conditions, such as rainfall, and food supplies can be harder to access when the soil is dry and prey species, such as earthworms, inhabit moister conditions at greater soil depths. Climate change projections for Northland over the coming decades indicate that droughts are likely to become more intense and last for longer periods compared with the present day. Consequently, close monitoring and adaptive long-term planning (including options for translocation) are required to ensure these iconic species survive and thrive.

Pōhutukawa (*Metrosideros excelsa*) flowers. *Source: DOC.*

The impacts of invasive pests and diseases will likely worsen as temperatures increase. An example of this is myrtle rust (*Austropuccinia psidii*) infection, which affects plants in the family Myrtaceae, such as pōhutukawa and rātā (*Metrosideros* spp.). Myrtle rust was first confirmed on mainland New Zealand in May 2017, being initially detected in Northland and then spreading quickly to several areas in the North Island and the Tasman region of the South Island. Climatic factors, particularly air temperature and humidity, play a key role in determining myrtle rust infection risk, with the highest risk occurring in summer. Consequently, the projected increases in New Zealand's temperature and humidity under climate change may cause the myrtle rust infection risk to increase. Such climate-induced changes to the infection risk profile in addition to the risk of spread of the disease via wind and human vectors means that the long-term management of myrtle rust infected Myrtaceae species will be an ongoing challenge.


Matiu/Somes Island biosecurity hut. *Source: DOC.*

Climate change will also have non-biological impacts. For instance, hundreds of kilometres of traplines run beside montane rivers that are prone to flooding, and the infrastructure on our numerous pest-free islands is vulnerable to sea-level rise. An example of this can already be seen on Matiu/Somes Island, which is a scientific and historic reserve in the middle of Wellington Harbour. Because this is a pest-free island, all visitors must go through biosecurity processes, which usually take place in the hut shown in this photo. However, in recent years, the wharf and hut have been inundated by sea water 5–6 times per year during storms, meaning that major repairs are needed to the wharf (which is critical to access and service the island) and sea wall in the future.

Case study 3: Te Manahuna Aoraki, Mackenzie Basin

Te Manahuna Aoraki is a large-scale conservation project focused on restoring the iconic natural landscapes and threatened species of the upper Mackenzie Basin and Aoraki/Mount Cook National Park. Management of this site needs to account for projected climate change impacts.

Upper Mackenzie Basin. *Source: DOC.*

This project is a multi-agency initiative that was launched in November 2018. It aims to enhance biodiversity across 310 000 ha of dryland landscapes, including braided river systems, alpine habitats and Aoraki/Mount Cook National Park.

The area is home to many endangered species, such as kea (*Nestor notabilis*), rock wren (*Xenicus gilviventris*) and alpine scree wētā (*Deinacrida connectens*) in the alpine zone and wrybill (*Anarhynchus frontalis*), robust grasshopper (*Brachaspis robustus*), banded dotterel (*Charadrius bicinctus*) and the world's rarest wading bird, kakī / black stilt (*Himantopus novaezelandiae*), along the braided rivers. Aoraki/Mount Cook also holds immense cultural value for Ngāi Tahu as mana whenua, in particular playing a pivotal role in southern creation heritage. As such, this mountain has Tōpuni[9] status.

Warmer winters, hotter and drier summers, retreating glaciers, increased storm intensities, and westerly rainfall spillover are some of the climate change projections for the Mackenzie Basin that will directly affect threatened species and the landscape. Indirect impacts of climate change may also include a changing prevalence of weeds and invasive animal pests.

The Mackenzie Basin is a large, complex system, so climate change adaptation will also be complex.

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[9] In the Ngai Tahu Settlement, 'Tōpuni' is defined as 'confirming and placing an "overlay" of Ngai Tahu values upon a piece of land owned and/or managed by the Crown, while not overriding the powers and obligations of the Crown to manage that land for the purpose for which it is held from time to time' (www.beehive.govt.nz/feature/ngai-tahu-settlement-112).

Adaptation measures for consideration include:

- Increasing predator control at sites to increase wading bird productivity and resilience to floods.
- Increasing predator control near more rivers with wading bird populations to increase resilience to localised flooding.
- Managing braided rivers so that their beds are dynamic and unconstrained to increase their capacity to cope with increasing volumes of gravel due to retreating glaciers and melting alpine permafrost.
- Increasing predator control in alpine and tall tussock grasslands.
- Considering translocating or establishing new threatened invertebrate populations to ensure resilience to a changing climate envelope range.

- Installing more and larger trout barriers to prevent invasive trout from moving upriver into refugia habitat used by upland longjaw galaxias (*Galaxias prognathus*).
- Considering translocating threatened ephemeral wetland and lake-edge plants from dried-up sites to appropriate wetter sites.
- Increasing the frequency of ungulate and hare (*Lepus europaeus*) control in the basin, as more benign winter weather conditions may increase the numbers of these pests.
- Increasing the spatial coverage of weed control up rivers and hillsides to combat the spread of weeds as a suitable climate for their growth expands into colder parts of the basin.
- Considering the eradication of rabbits (*Oryctolagus cuniculus*) at some sites, as wetter conditions from increased spillover of westerly rainfall may mean there are fewer rabbits at sites closer to the Southern Alps / Kā Tiritiri o te Moana.
- Including more resources when planning staff time and resources to enable more work to be done in shorter time periods because of the potentially increasing variability of the weather.
- Factoring in additional staff time and resources for maintaining and replacing trapping infrastructure in river beds that are susceptible to storm or flood damage.

A wrybill (*Anarhynchus frontalis*) nesting on the Tasman River. *Source: DOC.*

Terrestrial Biodiversity actions | Ko ngā hātepe rerenga rauropi whenua

The key Terrestrial Biodiversity actions and their associated accountabilities and delivery time frames are shown in Table 6

Table 6. Action table for the Climate Change Adaptation Action Plan (CCAAP) Terrestrial Biodiversity actions. See Table 1 for a list of the abbreviations for the units and groups.

ACTIONS		DOC Teams – unit (group)	Delivery time frame		
			2022	2024	2025
TB1	**Identify and fill information gaps**				
TB1a	Conduct a first-pass risk screening process across the terrestrial biodiversity domain to identify which elements that are at moderate or high risk from climate change require more detailed research to fill information gaps, including those indicated below.	**TU (BG)**	✓		
TB1b	Identify the sites and associated biodiversity that are most at risk from climate change (e.g. sea-level rise, storm damage, heat waves or incremental change). For example: • Species only located on offshore islands • Species only known from a single location – e.g. cobble skink (*Oligosoma* aff. *infrapunctatum* "cobble") • Species at the northern limit of their distribution – e.g. hoiho / yellow-eyed penguin (*Megadyptes antipodes*), northern royal albatross (*Diomedea sanfordi*)	**TSU (BG)**, PSU (BG), TU (BG)	✓		
TB1c	Identify habitat/ecosystem types that are most at risk from climate change (e.g. sea-level rise, storm damage, heat waves or incremental change) by examining, for example: • How changes in flood frequency and low flows affect braided river habitats and bird species • How changes in mast seeding frequency affect native species survival in areas such as beech forest, tall tussock grassland and alpine habitats • How changes in fire frequency will affect dryland ecosystems • How sea-level rise and storm surges will affect coastal terrestrial habitats	**TSU (BG)**, PSU (BG), TU (BG), NOU (OG)		✓	

ACTIONS		DOC Teams – unit (group)	Delivery time frame 2022	2024	2025
TB1d	Identify which terrestrial native species will be most sensitive to climate change (e.g. sea-level rise, storm damage, heat waves or incremental change). For example: • Species that use torpor – e.g. native bats, rock wren (*Xenicus gilviventris*) • Species that are sensitive to temperature change – e.g. native frogs, tuatara, invertebrates • Species with flyways and movement pathways that may be broken as a result of increased landscape/habitat fragmentation and loss – e.g. mobile species	**TSU (BG)**, TU (BG)		✓	
TB1e	Identify which terrestrial and riparian weeds have the potential to increase their distribution and suppress native plants as the climate changes. Prioritise research on weed species that we know are currently climate limited in some way. For example: • Wilding pines • Heather (*Calluna vulgaris*) Broom (*Cytisus scoparius*)	**TU (BG)**, TSU (BG), AU (BG)		✓	
TB1f	Identify which invasive animal pests have the potential to increase their distribution/abundance and suppress native animal species under climate change. Prioritise research on species that are known to currently be climate limited in some way. For example: • Ship rats (*Rattus rattus*) • Hedgehogs (*Erinaceus europaeus*) Wasps	**TU (BG)**, TSU (BG), NOU (OG)		✓	
TB1g	Identify which new and existing fungal pathogens, diseases, viruses and bacterial infections have the potential to increase their distribution or become established under climate change. Examples of existing pathogens are: • Myrtle rust (*Austropuccinia psidii*) • *Phytophthora agathidicida* (a causal agent of kauri dieback) *Plasmodium* spp. (the causal agents of avian malaria)	**TU (BG)**, TSU (BG), NOU (OG)	✓		
TB1h	Identify the impacts of climate change adaptation and mitigation by other land-use sectors (e.g. sea walls, offshore wind farms) on native ecosystems and species.	**TU (BG)**, AU (BG)		✓	

ACTIONS		DOC Teams – unit (group)	Delivery time frame		
			2022	2024	2025
TB1i	Identify opportunities for 'nature-based solutions' for climate change adaptation by other land-use sectors to enhance both biodiversity and climate change resilience.	**TU (BG)**, TSU (BG), PPLU (OG), PU (PVG)		✓	
TB1j	Identify how existing management tools and techniques will be complicated or improved as a result of climate change, including: • The use of aerial 1080 for predator control (e.g. baits sitting around for longer in drier eastern forests) • Predator trapping infrastructure due to major storm events – does DOC collect location/loss information for trap assets? Terrestrial reserves, including riparian components – e.g. wildlife refuges, scientific reserves.	**TU (BG)**, NOU (OG)		✓	
TB1k	Identify which natural and cultural resources and other taonga on public conservation land are most sensitive to the impacts of climate change, as agreed with Treaty partners.	**TSU (BG)**	✓		
TB2	**Undertake risk assessments**				
TB2a	Undertake detailed risk assessments for identified significant sites.	**PSU (BG)**, TU (BG)		✓	
TB2b	Undertake detailed risk assessments for native terrestrial habitats that are identified as being at moderate or high risk from climate change impacts.	**PSU (BG)**, TSU (BG), TU (BG)		✓	
TB2c	Undertake detailed risk assessments for native terrestrial species that are identified as being at moderate or high risk from climate change impacts.	**PSU (BG)**, TSU (BG), TU (BG)		✓	
TB2d	Undertake detailed risk assessments for coastal terrestrial habitats that are identified as being at moderate or high risk from climate change impacts.	**PSU (BG)**, TSU (BG), TU (BG), AU (BG)		✓	
TB2e	Undertake detailed risk assessments for natural and cultural resources and other taonga on public conservation land that are identified as being at moderate or high risk from climate change impacts.	**PSU (BG)**, TSU (BG)		✓	
TB3	**Update existing planning and prioritisation systems**				
TB3a	Add a climate vulnerability qualifier to the New Zealand Threat Classification System (NZTCS) and assess how this feeds through into species zonation models and biodiversity planning systems.	**TSU (BG)**, PSU (BG), TU (BG)	✓	✓	
TB3b	Test the utility of adding climate risk information into ecosystems and species zonation models.	**PSU (BG)**		✓	

ACTIONS		DOC Teams – unit (group)	Delivery time frame		
			2022	2024	2025
TB3c	Update the biodiversity planning guidelines and management prescriptions to include climate change as a criterion.	**PSU (BG)**, TU (BG), TSU (BG), AU (BG), OPU (OG)	✓	✓	
TB3d	Identify which standard operating procedures (SOPs) and best practices (BPs) need to include climate change as a criterion and update these accordingly. This includes native species management, as well as predator and weed control standards.	**TSU (BG)**, TU (BG)			
TB3e	Update the species translocation SOP to include a climate change vulnerability assessment qualifier.	**TSU (BG)**, TU (BG)		✓	
TB3f	Update the Landscape Readiness Tool to include climate change as a site assessment criterion.	**PS (PG)**, PSU (BG), TU (BG)	✓		
TB3g	Provide terrestrial biodiversity climate change and risk assessment information for use in relevant planning systems as information is gathered.	**TSU (BG)**, TU (BG), OPU (OG)	✓		
TB3h	Develop criteria for Department of Conservation (DOC) risk appetite thresholds of climate change impacts to terrestrial biodiversity.	**TSU (BG)**, TU (BG), BAU (CSG)		✓	
TB4	**Implement adaptation actions**				
TB4a	Based on the research and risk assessments undertaken, identify and prioritise management actions for implementation and their timing and location using a precautionary approach.	**TSU (BG)**, OG			✓
TB4b	Undertake dynamic adaptive pathways planning (DAPP) for prioritised sites, ecosystems and native species that are at risk from climate change impacts (see Appendix 3).	**TU (BG)**, PSU (BG), TSU (BG), OPU (OG)	✓	✓	✓
TB4c	Identify climate change adaptation management actions for significant sites and conservation programmes that are being managed or led by partners, stakeholders and communities (e.g. NEXT foundation sites and the Billion Trees Partnership Programme).	**PSU (BG)**, TSU (BG), TU (BG), PS (PG)			✓
TB4d	Increase management of other pressures (e.g. weeds, animal pests, pathogens, fire) to increase the resilience of sites, habitats and species that are identified as being at risk from climate change.	**OG**, TU (BG)			✓
TB4e	Develop translocation strategies, as required, for at-risk species – e.g. species with only a single population stronghold or that are vulnerable to incremental climate change.	**TSU (BG)**			✓
TB4f	Incorporate feedback on needs from Treaty partners to minimise any impacts and maximise benefits to them from adaptation actions.	All groups	✓	✓	✓

ACTIONS		DOC Teams – unit (group)	Delivery time frame		
			2022	2024	2025
TB4g	Work with other government agencies to identify which plant species may require seed banking.	**TSU (BG)**		✓	
TB4h	Develop strategies to recover ecosystems and species' habitats promptly following catastrophic climate change related events – e.g. efficient habitat restoration methods following fire or hurricane events.	**TSU (BG)**, TU (BG), OG		✓	✓
TB4i	Develop climate change criteria for consideration when selecting native plant species for restoration or carbon sequestration plantation at a site to ensure resilience of the restoration and mitigation activities.	**TSU (BG)**, PS (PG)		✓	

8. Aquatic Biodiversity I Ko Rerenga Rauropi Wai

Changing weather patterns and extreme weather events will have a significant impact on freshwater and marine biodiversity. An increased frequency and magnitude of flooding and drought events will affect freshwater and estuarine biodiversity, while warmer ocean temperatures and acidification will have an impact on marine biodiversity.

As with our terrestrial biodiversity, many of the impacts of climate change on indigenous marine and freshwater species and ecosystems are unknown or poorly understood. Consequently, improving our understanding of the key risks and impacts is a high priority, as is devising ways to adapt to climate change in aquatic environments.

Climate change and associated changes in SST and oceanic circulation patterns have been implicated in the decline of many indigenous aquatic species (e.g. hoiho / yellow-eyed penguin (*Megadyptes antipodes*); Mattern et al. 2017). The ocean surface waters around New Zealand are projected to increase by 2.5°C on average by the end of this century. This warming is likely to increase the difference in water density between the surface and deeper, cooler waters, affecting how the ocean mixes and reducing the nutrient supply to the surface waters. This, in turn, may reduce the nutrients available for plankton growth, with knock-on effects on the food web and fish species composition and overall oceanic productivity (Law et al. 2016). This shift is already happening in the water off Tasmania and southeastern Australia, where greater numbers of subtropical species now occur in coastal ecosystems. Increasing temperatures of New Zealand waters could see more invasive species and diseases being found here, which could affect local ecosystems. Furthermore, aquatic species that bridge freshwater and marine environments (e.g. īnanga and eels) or use both marine and terrestrial environments (e.g. seabirds, New Zealand sea lion (*Phocarctos hookeri*)) will also be affected. For example, a changing SST has been implicated in the decline of a migratory galaxiid species in southwest Australia (Barbee et al. 2011). Therefore, research on the effects of increasing sea levels on īnanga spawning habitat availability is currently underway in New Zealand.

Waituna Lagoon, Southland. *Source: Dairy NZ.*

Coastal hydrosystems will also be at risk from the dual impacts of sea-level rise and changes in river flow regimes. Waituna Lagoon in Southland, which is a catchment of great cultural significance for Ngāi Tahu due to its mahinga kai / food-gathering places and historic values, is an example of a coastal area that will experience changes. The lagoon is home to a wide variety of birds and fishes, many of which are threatened endemic species, making it an important component of the Awarua Wetland Ramsar site. Analysis indicates that the lagoon will likely experience a shrinking intertidal zone, lower lagoon-bed light levels, and higher nutrient and sediment loads due to projected increases in rainfall, freshwater inflows, flood events and coastal inundation (Tait & Pearce 2019). Such changes may increase algal growth while inhibiting *Ruppia* spp. (desirable aquatic plants), potentially causing a regime shift and degradation of the water quality. Given the high risk of future habitat degradation and the complexity of the lagoon system (including periodic opening of the lagoon mouth to the sea to prevent flooding of neighbouring farmland), an adaptative management approach is needed alongside ongoing monitoring.

There is mounting evidence that native freshwater fish species such as galaxiids are at risk from climate change on multiple fronts (Boddy & McIntosh 2017). The spawning success of migratory galaxiid species and their larval migration to the sea can be affected by floods, while their eggs are particularly sensitive to temperature fluctuations and flooding, which can increase egg mortality by causing them to become covered in silt. Changes to the frequency and intensity of floods may also alter the reproductive cues used by kōaro (*Galaxias brevipinnis*) and banded kōkopu (*G. fasciatus*). Many of these species also have restricted distributions due to the dual pressures of introduced salmonid species (e.g. brown trout (*Salmo trutta*), rainbow trout (*Oncorhynchus mykiss*) and brook char (*Salvelinus fontinalis*)), which outcompete and prey on them, and water abstraction pressures, especially in dry eastern areas with intensive agriculture. Finally, the effects of increased storm intensities, increased water temperatures (which result in decreased dissolved oxygen levels in the water), and increased drought intensities and durations could cause local extinctions of some fish populations. Consequently, native freshwater fish species that already have restricted distributions (e.g. due to introduced salmonids and water abstraction) will be extremely vulnerable to additional pressures associated with climate change.

Case study 4: Alpine galaxias (Manuherikia River)

Alpine galaxias (Manuherikia River) (*Galaxias* aff. *paucispondylus* "Manuherikia") is a threatened, genetically distinct native freshwater fish species that has a restricted distribution and is temperature sensitive, placing it at risk from a warming environment.[10]

Hawkdun Range, upper Manuherikia River. *Source: DOC.*

Alpine galaxias (Manuherikia River) is only known from one location, the upper Manuherikia River above Falls Dam in the Central Otago region of the South Island. It is non-migratory, meaning that its entire life cycle is completed within the freshwater environment, and prefers shallow, fast-flowing streams with gravel beds.

The distribution of this galaxiid is likely driven by the dual pressures of competition with introduced salmonid species and water temperature. This species can co-occur with salmonid species in flood-disturbed streams with gravel beds, and alpine galaxiids in Canterbury appear to be absent from stream reaches with average summer water temperatures above 12.3–13.8°C, so this is also likely to be the case for alpine galaxias (Manuherikia River).

Alpine galaxiids that occur in only one location will be very vulnerable to extreme climatic events such as storms and droughts. The intensities of extreme storm and drought events are projected to increase under climate change, which could cause this fish species to become extinct through the contraction and loss of habitat.

[10] The information for this case study was taken from Dunn (2018).

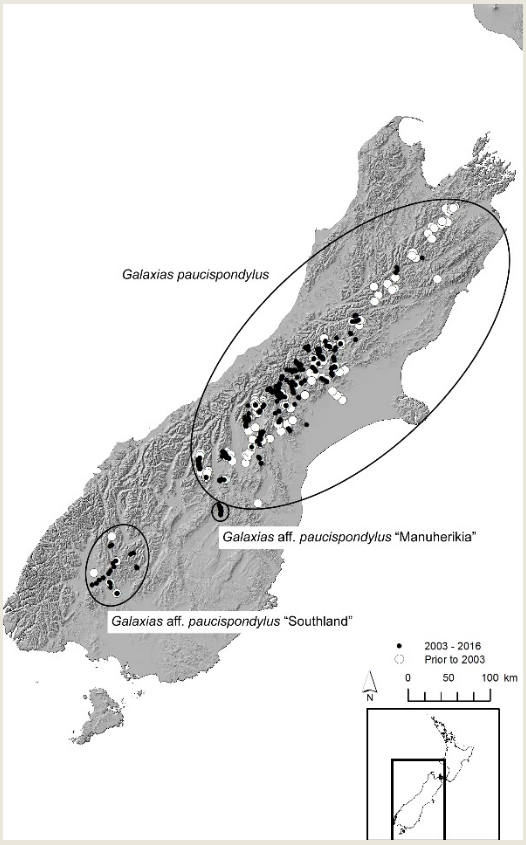

Upper Manuherikia River. *Source: DOC.*

Alpine galaxias (Manuherikia River) is already experiencing some of these climate change impacts. In January 2018, the average water temperature in the Manuherikia River above Falls Dam was above 14°C. The extent of available habitat for this fish under these circumstances is unclear, especially when combined with reduced river flows and predation from trout and char.

As tangata whenua with rangatiratanga over the area, Ngāi Tahu have long valued the Manuherikia River for its mahinga kai and the archaeological sites that have been identified there.

Adaptation measures for consideration include:

- Determining the distributional extent of alpine galaxias (Manuherikia River), particularly in the Manuherikia West Branch and its tributaries.
- Identifying colder springs and upwellings in the upper Manuherikia River catchment through a field-based water temperature study.
- Identifying potential tributary locations for built barriers.
- Installing built barriers and, if required, rotenone operations to remove salmonids from reaches beyond the barriers.
- Investigating the physiology (threshold detection), life history and movement of alpine galaxias (Manuherikia River) so that we can better understand the effect of temperature changes.



Map showing the distributions of alpine galaxiids.
Source: DOC.

Aquatic Biodiversity actions | Ko ngā hātepe rerenga rauropi wa

The key Aquatic Biodiversity actions and their associated accountabilities and delivery time frames are shown in Table 7.

Table 7. Action table for the Climate Change Adaptation Action Plan (CCAAP) Aquatic Biodiversity actions. See Table 1 for a list of the abbreviations for the units and groups.

ACTIONS		DOC Teams – unit (group)	Delivery time frame		
			2022	2024	2025
AB1	**Identify information gaps**				
AB1a	Conduct a first-pass risk screening process across the aquatic biodiversity domain to identify which elements that are at moderate or high risk from climate change require more detailed research to fill information gaps, including those outlined below.	**TU (BG)**	✓		
AB1b	Identify freshwater and marine sites that are most at risk from climate change (e.g. sea-level rise, flooding, heat waves, changing ocean currents or incremental change). Examples of research include: • The effect of sea-level rise on saltwater intrusion up coastal rivers and its impacts on īnanga spawning areas • The effect of warming and acidification in at-risk regions	**AU (BG)**	✓		
AB1c	Identify which freshwater and marine habitat/ecosystem types are most at risk from climate change (e.g. sea-level rise, flooding, heat waves, changing ocean currents or incremental change). For example: • Coastal and freshwater wetlands • Coastal hydrosystem typologies (e.g. see the Waituna Lagoon report by Tait & Pearce (2019)) • Thermal refuges in freshwater habitats • Seabed habitats	**AU (BG)**	✓		
AB1d	Identify which native freshwater and marine species are most sensitive to climate change (e.g. sea-level rise, flooding, heat waves, changing ocean currents or incremental change). For example:	**AU (BG)**	✓		

ACTIONS		DOC Teams – unit (group)	Delivery time frame		
			2022	2024	2025
	• Native fish species that are sensitive to the effects of warming and climate change related modifications to flow regimes (i.e. due to shifts in rainfall patterns and snowpack depths). This includes the survival and distribution of species. • Species at the upper elevational limits of their distribution, particularly those that cannot move to cooler habitats. • Species with life stages that are sensitive to climate variability (e.g. juvenile mudfish).				
AB1e	Identify which freshwater and marine weeds have the potential to increase their distribution and transform ecosystems (especially within waters managed by the Department of Conservation (DOC) in the case of marine species). Prioritise research on weed species that are known to currently be climate limited (e.g. didymo (*Didymosphenia geminata*), which likes longer periods of stable stream flow).	**AU (BG)**	✓		
AB1f	Identify which freshwater and marine invasive fish and invertebrate species have the potential to increase their distributions/abundances and affect conservation values and sites under climate change. Prioritise research on invasive species that are known to currently be climate limited (e.g. salmonids and red-eared slider turtles (*Trachemys scripta elegans*)).	**AU (BG)**	✓		
AB1g	Identify how climate change will complicate or improve existing management tools and techniques, such as: • Fish passage Biosecurity	**AU (BG)**, OG	✓		
AB1h	Identify which existing anthropogenic pressures will be compounded by climate change (e.g. disease, water abstraction, unsustainable harvesting, pollution, coastal infrastructure).	**AU (BG)**, OG	✓		
AB1i	Identify opportunities for 'nature-based solutions' for climate change adaptation by other land and aquatic sectors to enhance both biodiversity and climate change resilience.	**TU (BG)**, AU (BG), PU (PVG), PPLU (OG)	✓		
AB1j	Identify which natural and cultural resources and other taonga in the aquatic environment are at risk from the impacts of climate change, as agreed with Treaty partners.	**AU (BG)**	✓		
AB2	**Undertake risk assessments**				
AB2a	Undertake detailed risk assessments for freshwater and marine sites that are identified as being at moderate or high risk from climate change impacts.	**AU (BG)**		✓	
AB2b	Undertake detailed risk assessments for freshwater and marine habitats that are identified as being at moderate or high risk from climate change impacts.	**AU (BG)**		✓	

ACTIONS		DOC Teams – unit (group)	Delivery time frame		
			2022	2024	2025
AB2c	Undertake detailed risk assessments for native freshwater and marine species that are identified as being at moderate or high risk from climate change impacts.	**AU (BG)**		✓	
AB2d	Undertake detailed risk assessments for natural and cultural resources and other taonga in the aquatic environment that are identified as being at moderate or high risk from climate change impacts.	**AU (BG)**, PSU (BG),		✓	
AB3	**Update existing planning and prioritisation systems**				
AB3a	Add a climate vulnerability qualifier to the New Zealand Threat Classification System (NZTCS) and assess how this feeds through into species zonation models and biodiversity planning systems.	**AU (BG)**	✓		
AB3b	Test the utility of adding climate risk information into the freshwater river prioritisation for rivers model for lakes and wetlands.	**AU (BG)**, PSU (BG)	✓		
AB3c	Update the biodiversity freshwater and marine planning guidelines and management prescriptions to include climate change as a criterion.	**AU (BG)**, OPU (OG)		✓	
AB3d	Identify which standard operating procedures (SOPs) and best practices (BPs) need to include climate change as a criterion and update. This includes freshwater and marine species management, as well as predator and weed control standards.	**AU (BG)**	✓		
AB3e	Provide aquatic biodiversity climate change and risk assessment information for use in relevant planning systems as information is gathered.	**AU (BG)**, OPU (OG)	✓	✓	✓
AB3f	Develop criteria for DOC risk appetite thresholds of climate change impacts on aquatic biodiversity.	**AU (BG)**, TU (BG), BAU (CSG)		✓	
AB4	**Implement adaptation actions**				
AB4a	Based on the risk assessments, identify and prioritise management actions for implementation and their timing and location using a precautionary approach.	**AU (BG)**, OG		✓	✓
AB4b	Undertake dynamic adaptive pathways planning (DAPP) for prioritised freshwater and marine sites, ecosystems and native species that are at risk from climate change impacts.	**TU (BG)**, PSU (BG), TSU (BG), OPU (OG)	✓	✓	✓
AB4c	Identify climate change adaptation management actions for prioritised sites.	**PSU (BG)**, AU (BG),		✓	✓

ACTIONS		DOC Teams – unit (group)	Delivery time frame		
			2022	2024	2025
AB4d	Increase management of other pressures (e.g. freshwater weeds, pest fishes, water abstraction) to increase the resilience of freshwater and marine sites, habitats and species that are identified as being at risk from climate change.	OG			✓
AB4e	Develop translocation strategies, as needed, for at-risk species – e.g. species with only a single population stronghold or that are vulnerable to incremental climate change.	**AU (BG)**			✓
AB4g	Develop strategies to recover ecosystems and species' habitats promptly following catastrophic climate change related events – e.g. efficient habitat restoration methods following fire and hurricane events.	**AU (BG)**, TU (BG), OG		✓	✓
AB4h	Incorporate feedback on needs from Treaty partners to minimise any impacts and maximise benefits to them of the adaptation actions.	**All groups**	✓	✓	✓

9. Heritage, Visitor and Infrastructure | Ko Taonga Tuku Iho, Manuhiri me Hanga Whakaroto

Heritage, visitor and conservation infrastructure sites are vulnerable to many climate change impacts, including flooding, landslips and sea-level rise.

Climate change will likely affect how people use New Zealand's public conservation lands and waters and how heritage sites are managed. It is important that we understand the risks and impacts of climate change on heritage, visitor and conservation infrastructure so that New Zealanders can continue to visit the places they value in safe and sustainable ways.

Storm damage at White Horse Hill Campsite. *Source: DOC.*

DOC maintains many built assets at sites that are vulnerable to damage from extreme storm events and sea-level rise. These assets include tracks, picnic areas, campgrounds, historic sites, buried infrastructure, bridges, roads and biosecurity buildings. These areas, and access routes to them, are at risk from flooding and slips from extreme rainfall events, as well as coastal storm surges associated with higher tides.

Coastal assets are at particular risk, but assets near rivers and at alpine sites are also threatened, particularly those in the central Southern Alps region, where the loss of permanent ice (i.e. glaciers and permafrost) will cut off access routes and potentially result in slow-moving slips.

In a single storm event in March 2019, Aoraki/Mount Cook village experienced 578 mm of rain in 30 hours, while Mueller Hut had 820 mm. Water flow at the Hooker River bridge reached 900 cumecs at its peak, representing the highest flow rate since records began (for comparison, the much larger Rangitata River runs at 1200 cumecs at peak flow). In addition, 157 m of track disappeared in the Hooker River valley and there was a $200,000 repair bill (not counting staff time) for river protections, tracks, bridges and culverts. This is the same storm that destroyed the Waiho River road bridge (near Franz Josef/Waiau) and caused extensive damage on the West Coast. Extreme storm events like this are predicted to increase in intensity under climate change and we can realistically expect visitor infrastructure to become more costly to maintain.

Visitor assets are also at risk from pests as a result of climate change. Invasive wasps have significant effects on New Zealand's biodiversity and a range of industry sectors, such as agriculture (honey production) and recreation/tourism. A recent analysis estimated that invasive wasps cost the New Zealand economy upwards of $133M annually (MacIntyre & Hellstrom 2015). Milder winters due to climate change may exacerbate the distribution and density of wasp populations (Lester & Beggs 2019), with larger nests and a greater production of queens, increasing the costs associated with these pests. Alternatively, more extreme weather events (e.g. flash floods) or very high temperatures in some areas (e.g. > 40°C) may see wasp abundances decline. At present, DOC is receiving more complaints about wasps in the cooler months and we can expect that some sites, such as campgrounds and picnic areas, will experience less use as a result of unpleasantly high wasp numbers. Therefore, adaptation considerations may include removing assets or spending money on controlling wasps at some sites.


Invasive common wasp (*Vespula vulgaris*). Source: DOC.

Coastal heritage sites are also at risk from sea-level rise and storm surges (Tait 2019). Many of these are significant wāhi tapu sites, and there are many more that will be exposed as a result of coastal erosion from storm surge and sea-level rise. Wairau Bar in Marlborough and Kaitorete Spit in Canterbury are examples of sites with significant Māori archaeological values that are at risk from sea-level rise. European heritage is also at risk, including sites like the Quarantine Barracks on the beach front on Ōtamahua/Quail Island, which are now at risk from coastal erosion and sea-level rise. These barracks were used by leprosy sufferers at the turn of the 20th century and then to quarantine and train dogs and ponies for Scott and Shackleton's expeditions when Antarctic exploration was at its peak in 1901–1929.

Case study 5: Coastal section of the Heaphy Track Great Walk

The coastal section of the Heaphy Track Great Walk has already been damaged by storms and will be affected by ongoing sea-level rise.

Many of our coastal assets are in areas that are only a few metres above sea level. These sites, and access routes to them, are at risk from coastal flooding caused by very high tides or storm surges (Tait 2019). As the sea level rises over this century and beyond (potentially upwards of 1 m), the flood inundation risk at these locations will increase (i.e. occur more frequently and with deeper flooding) and extend further inland.

Coastal section of the Heaphy Track. *Source: DOC.*

The Heaphy Track is one example of an asset that is at risk from sea-level rise. At 78 km in length, this track takes walkers 4–6 days and mountain bikers 2–3 days to complete. Pedestrian counter data at the Heaphy Hut show that there are approximately 8000 users per year, while cycle counter data on the Kohaihai Heaphy Counter (southern trailhead) show 1800 users per year. The coastal section of this track has already suffered from storm surges associated with ex-tropical cyclones and other storms and is likely to be affected by sea-level rise.

Storm damage remediation costs (i.e. reactive capital) for the coastal section of the Heaphy Track were approximately half of the overall revenue earned for the track in 2016 and a quarter of the overall revenue earned in 2017. Ex-tropical cyclones Fehi and Gita caused considerable damage in 2018, adding to the ongoing repair and adaptation work required on the track, which has cost over $225,000 in capital expenditure to date (as at December 2019).

Adaptation actions needed as a result of the 2018 storms include:

- Addressing issues of widening stream beds. A few small coastal creeks have become gaping chasms over the years due to heavy rainfall and erosion (see photo below). Re-routing is a challenge due to the encroaching Tasman Sea just below the track and the steep unstable terrain above. Recently, a small creek north of Scotts Beach blew out in an isolated coastal downpour. An engineered structure is proposed to keep users high and dry.

Erosion on the Heaphy Track. *Source: DOC.*

- Re-routing the track at the southern end of Twin Beach, where it is disappearing due to big seas eroding the foot of the bluffs. An imminent re-route of the track up and over the bluffs is needed.
- Re-benching the track further along at Twin Beach, where slips have occurred as a result of erosion (see photo on right).

Erosion on the Heaphy Track. *Source: DOC.*

- Re-routing the coastal section of the track further inland to address issues of tidal inundation and ongoing sea-level rise washing hard up against the bank, which are making the track untenable at various places. Increasingly high seas and storm events have not helped this situation. However, such a re-route will be technically tricky and expensive.
- Re-routing the old track that traverses the prominent point at the northern end of Scotts Beach, as it is being hit with waves during more frequent big sea events.
- Addressing access issues to the southern end of the Heaphy Track. The Kōhaihai River suspension bridge leads onto the Heaphy Track via a tongue of land that is at risk from floods and high sea events. If this land disappears in the future, re-routing will be expensive and will most likely involve an expensive bridge rebuild upstream with accompanying canter-levered galleries. Some protection works have been carried out but have already been significantly eroded.

  The identification of coastal hazard risks and evaluation of risk management options need to be considered by Resource Management Act (RMA) decision makers in their decisions on the RMA, policies, plans and consents.

Kōhaihai River suspension bridge, Heaphy Track. *Source: DOC*.

Heritage, Visitor and Infrastructure actions | Ko ngā hātepe taonga tuku iho, manuhiri me te hanga whakaroto

The key Heritage, Visitor and Infrastructure actions and their associated accountabilities and delivery time frames are shown in Table 8.

Table 8. Action table for the Climate Change Adaptation Action Plan (CCAAP) Heritage, Visitor and Infrastructure actions. See Table 1 for a list of the abbreviations for the units and group.

ACTIONS		DOC Teams – unit (group)	Delivery time frame		
			2022	2024	2025
HV1	**Identify information gaps**				
HV1a	Conduct a first-pass risk screening process for the heritage, visitor and infrastructure domain to identify which elements that are at moderate or high risk from climate change require more detailed research to fill information gaps, including those outlined below.	**HVU (PVG)**, PSU (BG), BSS (CSG)	✓		
HV1b	Identify the locations and types of sites where the Department of Conservation (DOC) provides visitor experiences and infrastructure that are at risk from climate change impacts in terms of people or the surrounding environment. These impacts include:	**PSU (BG)**, HVU (PVG), OPU (OG), BSS (CSG), NOU (OG)	✓		
HV1c	Identify visitor experiences and infrastructure that are at risk from coastal sea-level rise and storm surge.	**HVU (PVG)**, BSS (CSG)	✓		
HV1d	Identify the effects of weather on visitor use patterns and experiences. Use existing track counter data and weather data from NIWA and relate this to climate change impacts.	**PSU (BG)**, HVU (PVG)	✓		
HV1e	Identify the locations and types of sites where DOC manages cultural heritage assets infrastructure that is at risk from climate change impacts, including: • Storm damage (e.g. flooding, wind, erosion, slips) • Glacial retreat (e.g. erosion, slips) • Increased drought pressures (e.g. extreme fire risks)	**PSU (BG)**, HVU (PVG), OPU (OG), BSS (CSG)	✓		
HV1f	Identify cultural heritage assets and infrastructure that are at risk from coastal sea-level rise and storm surge	**HVU (PVG)**, BSS (CSG)	✓		

ACTIONS		DOC Teams – unit (group)	Delivery time frame		
			2022	2024	2025
HV1g	Identify wāhi tapu and infrastructure on public conservation land that will be exposed to climate change impacts, as agreed with Treaty partners.	**HVU (PVG)**	✓		
HV2	**Undertake risk assessments**				
HV2a	Undertake detailed risk assessments for heritage, visitor and infrastructure sites that are identified as being at moderate or high risk from extreme weather events.	**HVU (PVG)**, OPU (OG), BSS (CSG)		✓	
HV2b	Undertake detailed risk assessments for heritage, visitor and infrastructure sites that are identified as being at moderate or high risk from storm surges and sea-level rise.	**HVU (PVG)**, OPU (OG), BSS (CSG)		✓	
HV2c	Undertake detailed risk assessments for heritage, visitor and infrastructure sites (including alpine sites) that are identified as being at moderate or high risk from flooding, slips, glacier retreat, wind and erosion.	**HVU (PVG)**, OPU (OG), BSS (CSG)		✓	
HV2d	Undertake detailed risk assessments for wāhi tapu sites and infrastructure on public conservation land that are identified as being at moderate or high risk from climate change impacts.	**HVU (PVG)**, OPU (OG)		✓	
HV3	**Update existing planning and prioritisation systems**				
HV3a	Assess which standard operating procedures (SOPs) and business plans need to include climate change as a criterion.	**HVU (PVG)**, BSS (CSG)	✓		
HV3b	Add climate change criteria to site prescriptions for the management of heritage, visitor and infrastructure sites.	**HVU (PVG)**, OPU (OG), BSS (CSG)	✓		
HV3c	Revise heritage, visitor and infrastructure management and reporting systems to include climate change. Incorporate prioritised risk assessments into these systems.	**HVU (PVG)**, OPU (OG), OMU (CSG)		✓	
HV3d	Revise general guidance for heritage, visitor and infrastructure sites to account for storm damage and changing risks from acute weather events and long-term changes (e.g. retreating glaciers, sea-level rise, increased fire risk). This includes mountainous areas.	**HVU (PVG)**, OPU (OG), BSS (CSG)		✓	
HV3e	Provide heritage, visitor and infrastructure climate change and risk assessment information for use in relevant planning systems as information is gathered.	**HVU (PVG)**, OPU (OG)	✓	✓	✓
HV3f	Develop criteria for DOC risk appetite thresholds of climate change impacts on cultural heritage, visitor experiences and infrastructure.	**HVU (PVG)**, TU (BG), BAU (CSG)		✓	

ACTIONS		DOC Teams – unit (group)	Delivery time frame		
			2022	2024	2025
HV4	**Implement adaptation actions**				
HV4a	Based on the risk assessments and expected impacts on visitor patterns, identify and prioritise management actions for implementation and their timing and location using a precautionary approach.	**HVU (PVG)**, OPU (OG), BSS (CSG)		✓	✓
HV4b	Undertake dynamic adaptive pathways planning (DAPP) for prioritised assets and experiences that are at risk from climate change.	**HVU (PVG)**, OPU (OG)	✓	✓	✓
HV4c	Decide on sites where no new investment is to occur (e.g. within 1 m of sea level), work needs to stop or existing infrastructure needs to be removed/revised.	**HVU (PVG)**, OPU (OG), BSS (CSG)		✓	✓
HV4d	Audit/survey heritage sites on public conservation land or under DOC's management that are exposed to climate change impacts (e.g. sea-level rise, river flooding).	**HVU (PVG)**	✓		
HV4e	Include climate change adaptation assessment criteria in the Heritage and Visitor Strategy.	**HVU (PVG)**	✓		
HV4f	Incorporate feedback on needs from Treaty partners to minimise any impacts and maximise benefits to them of the adaptation actions.	**HVU (PVG)**, OPU (OG)	✓	✓	✓
HV4g	Develop strategies to recover visitor experiences and heritage sites promptly following catastrophic climate change related events – e.g. efficient response and recovery planning.	**HVU(PVG)**, TU (BG), OG		✓	✓

10. Planning, Permissions and Land | Ko Hoahoa, Whakaaetanga me Whenua

Conservation planning plays a central role in preparing for a changing climate. Effective planning is important to ensure resilience and minimise future vulnerability for all users of public conservation lands and waters.

Reviews of conservation management strategies (CMSs), national park management plans (NPMPs) and conservation management plans (CMPs) offer opportunities to embed climate change adaptation into management priorities for public conservation lands and waters. Given the potentially unprecedented changes that will occur in some landscapes as a result of climate change (e.g. retreating glaciers), it will be important to incorporate climate change guidance and management strategies into these statutory documents.

Uses of public conservation lands and waters are many and varied, including skiing, mountain biking, tramping, hunting, camping, picnicking and many other outdoor activities. Consequently, these areas are highly valued by New Zealanders, overseas visitors and concessionaires.

We need to develop a clear understanding of how climate change may impact on concessionaires and visitor use patterns so that we can anticipate where pressures may occur and what can be done to reduce or alleviate them. For example, glaciers may no longer be a viable destination for tourist helicopter landings if visitor and concessionaire safety is compromised as the glaciers retreat. Also, many small communities are largely dependent on the tourism business that occurs on public conservation lands and waters and indigenous biodiversity for their livelihoods and recreation. Some communities are surrounded by public conservation lands and waters, and climate change related landscape changes may force them to retreat (e.g. with coastal inundation from sea-level rise).

Upper Waiau Toa / Clarence River valley. *Source:* DOC.

Case study 6: Westland Tai Poutini National Park management planning

Westland Tai Poutini National Park is an important visitor attraction for the West Coast of the South Island. While this region will retain its scenic beauty under climate change, shrinking glaciers will create a management challenge.

Fox Glacier/Te Moeka o Tuawe. *Source: NIWA*

Westland Tai Poutini National Park is home to two glaciers: Fox Glacier/Te Moeka o Tuawe and Franz Josef Glacier/Kā Roimata o Hine Hukatere. The area is of significant cultural value to Ngāti (Kāti) Māhaki hapū due to its resources and connections to tīpuna/ancestors. These glaciers are also important visitor destinations for the West Coast of the South Island, contributing significantly to the region's economy. The Westland Tai Poutini National Park Management Plan (NPMP, which is reviewed approximately every 10 years, guides biodiversity, recreation and tourism management of the national park.

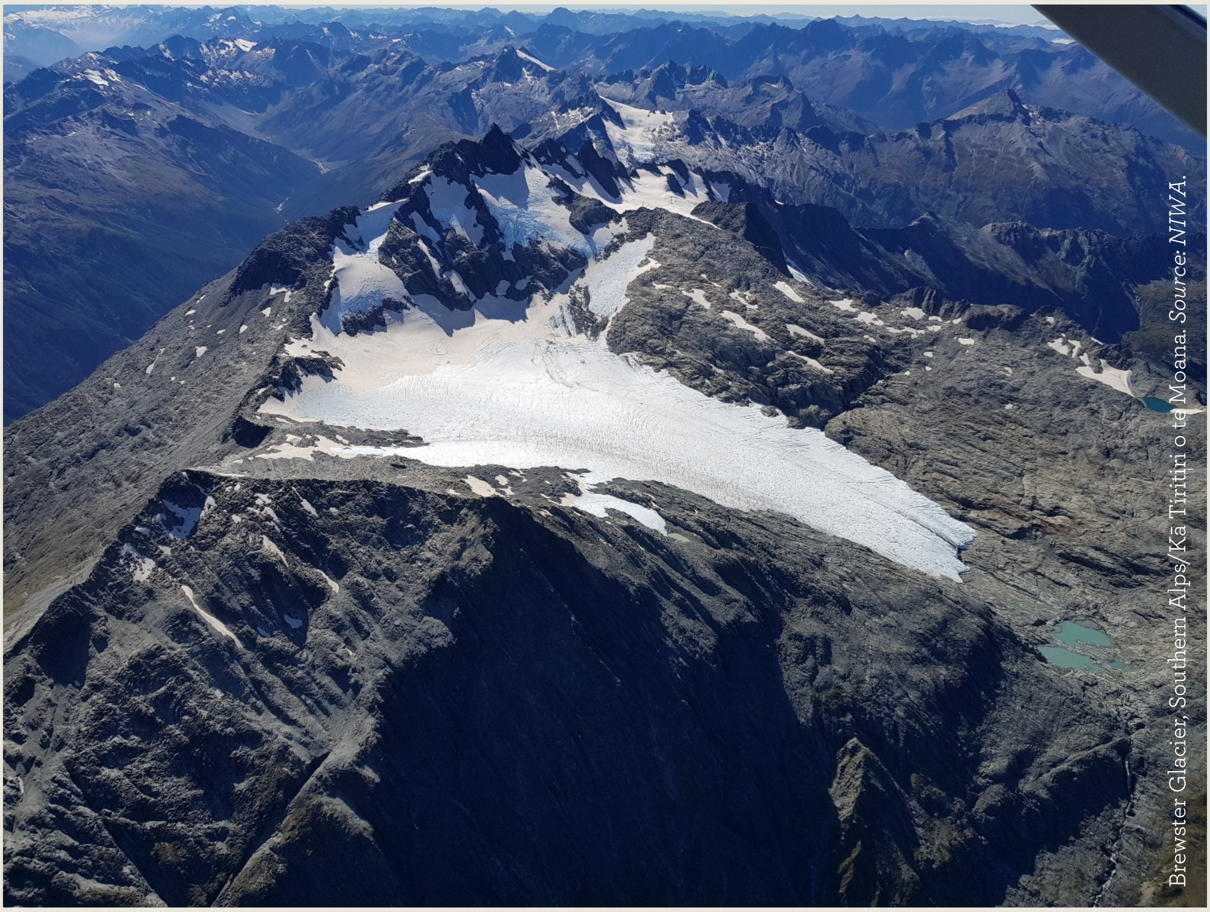
Associated with the glaciers are access roads, road-end car parks, toilets, walking tracks and bridges. This infrastructure is already frequently subject to storm damage. In particular, the Fox Glacier/Te Moeka o Tuawe access road had been washed out and rebuilt so frequently over the past few years that it was decided it would no longer be maintained in August 2019. Storm damage for the West Coast region may worsen under climate change, with much higher rainfall predicted. Therefore, increased infrastructure damage and repair costs are expected.

Concessionaires are also reliant on the glaciers for their commercial operations. Shrinkage of the glaciers and reduced foot access means that there are increased scenic helicopter flights and landings associated with glacier guiding and heli-hiking. The granting of commercial concessions is guided by the Westland Tai Poutini National Park Management Plan.

Accelerating glacier melt is occurring at both glaciers, so these important visitor attractions will further reduce in extent during the life of the next NPMP. This creates significant planning and management challenges for the NPMP, which is currently under review.

Adaptation measures for consideration in the review of the NPMP include:

- Considering how to retreat infrastructure from glacier road-end sites, as well as restoration of this infrastructure.
- Providing guidance for helicopter scenic flight limits in terms of the frequency and location of flights and landings.
- Finding ways to identify potential new pressures to the national park from changing visitor use patterns, both commercial and non-commercial.
- Finding ways to ensure that new opportunities can be considered and potential impacts identified.


Brewster Glacier, Southern Alps/Kā Tiritiri o te Moana. *Source: NIWA.*

Planning, Permissions and Land actions | Ko ngā Hātepe Hoahoa, Whakaaetanga me te Whenua

The key Planning, Permissions and Land actions and their associated accountabilities and delivery time frames are shown in Table 9

Table 9. Action table for the Climate Change Adaptation Action Plan (CCAAP) Planning, Permissions and Land actions. See Table 1 for a list of the abbreviations for the units and groups.

HERITAGE, VISITOR AND INFRASTRUCTURE ACTIONS		DOC Teams – unit (group)	Delivery time frame		
			2022	2024	2025
PPL1	**Implement the Planning, Permissions and Land Regulatory Strategy**				
PPL1a	Develop the Planning, Permissions and Land Climate Change Regulatory Strategy.	**PPLU (OG)**	✓		
PPL1b	Incorporate climate change adaptation considerations into reviews or amendments of statutory management planning documents. These should include: • The increased vulnerability of some habitats/locations • Changing visitor use patterns (both recreation and concessionaire) • Adaptation by concessionaires and permit holders • Adaptation and mitigation actions by other sectors (e.g. wind farms) • The prioritisation of sites that are at heightened risk	**PPLU (OG)**, BG, PVG	✓	✓	✓
PPL1c	Include climate change risk assessments, actions and outcomes in statutory management planning documents.	**PPLU (OG)**	✓	✓	✓
PPL1d	Investigate and implement climate change risk and adaptation as a consideration for all permissions and, where possible, amend existing permissions.	**PPLU (OG)**	✓	✓	✓
PPL1e	Include climate change risks and adaptation considerations in the acquisition, exchange and disposal of land.	**TR (PG)**, PPLU (OG)	✓	✓	✓
PPL1f	Include climate change criteria when considering marine areas for protection, including marine protected areas, marine reserves and marine mammal sanctuaries.	**PPLU (OG)**, PU (PVG), AU (BG),		✓	✓
PPL1g	Identify any impacts of adaptation actions with Treaty partners.	**PPLU (OG)**	✓		
PPL1h	Create a land asset strategy that recognises climate considerations through classification and land use.	**PPLU (OG)**	✓		

HERITAGE, VISITOR AND INFRASTRUCTURE ACTIONS		DOC Teams – unit (group)	Delivery time frame		
			2022	2024	2025
PPL1i	Increase the priority for engaging in Resource Management Act (RMA) regional and territorial processes (plans, strategies, consents) where activities are linked to climate change concerns.	**PPLU (OG)**	✓		
PPL1j	Develop tools and training for PPLU staff regarding climate change implications to strengthen the capability of decision makers.	**PPLU (OG)**	✓		
PPL1k	Develop a targeted engagement plan to raise awareness with our concessionaires and stakeholders that climate change will now be a key consideration in the assessment of concession applications.	**PPLU (OG)**	✓		
PPL1l	Develop a targeted engagement plan to raise awareness with our Treaty partner concessionaires that climate change will now be a key consideration in the assessment of applications.	**PPLU(OG)**	✓		

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12. Glossary | He kuputaka

TERM	DEFINITION
Adaptation	'Adaptation refers to adjustments in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts. It refers to changes in processes, practices, and structures to moderate potential damages or to benefit from opportunities associated with climate change' (UNFCCC n.d.).
Adaptive capacity	'The ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences' (IPCC 2014).
Assets	'"Things of value" that may be exposed or vulnerable to a hazard or risk. Physical, environmental, cultural, financial or economic element that has tangible, intrinsic or spiritual value' (MfE 2019).
Biodiversity	'The variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems' (United Nations 1992).
Climate	'Climate in a narrow sense is usually defined as the average weather, or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. The classical period for averaging these variables is 30 years, as defined by the World Meteorological Organization. The relevant quantities are most often surface variables such as temperature, precipitation and wind. Climate in a wider sense is the state, including a statistical description, of the climate system' (IPCC 2014).
Climate change	'Climate change refers to a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings such as modulations of the solar cycles, volcanic eruptions and persistent anthropogenic changes in the composition of the atmosphere or in land use' (IPCC 2014).
Climate projections	'A climate projection is the simulated response of the climate system to a scenario of future emission or concentration of greenhouse gases (GHGs) and aerosols, generally derived using climate models. Climate projections are distinguished from climate predictions by their dependence on the emission/concentration/radiative forcing scenario used, which is in turn based on assumptions concerning, for example, future socio-economic and technological developments that may or may not be realized' (IPCC 2014).
Consequence	'The outcome of an event that may result from a hazard. It can be expressed quantitatively (e.g. units of damage or loss, disruption period, monetary value of impacts or environmental effect), semi-quantitatively by category (e.g. high, medium, low level of impact) or qualitatively (a description of the impacts)' (MfE 2019).

TERM	DEFINITION
Emissions	'The production and discharge of substances that are potentially radiatively active (i.e. absorb and emit radiant energy) in the atmosphere (e.g. greenhouse gases, aerosols)' (MfE 2019).
Exposure	'The presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected by natural hazards and climate change' (MfE 2019).
Extreme weather event	'An event that is rare at a particular place and time of year. Definitions of rare vary, but an extreme weather event would normally be as rare as or rarer than the 10th or 90th percentile of a probability density function estimated from observations. By definition, the characteristics of what is called extreme weather may vary from place to place in an absolute sense. When a pattern of extreme weather persists for some time, such as a season, it may be classed as an extreme climate event, especially if it yields an average or total that is itself extreme (e.g., drought or heavy rainfall over a season)' (IPCC 2014).
Hazard	'The potential occurrence of a natural or human-induced physical event or trend or physical impact that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems, and environmental resources' (IPCC 2014).
Impacts	'… the effects on natural and human systems of extreme weather and climate events and of climate change. Impacts generally refer to effects on lives, livelihoods, health, ecosystems, economies, societies, cultures, services, and infrastructure due to the interaction of climate changes or hazardous climate events occurring within a specific time period and the vulnerability of an exposed society or system. Impacts are also referred to as consequences and outcomes' (IPCC 2014).
Intermediate outcomes	25-year targets (2015–2040) that specify where the Department of Conservation focuses its work to deliver its vision statement.
IPCC	Intergovernmental Panel on Climate Change – a scientific and intergovernmental body under the auspices of the United Nations.
Land-use change	'Land-use change refers to a change in the use or management of land by humans, which may lead to a change in land cover. Land cover and land-use change may have an impact on the surface albedo, evapotranspiration, sources and sinks of greenhouse gases (GHGs), or other properties of the climate system and may thus give rise to radiative forcing and/or other impacts on climate, locally or globally' (IPPC 2014).
Likelihood	The chance of a specific outcome occurring, where this might be estimated probabilistically (adapted from IPCC 2007).
Mātauranga Māori	'Mātauranga Māori or Māori knowledge … has many definitions that cover belief systems, epistemologies, values and knowledge both in a traditional and contemporary sense. Mātauranga Māori can be defined as the knowledge, comprehension or understanding of everything visible and invisible existing in the universe' (MfE 2019).

TERM	DEFINITION
Mitigation (climate change)	A human intervention to reduce the sources or enhance the sinks of greenhouse gases (adapted from IPCC 2007).
National Adaptation Plan (NAP)	A plan that will help New Zealand to prepare for, and adapt to, the effects of climate change. This is required in the Climate Change Response (Zero Carbon) Amendment Act 2019.
Representative Concentration Pathways (RCP)	A suite of representative future scenarios of additional radiative heat forcing at the Earth's surface by 2100 (in Watts per square metre), which is the net change in the balance between incoming solar radiation and outgoing energy radiated back into the atmosphere. Each RCP can be expressed as a greenhouse gas concentration (not emissions) trajectory adopted by the IPCC for its Fifth Assessment Report (AR5) in 2014 (IPCC 2014).
Resilience	'The capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation' (IPCC 2014).
Risk	'The potential for consequences where something of value is at stake and where the outcome is uncertain, recognizing the diversity of values. Risk is often represented as probability or likelihood of occurrence of hazardous events or trends multiplied by the impacts if these events or trends occur' (IPCC 2014).
Risk assessment	The overall qualitative and/or quantitative process of risk identification, risk analysis and risk evaluation, with multiple entry points for communication and engagement and monitoring and reviews.
Stressor (climate)	'Persistent climatic occurrence (e.g. change in pattern of seasonal rainfall) or rate of change or trend in climate variables, such as the mean, extremes or range (e.g. ongoing rise in mean ocean temperature or acidification), which occurs over time (e.g. years, decades, centuries), with important effects on the system exposed, increasing vulnerability to climate change' (MfE 2019).
Stretch goals	10-year targets (2015–2025) for focused goals for the Department of Conservation to achieve. These are linked to the long-term intermediate outcomes.
Sustainable Development Goals	The Sustainable Development Goals (SDGs), also known as the Global Goals, were adopted by all United Nations Member States in 2015 as a universal call to action to end poverty, protect the planet, and ensure that all people enjoy peace and prosperity by 2030.
Vulnerability	'The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt' (IPCC 2014).

Appendix 1 | Ko te āpitihanga 1

The Department of Conservation's strategic roles, intermediate outcomes and stretch goals, and examples of how they may be affected by climate change

Strategic roles	Intermediate outcomes (IOs)	Stretch goals (SGs; to be achieved by 2025)	Examples of how climate change may impact these IOs and SGs
Provide conservation services and leadership to protect and enhance New Zealand's natural and historic heritage	The diversity of New Zealand's natural heritage is maintained and restored (IO1) New Zealand's history is brought to life and protected (IO2)	The stories of 50 Historic Icon sites are told and protected 50% of New Zealand's natural ecosystems are benefiting from pest management 50 freshwater ecosystems are restored from 'mountains to the sea' A nationwide network of marine protected areas is in place, representing New Zealand's marine ecosystems 90% of our threatened species across New Zealand's ecosystems are managed to enhance their populations	Direct impacts on habitat and species distributions from increasing temperatures, changing rainfall patterns and coastal flooding Increased risk of predation by invasive species due to changes to their ranges and a better suitability of the climate for those species Reduced viability of New Zealand marine species due to ocean warming and acidification

Strategic roles	Intermediate outcomes (IOs)	Stretch goals (SGs; to be achieved by 2025)	Examples of how climate change may impact these IOs and SGs
Contribute to New Zealand's economic, social and cultural success	Whānau, hapū and iwi are enabled to carry out their responsibilities as kaitiaki of natural and cultural resources on public conservation lands and waters (IO3) New Zealand's unique environment and heritage is a foundation for our economic, social and cultural success (IO4)	Whānau, hapū and iwi are able to practise their responsibilities as kaitiaki of natural and cultural resources on public conservation lands and waters	Changes to the viability of mahinga kai / food-gathering places through increasing water temperatures and changes to the water chemistry Damage to coastal archaeological sites through sea-level rise and coastal erosion
Enhance the wellbeing of New Zealanders and international visitors by encouraging and enabling people to connect and contribute to New Zealand's nature and heritage	New Zealanders and international visitors are enriched by their connection to New Zealand's nature and heritage (IO5) New Zealanders and international visitors contribute to conservation (IO6)	90% of New Zealanders' lives are enriched through connection to our nature and heritage 90% of visitors rate their experiences on public conservation lands and waters as exceptional 90% of New Zealanders think the impacts of visitors on public conservation lands and waters are very well managed	Damage to visitor infrastructure through changes in extreme weather events, such as floods and ex-tropical cyclones

Appendix 2 | Ko te āpitihanga 2

Proposed criteria for prioritising actions

The critical pathways identify the sequence for implementing certain actions. However, within some broad categories of actions (e.g. those that involve the analysis of existing data or conducting risk assessments), sub-actions need to be prioritised. The following criteria are suggested to assist groups/units as they decide which actions to implement in what order.

Benefit

- Does the action provide a range of benefits?
- Do the benefits exceed the costs?
- Does the action provide cultural, pest control and/or mitigation co-benefits?
- Was the action developed in partnership with our Treaty partners?
- Does the action provide active protection to Māori conservation outcomes?

Urgency

- If we do not respond now, will we be able to respond in the future?
- Are the effects building up over time such that inaction now will cost more later?
- Do other actions depend on this action being accomplished first?
- Are the effects large in scale, pervasive or irreversible?
- If not addressed, can the effects tip this system (e.g. species, habitat, visitors) over a threshold into another state?
- What is the legal or reputational risk of not acting?

Likelihood of success

- Are the tools (e.g. technology) and processes (e.g. permissions and regulations) that will enable this action to succeed in place? Is the action sequential and reliant on something else occurring beforehand to be successful?
- What is the likely effectiveness of the action?
- Are the technical/scientific/implementation skills readily available within the Department of Conservation? If not, how long will it take to develop or secure these skills?
- Does the action respect the tikanga/customs and mātauranga Māori / traditional knowledge gained through generations of observation and practice and support their appropriate application to conservation planning, monitoring and decision-making?

Appendix 3 | Ko te āpitihanga 3

Dynamic adaptive pathways planning

Our climatic future is currently uncertain but holding back on decisions until there is more certainty is not a viable option. Therefore, decisions need to be made based on predictions. A planning approach known as 'dynamic adaptive pathways planning' (DAPP) has been developed to deal with this uncertainty, having been built on the basis that it is possible to identify various scenarios for the future. The Ministry for the Environment's guidance on coastal hazards and climate change (MfE 2017) uses DAPP and, while particularly aimed at coastal adaptation for coastal communities and councils, contains material that is related to the other impacts of climate change and environs and therefore is relevant to the Department of Conservation.

Under DAPP, possible scenarios are developed into a series of actions over time (pathways) to achieve objectives, and decisions to change these pathways are made over time as existing management pathways start to fail to meet their objectives as conditions change. By exploring different pathways and testing the consequences under different scenarios, an adaptive plan can be designed that includes a mix of short- and long-term options. The plan is monitored for thresholds that signal an approaching decision point to either implement the next step of a pathway or reassess the objectives or the plan itself.

This process is illustrated in Fig. A3.1, which shows that there are four possible actions (A–D) from the current situation. Some of these actions will be only effective in the short term (e.g. B), following which other actions will need to be tried. The triangle denotes signals to change pathways, and the rectangle is the trigger to change before it is too late. So, if we initially choose action B, we will need to move to action A, C or D once the trigger to change appears.

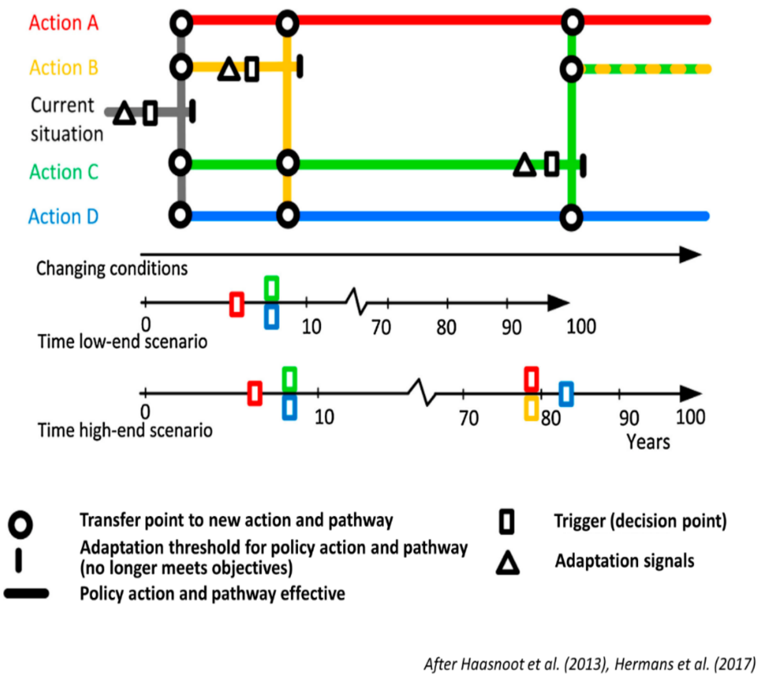

Figure A3.1. Example dynamic adaptive pathway (adapted from Haasnoot et al. 2013; Hermans et al. 2017).

A theoretical conservation example of DAPP is illustrated in Fig. A3.2. This is for climate change adaptive management of a threatened native species located on a predator-free offshore island. Note that no change in management is only a short-term solution, with long-term population security being reliant on predator-free sites further south.

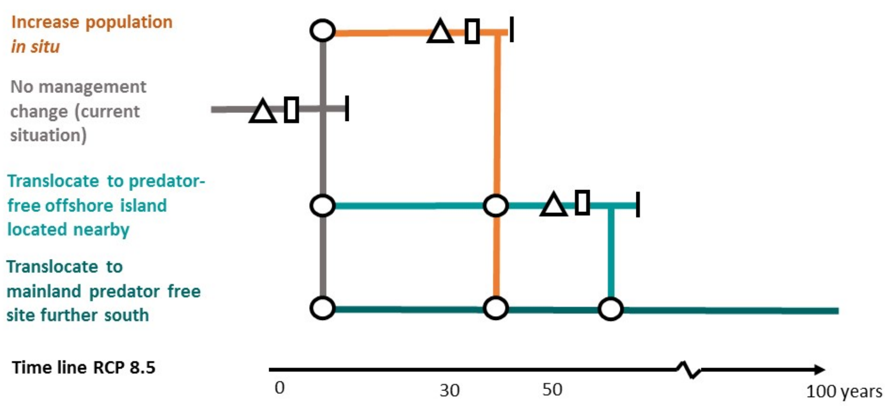

Figure A3.2. Example of theoretical dynamic adaptive pathways planning (DAPP) for threatened native species.

References

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