



Manaaki Whenua
Landcare Research

Environmental stewardship and well-being

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Environmental stewardship and well-being

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Executive Summary

Project and objective

This project is a partnership between Manaaki Whenua – Landcare Research (MWLR) and the Ministry for the Environment (MfE) and is supported through the Office of the Prime Minister’s Chief Science Advisor and MWLR Strategic Science Investment Funding.

The aim of the project is to develop and test a structured, systematic, transparent, and repeatable process that uses well-being to design indicators that better represent the link between nature and people. The process involved:

- reviewing international and New Zealand literature on environmental and well-being indicators,
- developing a structured process to identify relevant indicators that describe the contribution of nature to people’s well-being using ecosystem services as the conceptual basis,
- testing our process with stakeholders, and
- demonstrating its application to current government initiatives

Tracking the connection between nature and people’s well-being in New Zealand

- Two main initiatives in New Zealand assess state of the environment and people’s well-being. First is the state of the environment (SOE) reporting series led by MfE and Statistics New Zealand (StatsNZ). These environmental reports are based on a causal chain framework, the Driver-Pressure-State-Impact-Response (DPSIR). The focus in New Zealand is on the Pressure-State-Impact for reporting. Second is the Living Standards Framework (LSF) developed by the Treasury. The LSF is based on the OECD well-being framework, to reflect people’s well-being or ‘capability of people to live lives that they have reason to value’. The LSF is composed of several elements, including domains of current well-being and four future well-being capitals (financial, human, natural, and social). The Living Standards Dashboard comprises over 60 indicators to monitor progress on social, economic, and environmental well-being for the LSF. Data for these indicators will be supported by Statistics NZ’s Indicator Aotearoa NZ project.
- MfE and StatsNZ collate a range of Pressure, State, and Impact indicators. A review of these indicators showed most data and indicators track ‘pressure’ and ‘state’ with little information/few indicators available for tracking ‘impact’. Given impact indicators connect how changes in the environment relates to people’s well-being, this is an important gap in New Zealand’s knowledge and understanding of well-being. This deficiency was highlighted by the Parliamentary Commissioner for the Environment who suggested additional data/indicators are needed for ‘drivers’ of change. We suggest ecosystem services (ES: benefits that people receive from ecosystems) or Nature’s Contributions to People (NCP: an alternative framing introduced by the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES)) is an appropriate framing for identifying indicators to track impacts.

A proposed process to identify robust indicators that meaningfully connect well-being to nature

- We developed a process based on ES/NCP concepts to identify those impact indicators that can provide meaningful information on well-being for New Zealand. The process allows for a robust discussion on what the relationship(s) is/are between different ES/NCPs and dimensions of well-being, thus enabling us to identify 'fit for purpose' indicators that also align with the LSF.
- Our co-production indicator process involved:
 - 1 Framing. In this step, the overarching framing for the process is agreed. For our purposes, we agreed to use the ES/NCP classification and the LSF well-being framework. The LSF is being used by several central government agencies. The ES/NCP categories used were provisioning or material ES/NCP (e.g. food or fibre), regulating (e.g. regulation of climate, natural hazards or water), and cultural or non-material ES/NCP (e.g. spiritual or recreation). These are commonly used in the literature.
 - 2 Prioritisation. Not every ES/NCP is relevant to each well-being considered in the LSF. In this step, we developed a series of criteria to help narrow down and prioritise which ES/NCP-well-being relationship should be considered for indicator development. The criteria we used included the nature of importance of the relationship (direct/indirect and magnitude of relationship), the scale of its importance (proportion of population or spatial extent) and the substitutability of the ES/NCP (i.e. whether there were cost-effective man-made alternatives or similar/same options in close proximity).
 - 3 Designing indicators. Impact indicators are complex and can represent various elements of typically complex relationships between humans and nature. We propose to split impact indicators into 'supply' and 'benefit' indicators. Supply indicators represent the ecosystem's capacity to provide the service (biophysical potential) and the anthropogenic inputs necessary to realise the service (e.g. through accessibility and added anthropogenic assets). Benefit indicators refer to the impact that people receive for their well-being. It reflects the relevance of an ecosystem service to people, highlighting the actual use and demand for an ES/NCP.

Testing our process

- We tested the process with central government agency stakeholders in a workshop setting. This involved running two exercises to determine how well the process worked with a diverse audience. The first exercise tested the prioritisation process using two well-being domains (health and subjective well-being) and three ES/NCP. The second exercise explored the identified of appropriate indicators to represent the relationships between the well-beings and prioritised ES/NCP. Overall, participants generally agreed on using an ES/NCP framing to describe the relationship between well-being nature. The discussions, however, highlighted the variability in the prioritisation scoring depending on the perspectives from different groups (e.g. Māori vs trampers vs city dwellers).
- To populate the full ES/NCP well-being matrix, an assessment to derive the importance of ES/NCP for each well-being and prioritise the relationship on which to focus indicator development was undertaken by the MWLR authors. The authors endeavoured to consider the range of potential stakeholder interests and perceptions

during their assessment and drew from the literature where possible. The conclusions from this assessment should be tested with a wider group of stakeholders to ensure a range of perspectives were adequately captured. From our qualitative assessment, we noted:

- Material (and non-material) ES/NCPs are essential for backbone economic activities (e.g. material NCP from indigenous vegetation is the production of honey from Manuka that has increased in export value since the beginning of the pandemic (<https://www.mpi.govt.nz/dmsdocument/42360-New-Zealand-honey-exports>). Material (and non-material) ES/NCPs are important for many of our economic sectors such as tourism, agriculture and commodity exports, and the screen industry.
- Regulating ES/NCPs are essential for our health and personal security – ensuring clean air and water, healthy soils, and the decomposition of waste. They also indirectly affect the material dimension of well-being by, for example, mitigating erosion and flooding and thus reducing the costs of erosion and flood damage.
- Non-material ES/NCPs are essential for our mental health, cultural identity, and social cohesion and will be important for community social resilience for COVID-19 recovery.
- ‘Maintenance of options’ is a longer term and fundamental NCP and includes ‘Nature’s Contribution to Adaptation’. It reflects the value of maintaining and investing in natural capital to keep options open for future generations, build resilience to future shocks (e.g. financial crisis, future pandemics, natural disasters), as well as adaptation to climate change.

Application and implementation pathway

This project has informed government decisions in the following areas:

- The rapid review of ES/NCP and how they underpin well-being helped shape conversations on budgetary prioritisation for the MfE during the COVID-19 response. Many in the public service were required to make rapid decisions on where and what to invest in for recovery funding to stimulate the New Zealand economy. Given the speed of these decisions there was the chance that both the impact on the environment and opportunities to enhance nature would be overlooked. The high-level relationships between ES/NCPs and well-being were used as a ‘checklist’ to assess the longer-term impacts of these decisions.
- The indicators currently being tracked for Environmental Reporting tend to focus on the ‘state’ of ecosystems or ecosystem services. Supply or benefit indicators were found to be lacking. Only six indicators (out of 21 ES/NCP) had direct relevance to the supply of ES/NCPs, with only five out of 18 ES/NCPs partially informed by the current set of indicators in terms of ‘benefits.’ In general, there was good information available to cover the provisioning services but comparatively little information for the regulating and cultural services.
- The environmental reporting programme at MfE has been exploring how to expand the set of core measures to demonstrate the connection between Pressure-State-Impact indicators and well-being using an ES-based approach. These new data would enable a narrative to emerge that not only links pressures from human and natural factors to the state of the natural capital ‘stocks’, but also links changes in these stocks to changes in

the benefits provided to people. To develop a robust set of additional indicators should involve a participatory approach with relevant stakeholders to foster ownership and continued use of the indicators. Stakeholder participation can help to determine the intended use of the indicators.

Future development of the process to link nature to well-being

Sustainable long-term funding was highlighted as a key risk for the on-going collection of ES/NCP indicators for well-being. A business case that highlights the value of such an indicator set and outlines a host organisation for their collection would be beneficial. The initiatives by Statistics NZ on SEEA or IANZ could be broadened to include the indicators identified during the process.

We identified three areas for future development (based on our discussions with workshop participants, the Treasury and MfE):

- The matrix of relevance of ES/NCP to well-being domains should be cross validated by a wider group of stakeholders/agencies. This would ensure buy-in and recognition of the value of this process.
- Further work should discuss complementarity with Māori well-being frameworks. Identifying common indicators would help consolidate and prioritise the data needed to measure and track well-being. A co-development process for identifying and/or integrating Māori values into the process would add value to process and resulting indicator set.
- The process for designing indicators of supply and benefit to people needs further development and consider factors such as diversity of the community, accessibility to an ES/NCP for well-being, and equity. Specific case studies (e.g. policy evaluation, monitoring, or reporting) could be used to further refine and test the revised indicator component of the process.

1 Introduction and context

We have a fundamental relationship with the environment: we both influence it and are influenced by it. We influence it through how we manage and use the environment, causing 'pressures' on and changes in the 'state' of the environment. The other domain of our relationship with the environment is how it influences us. We depend on the environment and the benefits the environment provides us. Examples of these benefits include food, energy, health, recreation, and identity (which acknowledges the deeper connection we have with the environment).

Given how deeply intertwined people and the environment are it is important that environmental stewardship and related management decisions include consideration of our place within the environment. MfE is the government agency with responsibility for environmental stewardship, including providing national direction (through instruments such as National Policy Statements) for the wise use of land, water, climate, and seas. MfE also has a legal responsibility to report on the State of New Zealand's Environment (since the enactment of the Environmental Reporting Act in 2015) and under international agreements such as the United Nations Framework Convention on Climate Change (UNFCCC). Other obligations include the ratification of the Convention on Biological Diversity (CBD) that has led to the New Zealand National Biodiversity Strategy and Action Plan led by the Department of Conservation (Te Mana o te Taiao) and the Sustainable Development Goals set up by the United Nations in 2015.

The completion of the first full cycle of the environmental reporting series in April 2019 provided a timely opportunity to the Parliamentary Commissioner for the Environment (PCE) to review the entire system. The Commissioner noted several issues and proposed improvements to the Environmental Reporting Act. Gaps in data and knowledge undermine stewardship of New Zealand environment and evidence-based decision making. One the most crucial gaps is the link between changes in the environment and the impact on people's well-being. These dependencies and benefits are often described as 'ecosystem services', as popularised by the Millennium Ecosystem Assessment (MEA 2005). This is an active area of research at the science to policy interface, particularly through international frameworks such as the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) and the European Union Biodiversity Strategy. In New Zealand, research on the linkage between environment and people has included reviews on ecosystem services (Dymond 2013; Dymond & Ausseil 2019), and research on the relevance of ecosystem services to the farming community, businesses and local government authorities through the BEST programme (<https://www.landcareresearch.co.nz/science/portfolios/enhancing-policy-effectiveness/best>).

2 Project scope

This project is a partnership between Manaaki Whenua and MfE supported through the Office of the Prime Minister's Chief Science Advisor, established to build capability and understanding at the science to policy interface.

The specific focus of the project is to develop and test a structured, systematic, transparent, and repeatable approach to represent the links between nature and people. The approach includes the following elements (Fig. 1):

- Explore the Treasury’s Living Standard Framework and state of the Environment reporting framework from MfE (section 3)
- Review key international initiatives and frameworks used to link nature to people (section 4)
- Explore the concept of ecosystem services/Nature’s Contributions to People (section 5)
- Frame a systematic and structured process to formalise the contribution of nature to people’s well-being (section 6)
- Testing the process with stakeholders and within the research team (section 7)
- And finally test application within a policy context (section 8)

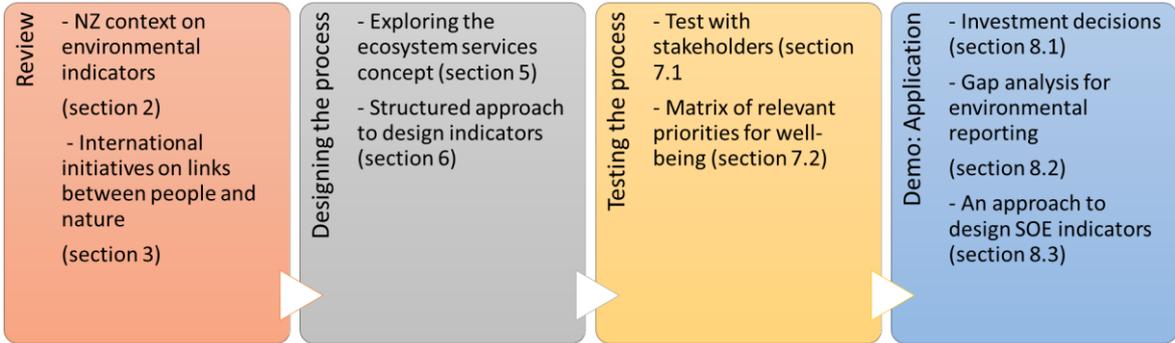


Figure 1. Guiding roadmap for this report.

3 Background: the NZ context

3.1 Treasury’s well-being priorities

The Treasury developed the Living Standards Framework (LSF) to help inform economic policy advice to government. It is based on the OECD well-being framework and reflects people’s well-being or the ‘capability of people to live lives that they have reason to value’ (Treasury 2019). The LSF is composed of several elements (Fig. 2):

- Domains of current well-being to reflect the range of outcomes that matter to New Zealander’s well-being. These are primarily based on the OECD better life index, with the addition of a ‘cultural identity’ domain.
- Four capitals for future well-being (social, built, human and natural capital) which are important to sustain for future generations

- Risk and resilience to reflect the capacity to sustain well-being through unexpected events
- Distribution that reflects how well-being varies across space, time/generations, and population groups.

The well-being budget 2019 (Treasury 2019) has six priority areas, including transforming the economy to a sustainable and low-emissions economy. With the recent COVID19 crisis, the well-being budget 2020 has focused on rebuilding the economy for post-COVID19 recovery. It has, among other initiatives, established a new fund, 'jobs for Nature', to boost predator control efforts, restore wetlands, regenerate planting, and improve tracks, huts, and other recreational and visitor assets on public conservation land

(<https://www.doc.govt.nz/news/media-releases/2020-media-releases/investment-to-create-11000-environment-jobs-in-our-regions/>).



Figure 2. The Living Standards Framework.

The LSF Dashboard is a measurement tool to inform Treasury advice to Ministers on priorities to improve well-being. Indicators Aotearoa New Zealand (IANZ)¹ is seen as the basis for populating the Living Standards Framework dashboard in the future. It is delivered

¹ <https://www.stats.govt.nz/indicators-and-snapshots/indicators-aotearoa-new-zealand-nga-tutohu-aotearoa/>

by StatsNZ and is meant to support many cross-government initiatives, including the LSF but also the United Nations' Sustainable Development Goals.

A set of indicators were identified to monitor progress against each of the current well-being domains (Appendix 1). The Treasury had a limited set of indicators (eleven), related to 'environment quality' (current well-being) or natural capital (future well-being) (Table 1). These indicators have been chosen in a pragmatic way (Treasury 2019), based on an initial review of available information (van Zyl & Au 2018).

Table 1. Environmental quality (current well-being) and Natural capital (future well-being) indicators used in the Living Standards Dashboard (Treasury 2019)

Category	Indicator	Statistic	Data source
Current well-being – Environment	Air quality (PM10)	National annual average PM10 concentration Population-weighted exposure to PM2.5 concentrations, micrograms per cubic metre, 3-year moving average (international statistic)	StatsNZ
	Access to the natural environment	Percentage of adults who said they could easily get to all or most of the green spaces in their local area	New Zealand General Social Survey (StatsNZ)
	Water quality (swimmability)	Percentage of tested river sites that are safe to swim in under normal conditions	MfE
	Perceived environmental quality	Percentage of people who rated the overall state of the natural environment in New Zealand as good or very good	Public perception of New Zealand's environment, Lincoln University survey
Future well-being – natural capital	Net greenhouse gas emission	Net greenhouse gas emissions in kilotonnes of CO2 equivalent	New Zealand's greenhouse gas inventory (MfE)
	NZ's renewable energy	Renewable energy as a percentage of total primary energy supply	StatsNZ and MBIE
	Climate regulation	Carbon stored in forest and soil biomass	New Zealand's greenhouse gas inventory (MfE)
	Sustainable food production	Percentage of tested sites within targets for at least six of the seven types of soil test	MfE
	Drinking water	Proportion of the population served with drinking water that met all standards	Annual Report on Drinking-water Quality, Ministry of Health
	Biodiversity and genetic resources	Percentage of indigenous species at risk/threatened among assessed species	Department of Conservation
	Waste management	Kilograms of waste, per capita	Review of the effectiveness of the waste disposal levy, MfE

3.2 Environmental reporting

The National Environmental Reporting Act was passed into law in 2015 (MfE 2014), setting up an obligation for New Zealand to report on the state of its environment (SOE) on a regular basis. At present, MfE and StatsNZ are required to produce a synthesis report on the state of New Zealand's environment once every 3 years, with rolling domain reports for air, land, freshwater, marine and climate produced on a six-monthly basis. These reports are based on the Driver-Pressure-State-Impact-Response framework. **Drivers (D)** are the phenomena that provide context for changing pressures (economics, population growth...), **pressures (P)** are the direct natural or human influences that can explain changes in the state, **state (S)** is the physical, chemical and biological characteristics of the environment and how these change over time, **impacts (I)** are the consequences of changes in the state of the environment and **responses (R)** are the actions taken by institutions, government, and communities. **Responses** loops back to the drivers and pressure and provides a closed system. The DPSIR is the basis for New Zealand's state of the environment reporting series, however, it only focuses on PSI, with Response and Drivers being considered out of scope (Fig. 3).

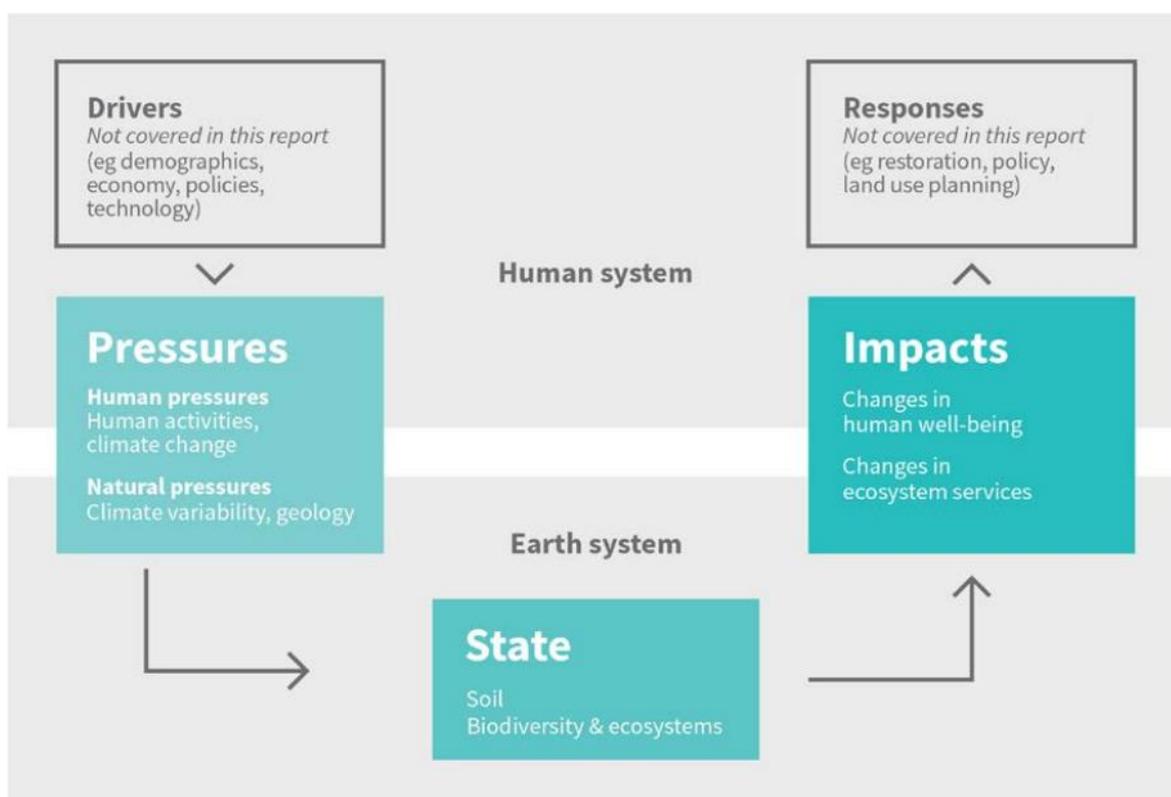


Figure 3. Pressure-state-impact framework from Our land 2018 (MfE and StatsNZ 2018).

Indicators for pressure, state and impacts have been designed for all five domains (Table 2). These indicators fall into the topics defined by the Environmental Reporting Regulations 2016 (MfE and StatsNZ 2016). These topics ensure which key issues should be reported within each domain. State topics describe the broad aspects of the condition of the domain, pressure topics describe the main sources of pressure and impact topics cover the impacts in the areas of ecological integrity, public health, the economy, te ao Māori, and culture and recreation.

Table 2. Number of current MfE Environmental Reporting indicators aligned by domains²

Domain	Pressure	State	Impact	Total
Air	0	9	2	11
Freshwater	5	15	1	21
Land	11	16	2	29
Marine	15	15	1	31
Atmosphere and climate	7	11	3	21

3.3 Exploring how some government initiatives link people to nature

Besides the SOE Reporting series and the LSF, we also reviewed several initiatives in New Zealand and internationally (Table 3) to explore how they interact and where there are common goals.

Table 3. Main initiatives reviewed in this report

Initiative	Purpose	Scale	Audience
Resource Management Act (RMA) (MfE), National Policy Statement (NPS) (MfE)	<i>Promote the sustainable management of natural and physical resources</i>	National to local	Natural resource managers (farmers, local governments)
NZ Environmental reporting (MfE)	<i>Provide evidence base to know what impact we are having on the environment</i>	National	Public, policy makers, businesses
Living Standards framework (LSF) (Treasury)	<i>Strengthen the robustness and rigour of Treasury's advice about lifting living standards, beyond a healthy economy</i>	National	Policy makers
Indicators Aotearoa NZ (IANZ) (StatsNZ)	<i>Provide statistically robust data for other initiatives (SOE, Living standards)</i>	National	Central government, general public
System of Environmental Economic Accounting (SEEA) (StatsNZ)	<i>Provide a statistical system to measure condition of the environment and contribution of the environment to the economy, and impact of the economy on the environment</i>	National	Policy makers, central government
Aotearoa circle	<i>Pursue sustainable prosperity and reverse the decline of New Zealand's natural resources through partnership of public and private sector leaders</i>	Industry	Businesses
NZ Planetary Boundaries (MfE)	<i>Raise awareness on NZ's contribution to global issues</i>	Global to national	General public, policy makers

² NB: Some of MfE indicators can be counted twice, as an impact indicator and state indicator in another domain.

Initiative	Purpose	Scale	Audience
Intergovernmental Platform on Biodiversity & Ecosystem Services (IPBES) (UN)	<i>Provide evidence base to know what impact we are having on the environment and how it affects human well-being</i>	Global	Policy makers
Sustainable Development Goals (SDG) (UN)	<i>Provide a blueprint to achieve a better and more sustainable future, addressing global challenges (poverty, inequality, environmental degradation, prosperity, peace, and justice)</i>	Global and industry	Policy makers, businesses

Using the DPSIR framework, the focus area for these initiatives can be mapped into broad objectives (Fig. 4):

- **Understanding the environment**

Planetary boundaries is a concept to describe earth system processes and their environmental boundaries (Rockström et al. 2009). The concept was developed to demonstrate how human society is putting **pressure** on the environment. MfE has reviewed the framework and piloted downscaling of the global boundaries to New Zealand. The New Zealand Planetary Boundary goal is to communicate to the public New Zealand's contribution to the planetary boundaries. This framework was applied in several countries and showed a way to identify large overshoots over 5–10-year periods (Dao et al. 2018). This approach has some limitations as it only refers to global issues that may not be representative of NZ-related issues and relies on many approximations to downscale to country level (Häyhä et al. 2016).

As stated previously, New Zealand's State of the Environment reporting focuses on understanding and reporting on pressure, state, and impact for the environment. The reporting programme has purposefully refrained from including 'response'.

- **Collecting data initiatives**

To support central government agencies in their decisions, StatsNZ leads two data and information initiatives:

- Indicators Aotearoa NZ (IANZ) is designed to provide key indicators for He Arotahi Tatauranga, the Living Standards Framework, and the UN Sustainable Development Goals. Some of the indicators are drawn from the Environment Aotearoa state of the environment reports. These indicators sit across the PSI spectrum and different domains of human well-being.
- The System of Environmental-Economic Accounting (SEEA) is still in an experimental phase in NZ. The SEEA covers water, minerals, marine, forestry, fish, environmental protection expenditure and energy (http://archive.stats.govt.nz/browse_for_stats/environment/environmental-economic-accounts.aspx). This accounting system is consistent with the System of National Accounting (SNA) and allows for the integration of economic and environmental data.

Reporting to international conventions

New Zealand has an obligation to report on several international frameworks, including the Convention for Biological Diversity (CBD; state of biodiversity) and the United Nations Framework Convention on Climate Change (UNFCCC; greenhouse gas emissions). The CBD has also set biodiversity targets (Aichi Targets). Reporting against these targets provides information on how well each country is progressing in halting biodiversity loss.

The United Nations Sustainable Development Goals (SDGs; <https://sustainabledevelopment.un.org/?menu=1300>), another United Nations initiative, has 17 goals. The SDGs bring together the three dimensions of sustainable development – economic, social, and environmental – and therefore sits across the DPSIR framework (Chandrakumar & McLaren 2018) (Fig. 4).

Setting National policy directions

Several legislative and regulatory requirements in New Zealand address environmental change (i.e. 'response' in the DPSIR). These include, at national scale, the Resource Management Act (RMA; 1991) and subsequent National Policy Statements (NPS). The RMA and NPS set the national environmental management directions for local and territorial authorities. Regional councils and territorial authorities are then obliged to give effect to the NPS through their regional policy statements, regional plans, and district plans.

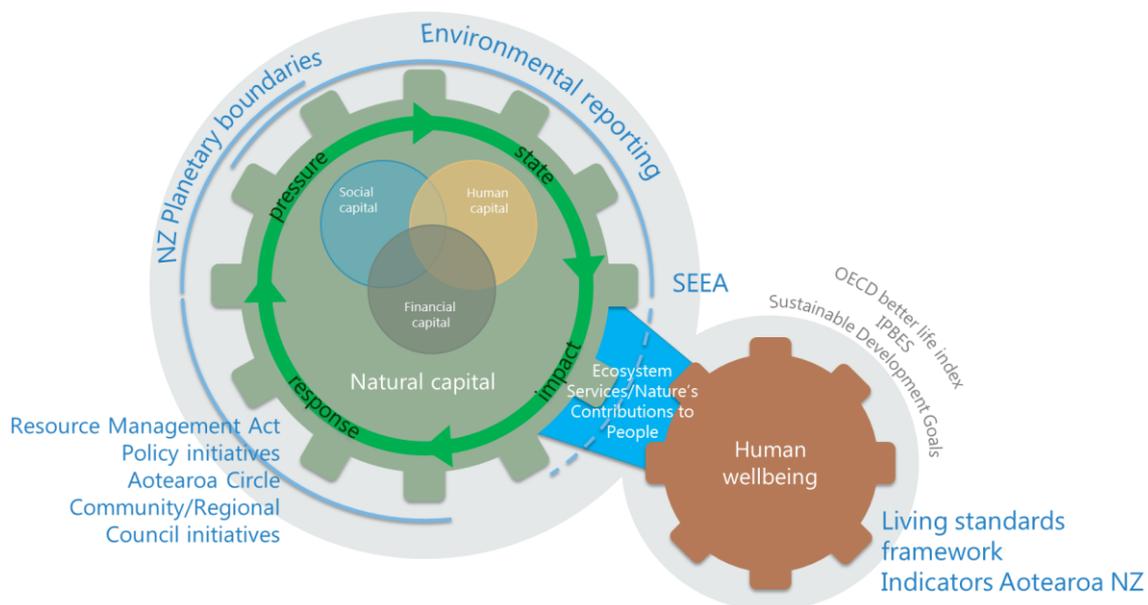


Figure 4. Linkages between key NZ and international initiatives.

4 International initiatives tracking links between people and nature

As the link between people and nature is complex and multi-dimensional, many frameworks have been developed to represent these linkages (Naeem et al. 2016) (Fig. 5). A common approach is to represent these linkages using a causal chain such as the DPSIR framework (Fig. 5a), as used by MfE. A major milestone in the representation of the fundamental relationship between nature and human well-being was the Millennium Ecosystem Assessment (Millennium Ecosystem Assessment 2005). The MEA helped refine and disseminate the concept of 'ecosystem services' (ES) (Figs 5b and 6). **Ecosystem services (ES) are defined as the 'benefits people obtain from ecosystems'** and derived from natural capital (i.e. living and non-living resources).

Since then, numerous initiatives and researchers have expanded or refined this concept. Potschin and Haines-Young (2011) in particular have been instrumental, and have clarified the ES concept through the cascade model (Fig. 5c) that was used as a basis for implementing the EU biodiversity framework (Fig. 5f). In this cascade, biodiversity plays a key role in maintaining basic processes and supporting ecosystem function. ES are derived from ecosystem functions and represent the realised flow of services for which there is demand. Human well-being is then defined via benefits and values obtained from the services supplied. It links more specifically the two main systems: socio-economic and ecosystems via the flow of ecosystem services and drivers of change.

The Safe Planetary Boundaries framework has also gained worldwide attention and takes a different approach. Implicitly, human well-being is at the heart of the circle, with threats to biodiversity and human society being defined through nine broad dimensions (including biodiversity) that are conceptualising the loss of integrity for planetary processes (Rockström et al. 2009) (Fig. 5d).

In 2012, the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) was established at the request of governments, and currently has 137 member countries. It was instituted in response to the success of the MEA to strengthen the science-policy interface for the conservation and sustainable use of biodiversity, long-term human well-being, and sustainable development. The objectives of IPBES are to provide regular assessments, support policy formulation and build capacity. The first task of IPBES was to design a conceptual framework that would be broad enough to encompass different worldviews and concepts of nature-people systems. The resulting conceptual framework brings together elements of the DPSIR and the MEA framework (Fig. 5e, Appendix 2) (IPBES 2019). IPBES moved from the terminology of ecosystem services and referred to 'nature's contributions to people' (NCP) (Appendix 2). **Nature's Contributions to People** are defined as **all the contributions, both positive and negative, of living nature (diversity of organisms, ecosystems, and their associated ecological and evolutionary processes) to people's quality of life**. It was introduced to be more flexible around the concept of 'ecosystem services', which did not always resonate with other worldviews from indigenous communities around the globe and reflected primarily utilitarian valuation of nature (Díaz et al. 2018). IPBES has produced several assessments including the global assessment on biodiversity (IPBES 2019), and four regional assessments for Europe and Central Asia, Africa, the Americas, and Asia and the Pacific with relevance to New Zealand (IPBES 2018). These global and regional assessments provide both an update on current state and trends from the 2005 MEA effort, and a translation of science evidence connected to global targets (Convention of Biological Diversity, Sustainable Development Goals).

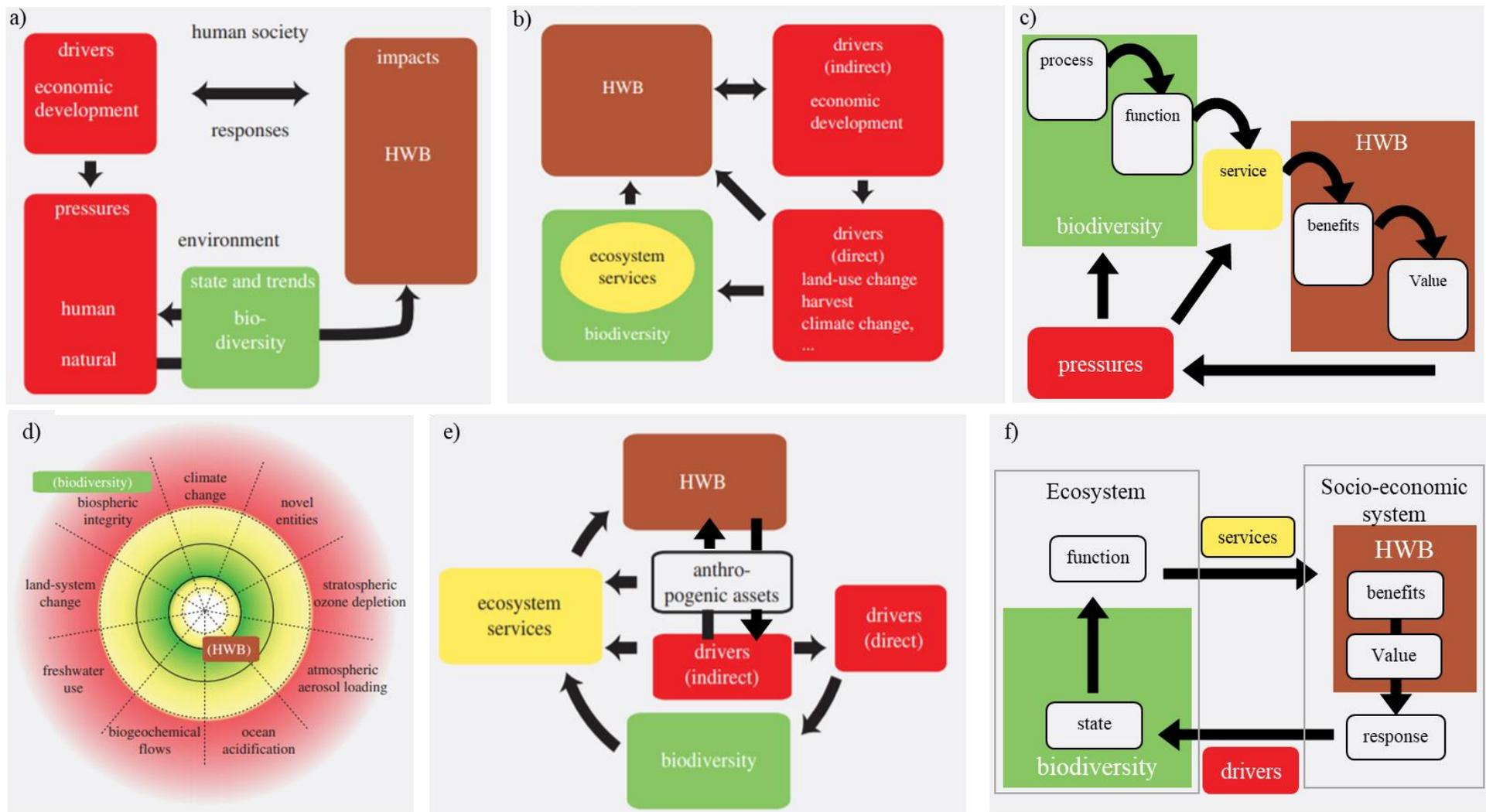


Figure 5. Comparison of different conceptual frameworks (modified from (Naeem et al. 2016): a) DPSIR; b) MEA; c) the ES cascade (Potschin & Haines-Young 2011); d) Planetary boundaries (Rockstrom et al. 2009); e) IPBES (Diaz et al. 2015); f) EU biodiversity framework (Maes et al. 2013).

5 Exploring the ecosystem services concept for well-being indicators

5.1 Terminology used

The multitude of frameworks (Fig. 5) has led to some confusion in terminology, and debates are still active (La Notte et al. 2017). Different terms can be used by different frameworks for a same/similar concept (e.g. Table 4). These frameworks, while developed for different purposes, highlight the challenges facing practitioners who wish to implement these concepts in natural resource management policy and decisions. A wide range of terminology could hinder the utility of these frameworks and may detract from the value of these approaches to help decision-making.

Many conceptual frameworks from Figure 5 rely, to some extent, on causal chains but use different terms and separate the steps in the chain at different points. For instance, the EU biodiversity strategy defines pressure similarly to the DPSIR 'pressure' and characterises 'state' of ecosystems as having a 'condition' and 'extent' accounts. The condition and extent terminology is consistent with the Systems of Environmental- Economics Accounting Experimental Ecosystem Accounting (SEEA EEA), which is being developed by the United Nations Statistical Commission for natural capital accounting (Maes et al. 2018).

IPBES has a similar causal chain framework, although drivers and pressures from the DPSIR are defined as indirect drivers (e.g. demographics, economic, governance) and direct drivers of biodiversity change. Direct drivers include climate change, nature over-exploitation, pollution, invasive alien species, and land use change. IPBES also introduces the notion of substitution, where, for instance, food produced within an ecosystem could be replaced by highly engineered substitutes such as cultured meat or hydroponics. Another important contribution of the IPBES framework is introducing the notion of co-production, symbolised by the arrow connecting the contribution of anthropogenic capitals and associated institutions to processes of value creation from nature. This is an important (and still ongoing) innovation as compared to other policy frameworks.

Table 4. Comparison of terminology between 3 frameworks

DPSIR and NZ Environmental Reporting framework (MfE 2014)	Inter-governmental Platform on Biodiversity & Ecosystem Services (Díaz et al. 2018)	EU Biodiversity framework (Maes et al. 2013)
Driver [excluded from the State of the Environment reporting in New Zealand]	Indirect driver (population, economy, governance, Science and Technology)	Driver
Pressure	Direct driver (climate change, over-exploitation, invasive alien species, pollution, land-use change)	Pressure
State	Nature or Natural Capital	<ul style="list-style-type: none"> • Extent account • Condition account • Capacity account
Impact	<ul style="list-style-type: none"> • Potential and realised NCP <p>Changes in Good quality of life:</p> <ul style="list-style-type: none"> • Output • Impact on human well-being 	<ul style="list-style-type: none"> • ES supply <p>Changes in human well-being:</p> <ul style="list-style-type: none"> • ES demand or benefit • Value
Response [excluded from the State of the Environment reporting in New Zealand]	<ul style="list-style-type: none"> • Institutions and indirect drivers • Anthropogenic assets 	Response

For the purposes of this report and to demonstrate an application of a proposed process identify appropriate indicators that reflect the importance of natural capital to human well-being, we use:

- Well-being – Living Standards Framework well-being domains (Treasury 2019) that is based on the OECD well-being framework.
- Natural capital/nature/biodiversity –Throughout the report ‘nature’ encompasses biodiversity, environment, and natural capital. Natural capital refers to the living and non-living **stocks** of natural resources, which include plants, animals, soils, air, water, and minerals that form ecosystems that generate ecosystem services. Since biodiversity encompasses ‘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 a part; this includes diversity within species, between species and of ecosystems’. We consider biodiversity as the variety from genes, species to ecosystems. Biodiversity underpins ecosystem functions and the provision of ecosystem services and can therefore be considered synonymous to ‘natural capital’ or ‘nature’.
- Ecosystem services or Nature’s Contributions to People (ES/NCP) are the *flows* derived from natural capital. ES/NCP – We refer to **ES/NCP** synonymously when talking about the *contributions people obtain (positively or negatively) from ecosystems*, which is consistent with the MEA definition but also aligns with definitions used in other frameworks (e.g. IPBES).

5.2 A review of environmental indicators in New Zealand

The terminology of pressure, state, supply, benefit indicators was compared with the indicators used in some key reporting frameworks used in New Zealand. We categorised the LSF indicators relevant to natural capital according to the PSI definitions (Table 15 in Appendix 1) and found that most were related to state and impact (Table 5). The Treasury has based these indicators on currently available data and is thus aware that they do not provide a full picture of the value of natural capital and its changes over time (van Zyl & Au 2018).

MfE has the largest database of environmental indicators in New Zealand. Most are related to state and pressure, with very few related to impact. Note that in our analysis, some indicators could be counted twice, as an impact in one domain (e.g. impact of state of atmosphere on ocean acidification) could also be a state in another domain (e.g. marine state of acidification). IANZ had mainly state indicators, most of which came from the State of the Environment reporting. The supply indicators had some placeholder indicators such as 'regulating services' or 'provisioning services' indicators that have no data.

Table 5. Summary of number of indicators in the PSIR framework for the main sources of information in NZ

Initiative	Indicator	Driver	Pressure	State	Impact	Response
IANZ (Stats NZ)		0	4	25	10	1
Environmental Reporting (MfE/StatsNZ)		0	37	66	9	0
Living Standards Framework (Treasury)		0	1	4	5	2
Waikato Well-being project (Regional Council)		0	0	6	1	0
Auckland Plan 2050		0	2	10	0	3
Environmental health indicator NZ		0	0	0	6	0

5.3 Linking natural capital to well-being in the LSF

The review of indicators from a number of initiatives in NZ shows there is a clear gap in indicators focusing on the impact side of the PSIR, thus reflecting the lack of knowledge and data on connections between people and nature. The concept of ES/NCP introduced in Section 4 could help fill this gap, by providing a structured framework on how to describe linkages between nature and people. Since the LSF refers to 'natural capital' and 'well-being', we can then describe the links between future and current well-being through the flow of ES/NCP (Fig. 6):

- The LSF well-being domains can be classified into six broad categories, five from the MEA well-being elements (freedom of choice, security, health, material, and social relations) and one on environmental quality.
- ES are usually classified into three broad categories: provisioning services (e.g. food, fibre); regulating (e.g. regulation of climate, water, air); and cultural services (e.g.

inspiration, recreation, learning). IPBES has used a similar classification for its NCP, although the broad categories are defined as material, non-material and regulating. Non-material NCP largely include cultural ES, but it is acknowledged that culture permeates across all three categories as part of co-production and value development (Diaz et al. 2018). The other innovation is NCP18 'Maintenance of options', which is an additional categorisation, although partly related to the provisioning 'Genetic resources' of the MEA. This NCP reflects a longer term and fundamental contribution of nature and people through ecological resilience and transformability (e.g. through evolutionary processes, dispersal and reconfiguration) and could include the recent concept of 'Nature's Contribution to Adaptation' (Colloff et al. 2020). It reflects the value of maintaining and investing in natural capital to support the choice of future generations and build resilience to future shocks (financial crisis or future pandemics), as well as adaptation to climate change.

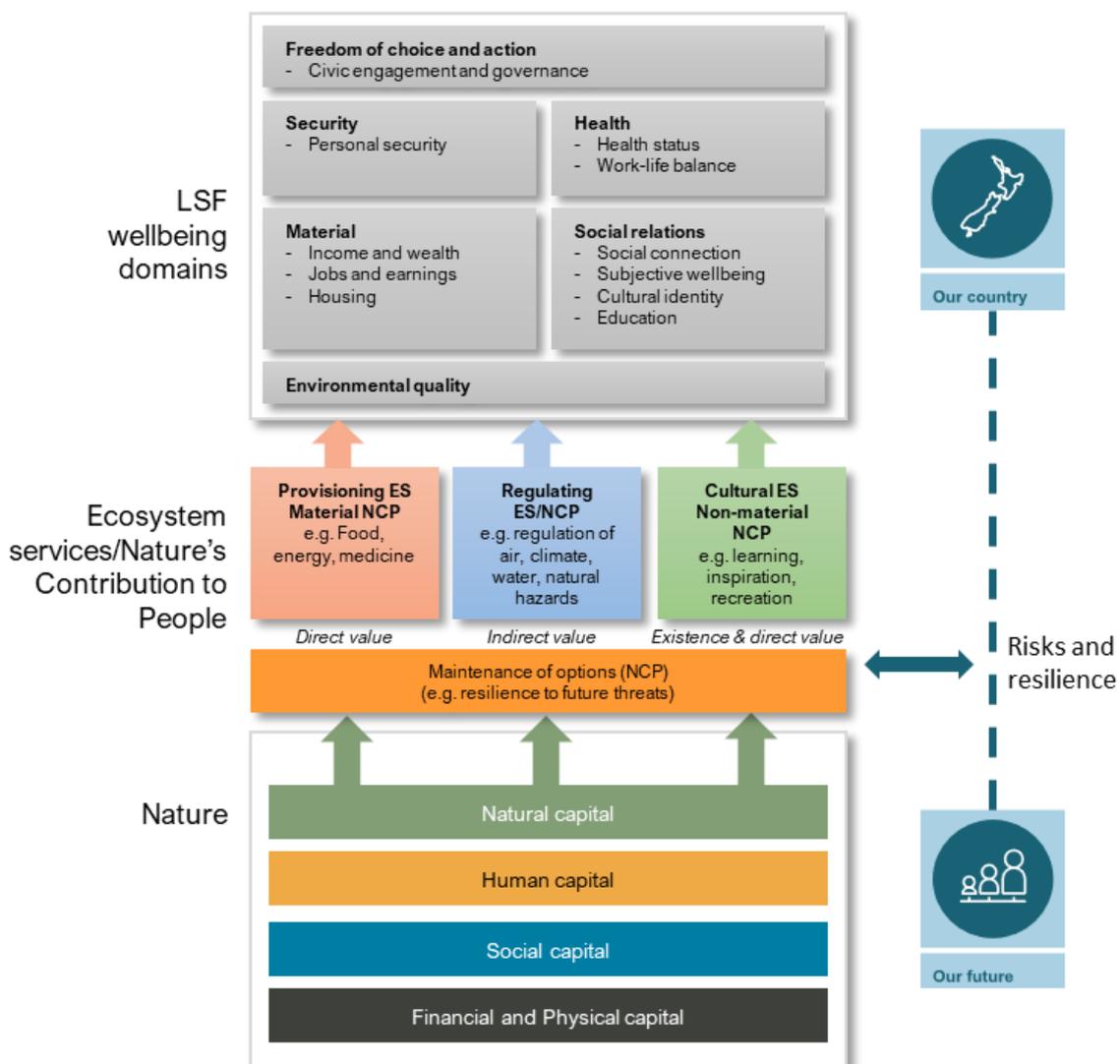


Figure 6. Conceptual framework linking natural and anthropogenic capitals, ES/NCP and LSF well-being elements.

6 A proposed process with stakeholders to prioritise indicators

A process was developed to provide a systematic, structured, transparent, and repeatable approach to identify meaningful indicators to use that capture the contribution of natural capital (via ecosystem services) to well-being and enable the tracking of well-being over time. This approach is meant to facilitate discussions between scientists and a variety of stakeholders interested in this topic. This participatory and co-produced process should ensure the results meet the needs from stakeholders and are usable for their purposes.

The process to identify natural capital/ecosystem service indicators for well-being involves (Fig. 7):

- 1 *Framing*: Framing the well-being and natural capital/ecosystem service concepts to underpin indicator choice.
- 2 *Prioritising*: Assessing if (and how) different ES/NCP impact on each domain of well-being and if (and how) each domain of well-being depends on the different ecosystem services. This step can be used to do a rapid assessment to identify which ecosystem services are relevant to consider for each domain of well-being.
- 3 *Identifying indicators*: Designing fit-for-purpose and meaningful indicators that reflect how an ecosystem service supply and benefit to the different domains of well-being. Some of the indicators may be appropriate for multiple domains of well-being.

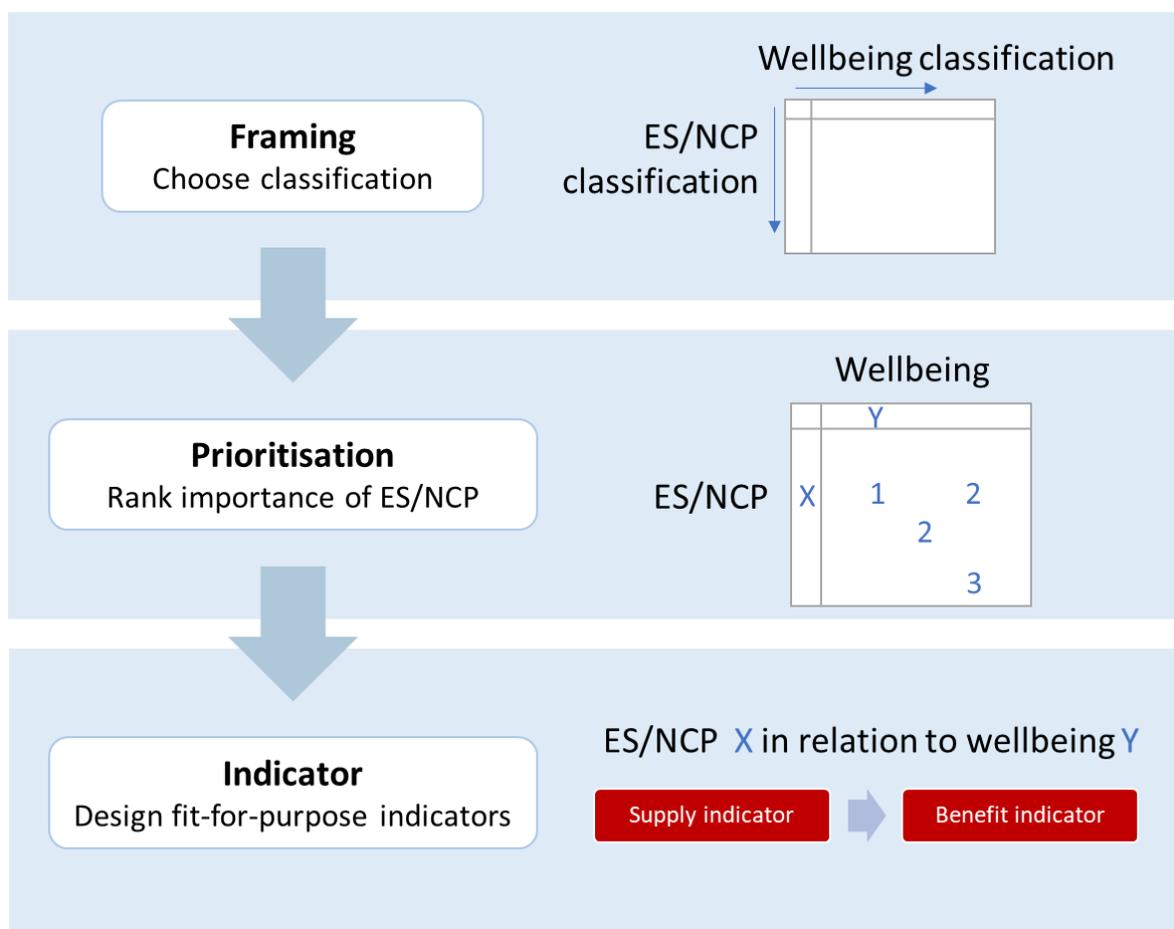


Figure 7. Proposed process to design ES/NCP indicators.

6.1 Framing

In this step, both the ES/NCP classification and well-being classification need to be agreed upon. It is important to choose a classification system for both ES/NCP and well-being to ensure terminology is well understood, and all aspects of both well-being and ES/NCP are well covered. The process we outline could utilise any well-being framework or ES/NCP classification (e.g. MEA or IPBES 2019); it is not dependent on the frameworks and classifications used to demonstrate the application of the process.

6.1.1 Well-being framework

Although many well-being frameworks exist, a review was beyond the scope of this report. Te Puni Kōkiri and the Treasury (2019) and Roberts et al. (2015) provide some useful insights to other ways of framing well-being. In our case, we used the Treasury’s well-being domains from the LSF to retain consistency with the New Zealand government’s current well-being focus. The LSF well-being domains are based on the OECD well-being framework and adapted for the New Zealand context (Fig. 2). Definitions of each well-being are described in Table 6.

Table 6. Well-being framework and definitions used by the Treasury (Treasury 2019)

Domains of well-being	Definition
<i>Quality of life well-beings</i>	
Health status	Our mental and physical health
Time use ³	The quality and quantity of people’s leisure and recreation time (that is, people’s free time where they are not working or doing chores)
Knowledge and skills ⁴	People’s knowledge and skills
Social connections	Having positive social contacts and a support network
Civic engagement and governance	People’s engagement in the governance of their country and their civic responsibilities, how ‘good’ New Zealand’s governance is perceived to be, and the procedural fairness of society
Environmental quality	The natural and physical environment and how it impacts people today
Safety and security	People’s safety and security (both real and perceived) and their freedom from risk of harm and lack of fear
Subjective well-being	Overall life satisfaction and sense of meaning and self
Cultural identity ⁵	Having a strong sense of identity, belonging, and ability to be oneself, and the existence value of cultural taonga

³ Work-life balance in the OECD better life

⁴ Education and skills in the OECD better life framework

⁵ Not present in the OECD better life framework.

<i>Material conditions</i>	
Income and consumption ⁶	People's disposable income from all sources, how much people spend and the material possessions they have
Jobs and earnings	The quality of people's jobs (including monetary compensation) and work environment, people's ease and inclusiveness of finding suitable employment, and their job stability and freedom from unemployment
Housing	The quality, suitability, and affordability of the homes we live in

6.1.2 ES/NCP framework

There are several options that have been developed internationally for ES/NCP classifications, including the Millennium Ecosystem Assessment, the IPBES and the Common International Classification of Ecosystem Services (CICES) developed for natural capital accounting purposes. All three classification systems have some level of corresponding categories (Appendix 4) although the CICES is the most detailed one.

Our process is demonstrated using the MEA classification for provisioning, regulating and cultural services (Table 7), with the addition of one supporting service (creation and maintenance of habitat) to ensure equivalence with the IPBES classification. Results can be shown using the IPBES terminology from the equivalence table in Appendix 4.

Table 7. Ecosystem services classification used in this report, modified from the MEA (2005) and IPBES (2019)

Service	(Sub-category)	Definition	Examples
REGULATING SERVICES – the benefits obtained from an ecosystem's control of natural processes			
Erosion control	Role plants play in soil retention		Trees/forest on hills and mountains reduce mass-movement erosion Plants on dry-lands and agricultural lands reduce surface erosion
Natural hazard regulation (Storm protection)	Degree to which ecosystems reduce damage caused by natural hazards		Mangrove protection against tidal surges Riparian margins and green buffer areas protect against river floods Coastal dunes protect against coastal storms (erosion and flooding)
Water regulation (timing and volume of water flows)	Influence ecosystems have on the timing and magnitude of water runoff, flooding, and aquifer recharge (particularly in terms of the water storage potential of the ecosystem or landscape)		Permeable soils facilitate aquifer recharge River floodplains, lakes, wetlands, and forests have water storage capacity that ameliorate flood peaks and low water levels

⁶ Income and wealth in the OECD framework

Service	(Sub-category)	Definition	Examples
Air quality regulation		Influence ecosystems have on air quality by either emitting chemicals to the atmosphere (reducing air quality) or extracting chemicals from the atmosphere (increasing air quality)	Weather, geography and vegetation all influence air quality (e.g. vegetation can help filter air pollution in urban areas) Forest fires emit pollutants
	Local and regional	Influence ecosystems have on local and regional temperature, rain, winter, frost frequency, and other climate factors	Influence of vegetation on temperature in urban areas Influence of vegetation on regional and local precipitation, wind, temperature, and frost frequency
Climate regulation	Global	Influence ecosystems have on the global climate by emitting greenhouse gases or aerosols to the atmosphere, or by absorbing greenhouse gases or aerosols from the atmosphere	Livestock greenhouse gas emissions (methane) Nitrous oxide emissions from pastoral systems Soil capture of and storage (soil carbon) of carbon dioxide and methane Forest and marine ecosystems (seaweeds, kelp...) capture and storage of carbon dioxide
			Managed bees are used to pollinate fruits and crops Many wild native pollinators (bees, beetles, flies, butterflies, moths, bats, birds, etc.) pollinate crops and native species
Pollination		Role ecosystems play in transferring pollen between male and female plants	
Water purification & waste treatment		Role ecosystems play in filtering nutrients, heavy metals, and pollutants in water	Soils absorb phosphorous and heavy metals, assimilate nitrogen, and deactivate and decompose endocrine disruptors
		Role ecosystems play in decomposing organic wastes and recycling them (taking up and detoxifying compounds through soil and subsoil processes)	Wetlands remove pollutants from water by trapping metals and organic materials Soils degrade organic waste such as animal dung and urine
Biological control		Influence ecosystems have on the amount of crop and livestock pests and diseases	Pest predators in natural ecosystems enhance pest control on nearby farms. For example, lady bugs prey on aphids
		Bio control agents and pathogens limit the need for chemical interventions	
Disease regulation		Influence that ecosystems have on the incidence and abundance of human pathogens	Plants, animals and soils can prevent agricultural runoff (e.g. dung beetles), minimise spread of cattle-borne diseases such as campylobacter, salmonella, cryptosporiosis, and E. coli, etc.
		Bio control agents and pathogens limit the need for chemical interventions.	Undisturbed vegetation can minimise the abundance of disease carrying insects abundance (e.g. mosquitos and ticks carrying Ross river virus, dengue fever, etc.) by minimising breeding sites

Service	(Sub-category)	Definition	Examples
CULTURAL SERVICES – the non-material benefits people obtain from ecosystem services			
Recreation and ecotourism		Recreation undertaken in nature, including tourism sector business and tourist activities that rely on natural or managed ecosystems	Walking, tramping, hunting, biking, kayaking, camping, touring, fishing, surfing, boating etc.
Ethical and spiritual values		Aesthetic, spiritual, religious, cultural heritage values, social relations, sense of place, cultural diversity that people attach to ecosystems, landscapes or species	Sense of belonging by those people who associate themselves with a place, a landscape, or a natural feature (river, mountain) Spiritual connection, creative art and fulfilment derived from sacred lands and rivers
Inspirational & education values		Information people get from ecosystems that are used for intellectual development, culture, art, design, and innovation. Includes inspiration, education, and knowledge systems	The structure of tree leaves has inspired technological improvements in solar power cells School field trips to nature reserves help teach scientific and research skills
PROVISIONING SERVICES – the goods or products obtained from ecosystems			
Food	Crops	Cultivated plants for use by people or animals	Vegetables, fruits, grains
	Livestock	Animals raised for domestic or commercial consumption or use	Dairy cattle, beef cattle, sheep deer, pigs, chickens
	Capture fisheries	Wild fish captured through trawling and other non-farming methods	Hoki, Mackerel, Oreo, Snapper
	Aquaculture	Fish, shellfish, and/or plants that are bred and reared in ponds, enclosures	Green lipped mussels, Pacific Oysters, King Salmon
Fibre	Timber and wood	Products made from trees harvested from forest ecosystems, plantations, or non-forested lands	Wood/logs, wood pulp, paper
	Other fibres	Non-wood and non-fuel-based fibres sourced from the environment	Wool, possum, alpaca, harakeke flax, leather, hemp
Freshwater		Inland bodies of water, groundwater, rainwater, and surface waters for household, industrial, and agricultural uses	Freshwater for drinking, cleaning, cooking, cooling, industrial processes, stock water, electricity production, or mode of transport
Fuel/energy		Sources of fuel derived from plants and animals	Wood (various) Biofuel production (e.g. tallow and used vegetable oils)
Wild foods		Plant and animal food sources gathered or caught in the wild	Seafood (fish, whitebait, crayfish, shellfish), freshwater fish (trout, eels), deer, goat, pig, game birds, rabbits, tahr, water cress, indigenous plants
Ornamental Resources		Products from nature that serve aesthetic purposes	Wood and stone used for carving Traditional Māori use of wood for production (e.g. Kauri for building canoes, weapons, etc.)

Service	(Sub-category)	Definition	Examples
Biochemicals, natural medicines, and pharmaceuticals		Medicines, biocides, food additives, and other biological materials derived from ecosystems for commercial or domestic use	Fertiliser production; natural medicines (hemp seed oil, colostrum, enzogenol, deer velvet, etc.) and Rongoa – Māori medicinal use of plants (e.g. karaka, kawakawa, harakeke)
Genetic resources		Genes and genetic information used for animal breeding, plant improvement, and biotechnology	All animal and plant species and their diversity, represent the genetic resources of New Zealand (e.g. potential for marine species to be developed for medicine) Introduced plant species have been bred to develop new horticultural crops
Biochemicals, natural medicines, and pharmaceuticals		Medicines, biocides, food additives, and other biological materials derived from ecosystems for commercial or domestic use	Fertiliser production; natural medicines (hemp seed oil, colostrum, enzogenol, deer velvet, etc.) and Rongoa – Māori medicinal use of plants (e.g. karaka, kawakawa, harakeke)
Habitat creation (IPBES NCP1) and maintenance of options (IPBES NCP18)		The formation and continued production, by ecosystems, of ecological conditions necessary or favourable for living beings important to humans Capacity of ecosystems, habitats, species or genotypes to keep human options open in order to support a later good quality of life	Extent of suitable habitat, biodiversity intactness

6.2 Prioritising ecosystem services or NCP

We separated the questions into two basic elements:

- what is the nature and extent of impact an ES/NCP has on well-being, depending on the diverse group of people?
- how substitutable is an ES/NCP contribution to each domain of well-being?

We found that these questions were important considerations as they reflect whether and how an ecosystem may deliver benefits to people and the value of these benefits. Substitutability for instance, is a key element that has already been suggested by several authors as influencing or mediating the importance of ES/NCP to well-being (Garibaldi et al. 2019; Mandle et al. 2020). Vulnerability to change is another element that needs to be considered and requires to think about different groups in the community.

The following questions were used to guide the discussion on how people think about prioritising ecosystem services:

- For impact (nature and extent) of an ecosystem service:
 - Does the [ES/NCP] impact on people's (depending on community of people e.g. city dwellers, farmers, etc.) [well-being domain] directly or indirectly and what is the size of that impact (small/large)?
 - What is the extent of that impact or how many people are vulnerable to changes (based on number of regions or population)?

- For the substitutability of an ecosystem service:
 - Is there a substitute for the [ES/NCP] that is important for the [well-being domain]?
 - If yes, is it a cost-effective substitute or a similar alternative option?

A scoring system (Table 8) was developed to facilitate the ranking of ecosystem services in terms of their importance for each well-being domain. The system reflects the questions on nature, extent and substitutability described above. This scoring system would be used for each ecosystem service and well-being domain.

Table 8. Scoring system for prioritising the importance of each ecosystem service for each well-being domain

Rating	Impact I = N + max(E, P)		Substitutability S = T or A		
	Nature of the impact (N)	Extent of impact		Technological substitutes – how hard and costly is it to fix? (T)	Alternative options similarity and how far away (A)?
		Spatial extent of Impact (E)	Size of the impact – population affected (P)		
1	No importance	1–3 regions	Population nbs per region – see Appendix C <10%	Low cost and individuals can pay (private costs)	Many alternative options available of similar quality (or experience) within close proximity
2	Indirect and small	4–6 regions	10–30%	Communities or user groups can pay (private costs)	Some alternative options available of differing quality (or experience) within proximity
3	Indirect and big	7–10 regions	30–50%	Regional Councils can pay (public cost)	Some alternative options available of similar quality some distance away
4	Direct and small	11–13 regions	50–75% affected	Needs central government intervention (public cost)	Some alternative options available but of different quality (or experience) some distance away
5	Direct and big compared with national	14–16 regions	>75% population affected	Not affordable and no technology	No alternative options available

The scores for impact and substitutability are then used to help decide whether an ecosystem service should be prioritised for a well-being domain and an indicator(s) identified.

Several options for aggregating the scores and prioritising the importance of an ecosystem service for a well-being domain are outlined below:

Pre-defined matrix

Table 9 provides a matrix that can be used to prioritise the ecosystem services. As examples, if a service scores a 5 for impact and a 5 for substitutability then it would be prioritised and included as an ecosystem service to identify an appropriate indicator. If the impact is scored a 3 and substitutability a 1 then it is not considered important and would not be prioritised. If impact was a 1 and substitutability was a 3 then the ecosystem services is a maybe. In this last instance, the decision on whether this ecosystem service should be prioritised would involve a conversation with stakeholders (or similar) to make the final decision on its inclusion in the priority list for that well-being domain.

Table 9. Guide for using the scores to decide if an ecosystem service should be prioritised

I ↓ S →	1	2	3	4	5
1	No	No	maybe	maybe	Yes
2	No	No	maybe	maybe	Yes
3	No	No	Yes	Yes	Yes
4	No	No	Yes	Yes	Yes
5	maybe	maybe	Yes	Yes	Yes

Percentile approach

For the percentile approach the impact and substitutability scores are aggregated to form a total score. We equally weighted the impact and substitutability scores, but other weights could be used to suit a specific context. The percentiles chosen will determine the cut-off points for whether an ecosystem service is prioritised for a well-being domain. The percentiles can be derived from the frequency distribution of the scores.

Threshold approach

The threshold approach is like the Percentile approach except that the thresholds are chosen by the group undertaking the prioritisation process. The thresholds could be based on the importance the group attaches to the score descriptions.

In our test, and for simplicity, we used the pre-defined matrix to determine whether to categorise the ecosystem services indicator relevance as high (yes), medium (maybe) or low (no) priority.

6.3 Identifying well-being indicators

The level of details to categorise indicators varies depending on which framework has been chosen to monitor progress (Fig 8). MfE and StatsNZ draw on indicators for the three categories pressure, state and impact in environmental reporting. The EU has subcategories for the equivalent state with condition and extent indicators. IPBES has a complex line from potential, realised NCP and output but have used a single indicator per Nature's Contribution to People (NCP) to report on the Global Assessment. That complexity reflects the many mediating factors affecting the relationship between nature

and people, e.g. the existence of anthropogenic infrastructure, vulnerability of communities to change, availability of substitutes and the ability of beneficiaries to access the ES benefits (Mandle et al. 2020).

Given the literature, and for simplicity, we split the impact indicators into:

- **Supply indicators:** indicators related to the biophysical potential of a system to produce a given benefit. This includes the notion of accessibility whereby an ecosystem service is only considered to be supplied to people if it is also accessible to people (even if it is not necessarily used by people).
- **Benefit indicators:** indicators related to a beneficial or detrimental change to human well-being. It reflects the relevance of an ecosystem service to people, highlighting the actual use of an ecosystem service. It also includes the notion of substitutability, whereby the benefit from nature may be substituted by other anthropogenic assets (e.g. the water purification service provided by plants and soil could be undertaken by wastewater treatment plants).

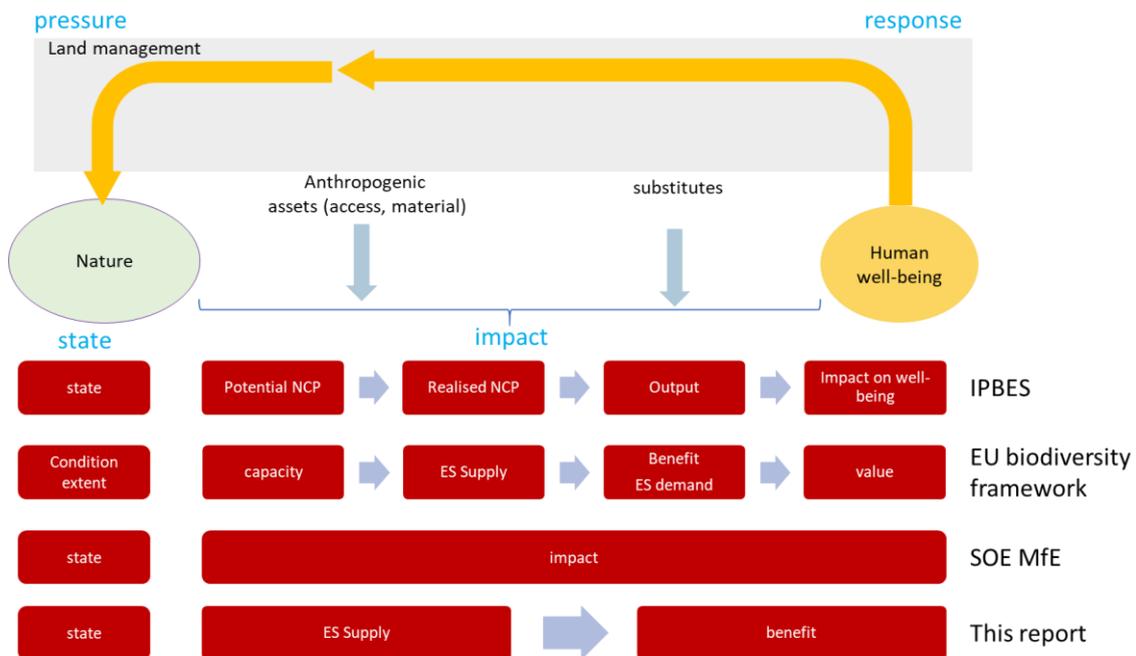


Figure 8. Proposed framing for natural capital and well-being indicators.

The indicators should reflect how an ES/NCP relates to the well-being component (i.e. use fit-for-purpose indicators), and how it affects different groups in the community. There may also be some ES/NCP indicators that are appropriate for multiple well-beings. For instance, to ensure the correct supply and benefit indicators are designed, each combination of ES and well-being domain should be examined, with questions such as:

- For supply: for this ES-WB in consideration, which indicator(s) best represent how much ES is provided and accessible to people?
- For benefit: for this ES-WB in consideration, which indicator(s) best represent how much people benefit from the ES?

To help with the design of supply and benefit indicator, it is also important to reflect on which natural system (air, land, marine or freshwater) is either a provider of the ES, or a receiving environment. This will ensure linkages with state indicators. For instance, air regulation as an ES is provided by vegetation through cleaning processes, but it is the state of the air that will change because of the provision of that service. It is also important to think about the ES in the context of each well-being domain, especially when reflecting on benefit indicators. In the context of health, for instance, benefit indicators would include a reduction in air-borne disease thanks to air regulation.

7 Testing the prioritisation and indicator design

7.1 Workshop with key stakeholders

Ideally, the prioritisation of ES/NCP for each well-being domain and the subsequent identification and design of indicators is undertaken by a group of experts/stakeholders. This will ensure the process is well understood, defensible and most importantly incorporates and considers a wider range of viewpoints.

The prioritisation and indicator identification components of the process, outlined in section 6.2 and 6.3, were tested with government stakeholders during a workshop (see Appendix 5 for details) in February 2020. The 18 Participants came from MfE, DOC, MPI, StatsNZ, Treasury, PCE, and MWLR.⁷ The process was tested using the Subjective Well-being domain and Health domain across three ES/NCP (Table 10). The three ES/NCP represented one of each main category of provisioning, regulating or cultural ES and were chosen arbitrarily as ES/NCP of interest for health or subjective well-being. Time constraints meant that some groups only assessed two ecosystem services for their assigned well-being domain.

The prioritisation and identification of indicators processes were tested by the research team before the workshop for the Health and Subjective Well-being domains across several ES/NCP. The scoring results from testing the prioritisation process are indicated in the quantitative results below. Qualitative results from testing the prioritisation and identificatory of indicators processes are discussed as well.

Table 10. Proposed ecosystem services and well-being domains tested during the workshop

Ecosystem service	Health domain	Subjective Well-being domain
Regulating	Air quality	Climate regulation
Cultural	Ethical and spiritual	Recreation & tourism
Provisioning	Drinking water	Food

⁷ One participant from MfE could only contribute to the prioritisation process and another from Treasury could only participate in the identification of indicators process due to their individual time constraints. Observations from these individuals are included in the analysis.

7.1.1 Challenges and observations from the prioritisation process

Prioritising the importance of each ecosystem service for a well-being domain was determined from participant's impact and substitutability scores. The detailed results presented in Appendix 5. Overall, participants believed all selected ecosystem services contribute directly to health and subjective well-being. For health, they found there are few or no substitutes for any of the ecosystem services. For subjective well-being, participants debated whether there were substitutes for recreation and tourism and food ecosystem services, but agreed there was little substitute for climate regulation.

Comments about the process – nature of the impact

Participants were asked to write down their thought processes used to determine scores. For most ecosystem services, participants used the language from the scoring system ('indirect/direct', 'big/small', see Table 8) to describe their thinking. For some of the ES-WB combinations, participants used other language to describe the relationship. For example, some language referred to timing (e.g. 'impact health temporarily') or feelings (e.g. relieving /influencing 'anxiety' or 'fears' and impact on 'mental health').

Participants described the nature of impact of ethical and spiritual, recreation and tourism, and climate regulation through the lens of mental health, and noted that while this connection is important, it may or may not be direct and is probably dependent on the experiences of a specific group, 'e.g. Māori, trampers, gardeners'.

However, despite relative agreement that recreation and tourism have a direct impact on subjective well-being (a score of 4 or 5), there was disagreement as to the scale of that impact (small or large). One respondent who gave a rating of 4, said that they did not think a rating of 5 was appropriate since recreation was not 'fundamental to livelihood' even if it was 'central to enjoyment'.

The nature of the impact for both provisioning services (drinking water and food) seemed to be agreed by most participants, although the magnitude of the impact of drinking water on health was debatable even if it was 'necessary for life'.

A few participants pointed out another dimension on the potential vs actual nature of the impact. For instance, while air quality and climate regulation have a 'direct' impact, the effects of air quality were 'varied because particulates are not an issue in New Zealand' and climate regulation was a signal to people to be 'more optimistic about the future'.

Comments about the extent of impact

Participants were mostly in agreement that the extent of impact on subjective well-being and health concerned at least 75% of the population. However, there was some disagreement on the extent of the impact ethical and spiritual services have on health and climate regulation has on subjective well-being, ranging from half to three-quarter of the population depending on specific populations, e.g. Māori, tourists, or the individual.

Reasons for some discrepancies concerned debates for local vs regional issues. For instance, participants described the extent of the impact of air quality regulation on health in terms of regions, urban or rural, 'local issues', and cities. One participant commented that since air quality regulation was a 'local issue' but impacted 'everyone' a high rating was more appropriate. Almost all participants said that the recreation and tourism ecosystem services impacted nearly everyone's subjective well-being (rating of 5 for extent of the impact). However, participants also noted that the extent of impact could be highly variable depending on urban or rural locations, and issues about 'travel costs and personal mobility'.

Of the participants who gave a medium rating for the extent of the impact of air quality regulation on health, comments from two participants mirrored the descriptions of the ratings, e.g. 'urban only part of 8 regions'. The comments from participants who gave a high rating of 5 were less clearly related to the descriptions for the scoring. For example, one participant thought that since 'most ecosystems produce some pollen or filter some pollutant' a rating of 5 would be most appropriate.

Mirroring language used in the comments for the nature of the impact, participants described the various groups who would be impacted by the relationship between ethical and spiritual ecosystem service and health, e.g. Māori, tourists. Participants who specified groups who are impacted tended to give lower ratings (2 or 3) which reflected the scoring system, i.e. 20–30% of population has a rating of 2 or 3. However, for some participants there was a disconnect between the comments and the final rating given, e.g. 15% translated into a rating of 5, or little to no contextualising comments for the final ratings, e.g. '4 or 5 population affected'.

Comments about the substitutability or alternatives

Most participants also thought there were no substitutes for 'natural air', but people could seek better air if they moved somewhere else or took medicines (e.g. 'for allergies'), or local air could be improved by changing 'user density', incentivising 'electric cars', or changing 'transport corridors'. Three of the participants were unsure about the exact substitutability of air quality regulation and gave a range of scores (3–5). These individuals thought that while alternative options were somewhat low, or people could 'move elsewhere', a technological substitute was either 'expensive' or non-existent. After factoring in these ranges, air quality regulation was still considered a priority.

Overall, participants thought there were 'some alternative options' for different 'elements' of the ethical and spiritual ecosystem service, but alternatives would be highly subjective, depending on the user. Several participants also said that the ecosystem service may be somewhat substitutable over time as 'attitudes', 'attributes/beliefs', and people's minds change. This language, consistent with language used in the nature of the impact and extent of impact described above, led participants to give a final rating of 4 or 5.

There was some disagreement between participants about whether there were alternatives to provisioning of drinking water and/or there existed a technological substitute. Some participants who gave a rating of 5 said that there were 'other sources' such as 'salt water', while other participants who gave the same rating said there were no substitutes that did not require 'significant capital investment'. Additionally, a participant who gave a rating of

4 said that while there was a technological substitute for the ecosystem services, e.g. 'water treatment plant', there may be no alternatives as 'drought may limit supply [of water]'.

Participants thought that technological substitutability/alternatives for recreation and tourism for subjective well-being were highly varied, e.g. 'In theory could...travel overseas at high cost' (rating of 4), 'lots of likely options elsewhere but...accessibility important' (rating of 2), and 'emotional, perceptive (unique)' (rating of 3). Additionally, most participants appeared to have difficulty settling on a final substitutability rating because while there are alternative recreation locations and activities or technological substitutes, e.g. VR and indoor ski fields, these substitutes could be very personal and may be inadequate for some people. One common theme across participants who gave a lower rating was the listing of possible alternatives and whether different groups might consider these sufficient substitutes.

However, participants did not think there were alternatives or substitutes for climate regulation. The only likely substitutes would be a public cost and provide a different quality of climate regulation (rating of 3).

Outcome of prioritisation exercise

While most participants gave definitive impact and substitutability scores, some participants were more uncertain and gave a range of possible scores. For most participants, these score ranges did not influence whether the ecosystem service was a priority (Dark green in Fig. 9), might be a priority (Yellow) or was not a priority (Red). When the score ranges did influence whether the ecosystem service was a priority, the participant's final prioritisation score was classified as might be a priority (Light green to Orange).

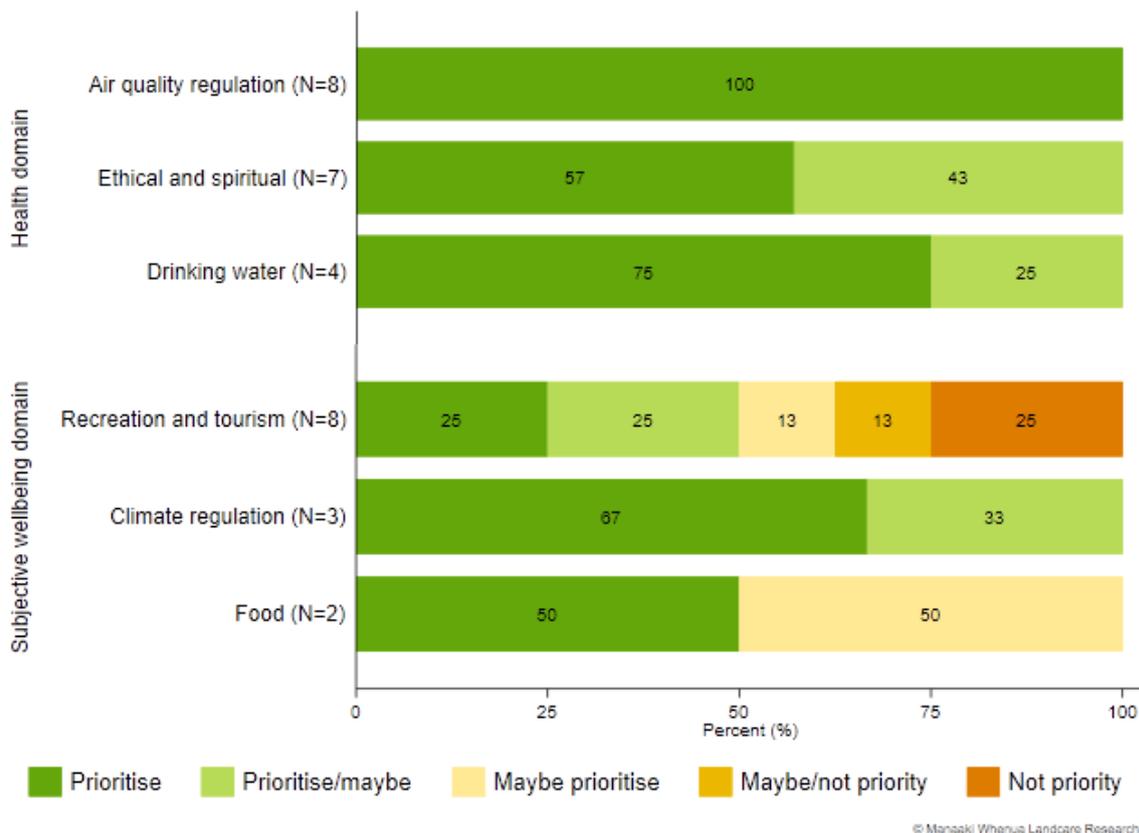


Figure 9. Final outcome from workshop participant’s scores determining whether the ecosystem service should be prioritised for identifying indicators as they relate to the Health or Subjective well-being domains. See Tables 8–9 for matrix of ratings used to determine prioritisation outcome.

Health domain

All participants thought that air quality regulation should be prioritised for identifying indicators related to the health domain, while most participants thought that ethical and spiritual (57% of participants) and provision of drinking water (75% of participants) should be prioritised for identifying indicators related to the health domain. In general, there was consensus that these ecosystem services have a direct impact on health; however, whether the ecosystem services should be prioritised for identifying indicators related to health was more heavily influenced by the substitutability of the ecosystem service (for air quality regulation and drinking water) or the extent of impact of the ecosystem service on health (for ethical and spiritual).

Participants said that, on average, air quality regulation has a direct impact on the health for most of the population and the ecosystem service was not easily substitutable. Limited alternatives and ‘expensive’ or ‘no [technological] substitutes’ meant that air quality regulation was considered a priority for identifying indicators.

Participants said that, on average, ethical and spiritual ecosystem service has a direct impact on health. However, disagreement on the extent of the impact of this ecosystem service on health, e.g. ‘20%? everyone including tourists?’, brought down the average impact/extent score used in the predefined matrix method (Table 9).

Participants said that while, on average, provisioning of drinking water ecosystem service has a direct impact on health, there might be some technological substitutes, such as 'water treatment' plants, that might require 'significant capital investment'. However, even after taking these possible substitutes into consideration, the provisioning of drinking water was still considered a priority for most respondents.

Subjective well-being domain

Most participants thought that climate regulation (67%) and food (50%) should be prioritised for identifying indicators related to the subjective well-being domain.

Recreation and tourism had a wider range of final scores: in general, the prioritisation was heavily influenced by the substitutability scoring. Participants who prioritised recreation and tourism for subjective well-being thought that while there might be some alternatives or technological substitutes, those alternatives would be very personal or might not be accessible to 'many people as frequently due to time/cost' and any technical substitutes may not be adequate for some people. These thoughts led these participants to give a substitutability score of at least a 3, leading to a high priority. The other participants giving a low priority with high substitutability thought there were a range of options, with substitutability being a 'grey scale' or 'very personal', more costly for urban areas, and/or dependent on accessibility and the spatial distribution of those alternatives.

Participants who thought that climate regulation has a direct impact on subjective well-being also tended to also think that the ecosystem service impacted everyone's subjective well-being and there were 'no alternative options'. Additionally, one of these participants gave a much lower substitutability score without further explanation, meaning the final priority score was lower for this participant. However, due to time constraints there were few supporting comments.

Unfortunately, time constraints of the workshop prevented participants from engaging in discussion of food provisioning for subjective well-being. However, the few comments showed that technological substitutes for food had a large range of interpretation. There was talk about 'lab food' and how loss of food provision could be overcome by 'industry farming'. This thought process meant that identifying indicators for food provisioning was less of a priority.

7.1.2 Challenges and observations from the identification process

Several indicators were identified by workshop participants to represent the relationship between an ecosystem service and well-being domain (Table 11). The indicators identified did not consider data availability; rather they identified what was the most appropriate indicator to reflect the relationships. The indicators aimed to cover state, ecosystem service supply and ecosystem benefit indicators.

Several challenges and observations were noted with the process of identifying relevant indicators:

- State and supply indicators can be difficult to separate as it can be challenging for participants to conceptualise the difference between a stock (e.g. forest carbon stocks) and a flow (e.g. carbon sequestration).
- Supply indicators should also reflect access to ecosystem service flows. For example, natural ecosystems may purify water and improve water quality in streams. However, in the recreation context, the supply indicator(s) would not only capture whether streams were swimmable (good water quality and safe flows) but also whether they were accessible, which relates to road/stream access. The benefit indicator would then reflect the extent to which people are using specific parts of a stream for swimming.
- Multiple supply and benefit indicators for one ecosystem service could be used to describe the relationship between the beneficiaries (who is benefiting from an ecosystem service) to the multiple types of supply from ecosystems (e.g. streams where people swim and forests where people tramp).
- Causality may be misinterpreted and lead to incorrect connections between ecosystem service supply and effect on well-being. For instance, weight of evidence may be weak in linking human health outcomes to supply of ecosystem services and should be investigated (de Jesus Crespo & Fulford 2018).

Table 11. Indicators identified during the workshop

Ecosystem service	Relevant state indicator	Relevant supply indicator	Relevant benefit indicator
<i>Health domain</i>			
Air quality	Condition of the land: vegetation, greenspace, species distribution, Condition of the air: air circulation patterns	Indicator related to ability of nature to provide clean air for health Vegetation/greenspace, wind, meteorological data Temperature inversion Filtration capacity of vegetation Negative contribution: pollen from trees, occurrence of wildfires Cropping development time	Indicator related to the health benefit people get from clean air Health statistics on respiratory related illnesses (asthma) Distance to allergens Depends on availability of substitutes (air cleaning infrastructure)
Ethical and spiritual	Condition of all ecosystems	Condition and preservation of culturally significant sites	Surveys on mental health and what nature means to people
Drinking water	Quality and quantity of water	Indicator related to ability of nature to provide clean water for health	Indicator related to the health benefit people get from clean water
<i>Subjective well-being domain</i>			
Recreation & tourism	All ecosystem types (Freshwater, land, mountains, etc.) Condition and extent of indigenous vegetation Water quality Biodiversity measure Health of marine fish stocks Separate the various activities: on and: walking, cycling, playing. Marine: swimming, fishing, playing (surf, etc). Freshwater: swimming, fishing, playing	Accessibility (roads to recreational spots): number of people within X km of a national park/beach Distance to travel Amount of parkland or reserve per head of population in urban areas Aesthetics Number of swimmable rivers Number of walkable national/regional parks Number of access points	Utilisation of recreational facilities Willingness to pay, satisfaction surveys Number of hours/week a person spend undertaking the defined activity Number of people visiting a place Number of fish caught Days spent tramping in a national park Fitness, energy level Happiness measure NB: Recreation = where I usually spend my time. Tourism: elsewhere
Climate regulation	Biophysical structure of tress, net primary production processes	C sequestration Local cooling Stability of air temperature over time Stability of climate over time	Number of people making decisions about their lives in which a factor is a changing climate
Food	Condition of all ecosystems providing food Soil quality	Biomass growth Provision of food from sustainable production systems	Number of people satisfied about healthy food Fitness and energy levels

7.2 Review of relevance of ES/NCP to well-being

We tested the prioritisation process between three authors⁸ for all ES/NCP and all well-beings from the LSF (Table 12). Each well-being was assigned two team members for pairwise comparison and the thought process was discussed and recorded to support evidence for the scoring (Appendix 6). This assessment, while reflecting the view of three persons only, was supported, where possible, by literature, in particular the review from Roberts et al. (2015).

The pairwise comparison was useful as it allowed the conversation to be enriched by finding new examples or experiences that would support the scoring for nature of importance and substitutability. It also showed reasonable consistency between participants. It became essential, though, to agree on the definitions of both the ES/NCP and the well-being, as various interpretations could lead to wide variations in scoring. Another observation is about separating potential vs actual importance for scoring. Some ES/NCP have been included as part of the prioritisation due to their importance for future risk. For instance, natural hazard regulation is important for safety and security. While the criterion has low spatial coverage (coastal zones and areas at risk of flooding), we decided to include this ES/NCP because of the likelihood of an increase in natural hazards.

By scoring high (2) and medium (1) priority pairs, this matrix shows that environmental quality and cultural identity are the two, main well-being domains relevant to nearly all ES/NCP. Health status is the third well-being domain that would need to be underpinned by ES/NCP indicators, with a narrow set of ES/NCP that would mainly be related to regulating services. On the other hand, cultural ES/NCP such as recreation, ethical, and inspiration are relevant to 6–9 well-being domains, including health, time use, knowledge, environmental quality, and cultural identity. Regulating ES/NCP are also important to a range of well-being domains, in particular regulation of natural hazard, water, air, climate. Provisioning services are less spread across well-being, contributing mainly to cultural identity, income, jobs, housing, and environmental quality.

⁸ All well-beings were assessed by three experts (Anne-Gaelle Ausseil, Pam Booth, and Suzie Greenhalgh). Cells with a red asterisk reflect results from the stakeholder workshop.

Table 12. Relevance and scoring of ES/NCP against the LSF well-being domains⁹

Well-being descriptor	Health status	Time use	Knowledge & skills	Social connections	Civic engagement & governance	Environmental quality	Personal security	Subjective well-being	Cultural identity	Income & wealth	Jobs & earnings	Housing	Total
Erosion control													2
Natural hazard regulation													9
Water regulation													5
Air quality regulation	*												4
Climate regulation								*					7
Pollination													1
Water purification													5
Biological control													2
Disease regulation													3
Rec. & Ecotourism								*					9
Ethical & spiritual	*												8
Inspiration & education													6
Food								*					6
Fibre													5
Wild food													3
Freshwater	*												4
Biochemical, natural medicines and pharmaceuticals													2
Fuel and energy													1
Ornamental resources													2
Genetic resources													3
Habitat creation and maintenance													8
Total (number of high or medium)	13	6	5	1	6	17	2	8	15	9	8	5	

High score – first priority list for indicators
Medium score – second priority list for indicators
Low score – low evidence of relationship between ES/NCP and the well-being domains.

⁹ All well-beings were assessed by three experts (Anne-Gaelle Ausseil, Pam Booth and Suzie Greenhalgh). Cells with a red asterisk reflect results from the stakeholder workshop.

8 Application

This project was initiated to help build understanding and capability at the science policy interface. It became apparent, however, particularly as the COVID-19 pandemic affected New Zealand, of the deficit of evidence to underpin conversations across government on the connection between nature and human well-being. The project was therefore useful in providing some emerging and conceptual evidence and these early-stage applications of the are briefly outlined in this section (Fig. 10).

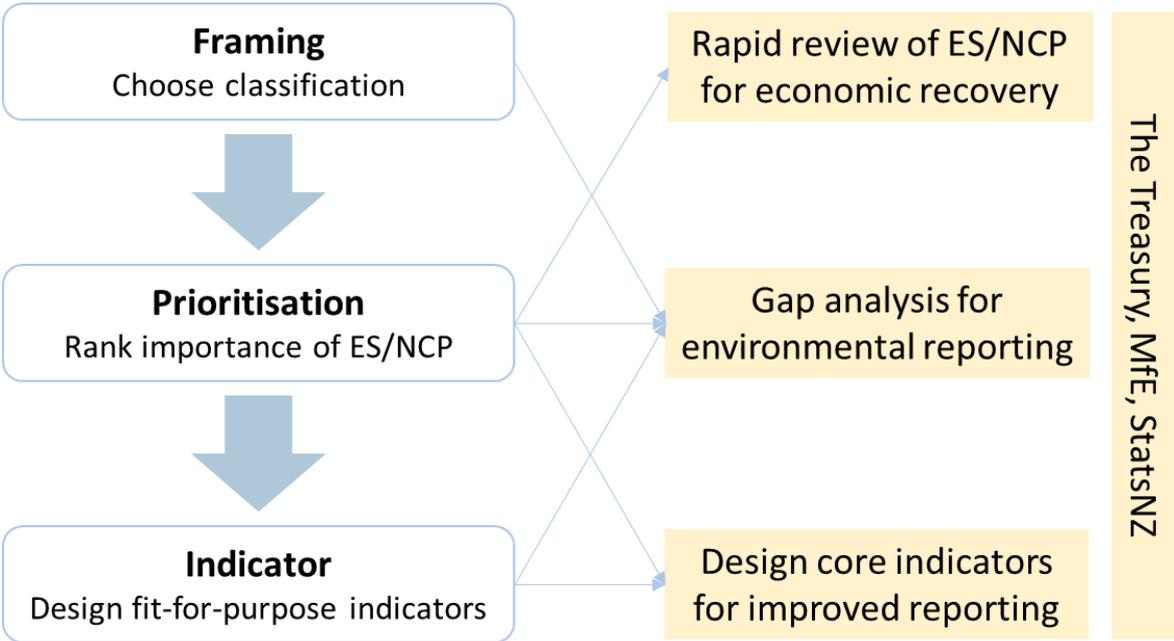


Figure 10. process steps relevance to some application.

8.1 Rapid review of nature’s contributions to people in post-COVID19 economic recovery initiatives

The economic recovery from COVID-19 has necessitated rapid refocusing of investment decisions. Despite the urgency, it is important decisions on short-term (economic) gain do not have unintended consequences or bring with them longer-term costs to nature and well-being.

To assist with economic stimulus decisions, some of the broad-scale relationships between different ES/NCPs and well-being supported were used as a ‘checklist’ to assess decisions and track longer-term impacts. The rationale for considering nature was to avoid the depletion of nature, and the unintended consequences on our well-being (Alison Collins, pers. Comm). Taking a step further, there were also opportunities to look at building resilience by including environmental impacts/improvements in decision-making processes. This would better preserve the choices available to future generations, particularly if green infrastructure approaches were used.

Incorporating nature within efforts to manage the impacts of COVID-19 and plan for recovery was challenging, given nature is often a minor component of existing analytical and planning frameworks. The approach developed during this project aimed to better show the link between nature and human well-being, providing preliminary evidence via expert knowledge (Anne-Gaelle Ausseil & Alison Collins), a rapid review of the scientific literature, and drawing on the ES/NCP and well-being process under development. This involved mapping the linkages between the ES/NCPs and the Living Standards Framework well-being domains and drew heavily on Roberts et al. (2015) which used Max-Neef's matrix of 'needs and satisfiers'.¹⁰

Given ES/NCPs make different contributions to well-being, this analysis brought to light several important and relevant themes that may assist COVID-19 recovery, including:

- Material (and non-material) ES/NCPs are essential for backbone economic activities (e.g. material NCP from indigenous vegetation is the production of honey from mānuka, which has increased in export value since the beginning of the pandemic (<https://www.mpi.govt.nz/dmsdocument/42360-New-Zealand-honey-exports>). Material (and non-material) ES/NCPs are important for many of our economic sectors such as tourism, agriculture and commodity exports, and the screen industry.
- Regulating ES/NCPs are essential for our health and personal security – ensuring clean air and water, healthy soils and the decomposition of waste. They also indirectly affect the material dimension of well-being by, for example, mitigating erosion and flooding and thus reducing the costs of erosion and flood damage.
- Non-material ES/NCPs are essential for our mental health, cultural identity, and social cohesion and will be important for community and individual resilience for COVID-19 recovery
- 'Maintenance of options' is a longer term and fundamental NCP and includes 'Nature's Contribution to Adaptation'. It reflects the value of maintaining and investing in natural capital to keep options open for future generations, build resilience to future shocks (e.g. financial crisis, future pandemics, natural disasters), as well as adaptation to climate change.

A high-level mapping of ES/NCP to well-being shows that the dependency on ES/NCP for COVID-19 recovery initiatives is variable. The initial, shorter-term needs would depend on those ES/NCPs that underpin high priority dimensions of human well-being such as economy and health. However, over time a wide range of well-being dimensions will increase in importance (such security and social relationships, freedom of choice and action), as these are needed for longer-term economic and social resilience. On-going investment in natural capital will be necessary to ensure the continuity of ES/NCP into the future.

¹⁰ Note: the well-being framing used, Max Neef's matrix of needs and satisfiers, differs from the OECD and Treasury's framework of well-being dimensions.

Green or 'natural infrastructure' provides additional opportunities to meet the nation's immediate economic recovery needs as well as build future resilience. While much of the literature in the green/natural infrastructure space often focuses on urban environments (e.g. low impact urban design) the opportunities are wider and rely on the ES/NCPs provided by nature and long-term sustainability of economic recovery for natural capital.

8.2 Environmental reporting gap analysis

Our review of MfE environmental reporting indicators and their relevance to assessing the condition of and trends in ES (Table 13) showed most environmental reporting indicators related to state indicators instead of ecosystem service supply and benefits.

The current environmental reporting indicators only directly related to six (out of 21) ES/NCPs supply indicators. There was a bigger gap in the benefit indicators where only five out of 18 ES/NCP were partially represented by the current indicators.

The provisioning services are better represented by the information collected through environmental reporting initiatives and other indicators routinely collected in NZ (e.g. StatsNZ production statistics) than the regulating and cultural services. This is consistent with other ecosystem services assessments (Malinga et al. 2015; Maes et al. 2016) where regulating and cultural service indicators and data were lacking.

Table 13. Relevance of current and past environmental reporting indicators to supply and benefit of ES/NCP. Indicators in italics are partially relevant

ES/NCP	Relevant environmental reporting pressure indicator	Relevant environmental reporting indicators (state)	Relevant environmental reporting indicators (supply)	Relevant environmental reporting indicators (benefit)
Food and feed		<i>Growing degree days (abiotic)</i> Agricultural and horticultural land use	High-class land for food production Primary productivity State and trends in freshwater fish	Livestock numbers Marine economy
Fibre				
Wild foods				
Freshwater				
Fuel/energy		<i>Sunshine hours (abiotic)</i> Occurrence of Oil and gas and minerals extraction		Value of water resources used for hydroelectric generation
Biochemical, natural medicines & pharmaceuticals				
Genetic resources		Conservation status of native freshwater fish and invertebrates, indigenous land and marine species Active Sand Dune Extent	Indigenous cover and protection in land environments	
Ornamental resources		Wetland extent Freshwater physical and coastal habitat Marine environment Distribution of indigenous trees		
Air quality maintenance		Air quality (multiple measures)	Artificial night sky brightness	Health effects from exposure to PM10
Climate regulation		GHG concentrations and emissions Carbon stocks in forests National temperature time series Sea level rise		

ES/NCP	Relevant environmental reporting pressure indicator	Relevant environmental reporting indicators (state)	Relevant environmental reporting indicators (supply)	Relevant environmental reporting indicators (benefit)
Water regulation	Consented freshwater takes Irrigated land	Groundwater physical stocks Annual and seasonal rainfall Deposited sediment in rivers		
Water purification & waste treatment	Nitrate leaching from livestock	water quality (river, lake, groundwater coastal and estuarine multiple measures) Trends in freshwater fish (state, also a supply for NCP12)		Occurrence of food-and water-borne diseases
Erosion control		Land cover and use Soil quality Estimated long-term soil erosion		
Disease regulation	Marine non-indigenous species			
Biological control				
Pollination		No data		
Natural hazards regulation		Ocean acidification		
Recreation and ecotourism		River, coastal and estuarine water quality (multiple measures)	Bird species on public conservation land	Use of public conservation land Participation in recreational fishing
Ethical and spiritual values		River, coastal and estuarine water quality (multiple measures)		Cultural health index for freshwater bodies
Inspirational and educational values			Bird species on public conservation land	Use of public conservation land Ski-field operating days Participation in recreational fishing
Habitat creation and maintenance		Indigenous cover and protection in land environments Land cover and use (extent)	Conservation status of native freshwater fish and invertebrates, indigenous land and marine species	

8.3 An approach for designing indicators with MfE and StatsNZ

In his 2019 report 'Focusing Aotearoa New Zealand's environmental reporting system', the Parliamentary Commissioner for the Environment (PCE) highlighted the absence of comprehensive and authoritative environmental data, including an evidential link between the state of the environment and well-being. Pushing the environmental reporting programme to connect through to well-being and fill the gap with indicators would support government, businesses, iwi, communities, and the public in being able to prioritise monitoring, reporting and resource management decisions.

As a result, the environmental reporting programme at MfE has been exploring how to expand the set of core measures to demonstrate the connection between PSI and well-being using an ES-based approach. These new data enable a narrative to emerge that not only links pressures from human and natural factors to the state of the natural capital 'stocks', but also links changes in these stocks to changes in the benefits provided to people. These proposed enhancements align with the Government's ambitions to improve the nation's well-being. The Minister of Finance expects well-being to be incorporated into agency planning and performance reporting. MfE and the latest PCE review acknowledged that the current set of indicators are not sufficient, with few impact indicators reflecting the relation between ecosystems and people's well-being.

MfE is interested in developing ecosystem services indicators that can be sustainability measured and maintained. To develop a robust set of indicators should involve a participatory approach with relevant stakeholders to foster ownership and continued use of the indicators. Stakeholder participation can help to determine the intended use of the indicators. Using an agreed set of criteria, or principles such as those from Breslow et al. (2017; Table 14) can help identify appropriate indicators.

Table 14. Screening criteria to evaluate indicators for human well-being (modified from Breslow et al. 2017)

Screening criteria for indicator evaluation	Categories
General criteria	conceptually valid, environmental linkage, social indicator, understandable, measurable, conforms to rules for good scales
Context-specific criteria	geographically relevant and comprehensive, socially relevant and comprehensive, relevant for decision-making context, sensitive and responsive to change
Data considerations	data availability, variable measured, spatial scope, temporal scope, level of data disaggregation
Suite consideration	objective or subjective, units of social organisation, leading or lagging, broad or specific reflection of human well-being
Project considerations	methods used, estimated cost, potential harm to people, collaboration with populations whose well-being is being measured

The Living Standards Dashboard uses information provided by StatsNZ and the assessment of New Zealand's well-being only data on a limited set of indicators is available and being used. A prioritisation process as outlined in this document could be used to identify a set of headline indicators and the justification for their choice. Additional indicators of lower priority could still be monitored but not routinely reported. This will provide a baseline for their use in future years should the need arise.

9 Discussion

9.1 Challenges and opportunities

Our process provides a structured and co-produced approach to developing indicators that better describe the relationship between people and nature

The process we proposed involves co-production at each step. In all, conversation between participants and discussion were found to be as important as the outcome of the process. Discussion about the ES/NCP and well-being framing enabled people to think about terminology and the definitions needed to ensure a common language was understood by all participants. The prioritisation process also prompted discussions around the differing views on the importance of nature to different aspects of human well-being. The process also highlighted the complexity of designing single purpose indicators that could reflect a wide range of community values, or regionally specific issues.

The use of an ES/NCP concept allowed us to bridge the broader gap between people and nature, facilitating the development of storylines and enabling people to understand how nature underpins their everyday lives. As the understanding of linkages and challenges between nature and people's physical and spiritual needs becomes clearer, this process can provide an evidence-based that allows central agencies to support sustainable investment decisions (section 8), raising the profile of investment into nature and formalising the contribution of natural capital to well-being such as in the Living Standards Framework.

The indicators to be developed using the process outlined in this document can also be used to provide evidence to report New Zealand's progress against international commitments such as the Sustainable Development Goals (SDG)¹¹ and the post-2020 Biodiversity targets from the Convention on Biological Diversity. To date, quantitative and qualitative information has been used to how New Zealand is tracking against the SDGs (New Zealand Ministry of Foreign Affairs and Trade 2019) or Aichi Targets (Department of Conservation 2019). Information that demonstrates the values and benefits people get from nature would enhance the narratives around barriers and opportunities for change for these international commitments (IPBES 2019).

Using an analytical procedure, our process helps identify robust indicators that can both raise the understanding of how people rely on nature and guide policy makers in decisions that affect the environment. We showed that robust discussions on the relationship between nature and people helps people understand the relationship from different perspectives and contexts and highlights the challenges of managing the environment (Appendix 5).

¹¹ We acknowledge that specific targets should be developed for the New Zealand context and the appropriate indicator(s) would track the nation's progress toward these targets.

No one framework fits for all

The concept of ecosystem services is anthropocentric as it focuses on the benefits nature provides to people. However, some would argue that people are part of nature rather than being served by nature. Thus, a range of worldviews and frameworks/perspectives can be warranted to capture the whole picture of the nature-people relationship. In New Zealand, te ao Māori frameworks would add value to the New Zealand picture (Harmsworth & Awatere 2013).

The need for clear definition, classification systems, and common language (terminology) came out strongly during the workshop. Discussions on the relationships between ecosystem services and well-being also highlighted the range of views held on these relationships and the challenges with prioritising which ecosystem services for each well-being should be the focus for indicator selection. Having a wide array of stakeholders from different backgrounds and interests will help ensure the range of views are heard in these types of prioritisation processes, and for alternative worldviews to be shared.

A clearer process for indicator design is needed

The questions for supply and benefit indicators are not yet sufficiently defined to allow people consistently to identify state versus supply and sometimes benefit indicators to represent the relationship between ES and well-being. Part of the issue is related to the ambiguity of some definitions (as noted above). Aspects to clarify included the range of beneficiaries and providing some contextual information about substitutability, scale (national or regional) and whether to account for the risk of future changes. Building an evidence base on the causality between nature, ES/NCP, and well-being so that the cascading consequences of environmental changes on people is better understood would also be useful. Besides, the direct links between the well-being domain 'environmental quality' and conditions of ecosystems need to be considered.

9.2 Links with te ao Māori frameworks

As highlighted by Diaz et al. (2018), there is no universal perspective on human-nature relations. To recognise the multiple ways of understanding and representing human-nature relationship, the Treasury and Te Puni Kōkiri have started to conceptualise Māori well-being (Te Puni Kōkiri & Treasury 2019). Their framework, He Ara Waiora, puts natural capital around the other capitals, and shows how the environment is intrinsically linked to people's well-being. Four concepts of tikanga Māori (systems of values) then underpin the maintenance of these four capitals. The number of well-being domains is reduced to seven, with a stronger concept for the role of Māori to be 'responsive to living and natural environment' (Fig. 11), reflecting core Māori concepts of reciprocity and kaitiakitanga.

More recently, the Tax Working Group has proposed an updated version to this framework (version 2.0) with the aim to inform proposed reforms to the taxation system (McMeeking et al. 2019). This framework is aligned to the LSF to some extent, with key differences: their model of well-being is not 'human centric and recognise(s) that the well-being of te Taiao is paramount and a predeterminant of human well-being' (Fig. 11).

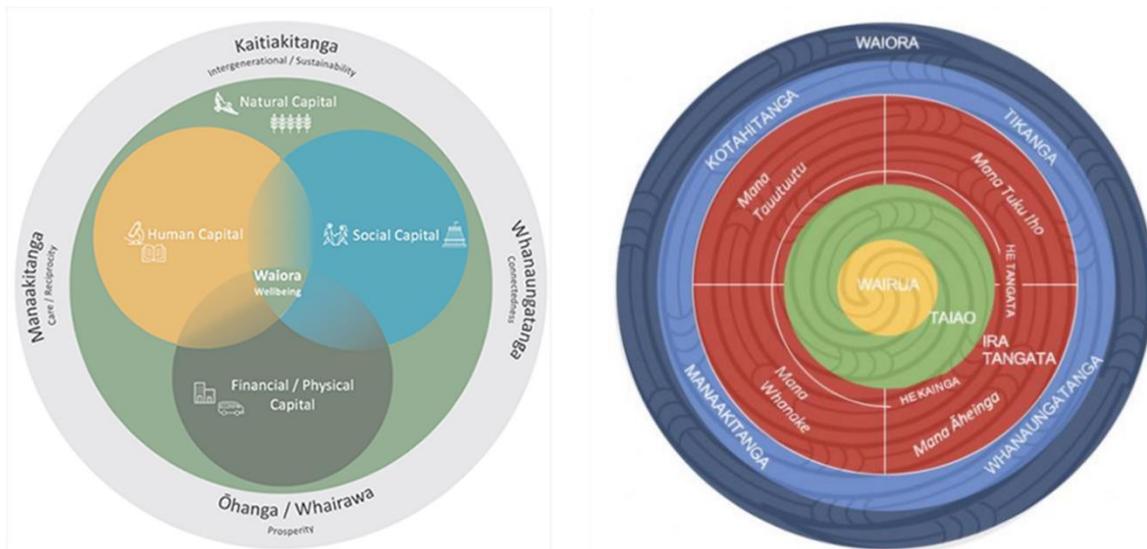


Figure 11. He Ara Waiora version 1.0 (left: from Te Puni Kōkiri and Treasury 2019) and version 2.0 (McMeeking et al. 2019).

McMeeking et al. (2019) recognise that measurements for each of the facets of well-being are still needed. Te Taiao, the environmental well-being, would have indicators on/about the equivalent 'natural capital' and 'various elements of environmental sustainability'. Similar to our findings, they too recommended the inclusion not only of 'stock' but also of 'flow' and 'risk' indicators.

9.3 Future development of the process to link nature to well-being

Sustainable long-term funding was highlighted as a key risk for the on-going collection of ES/NCP indicators for well-being. A business case that highlights the value of such an indicator set and outlines a host organisation for their collection would be beneficial. The initiatives by Stat NZ on SEEA or IANZ could be broadened to include the indicators identified during the process.

We identified three areas for future development (based on our discussions with workshop participants, the Treasury and MfE):

- The matrix of relevance of ES/NCP to well-being domains should be cross-validated by a wider group of stakeholders/agencies. This would ensure buy-in and recognition of the value of this process.
- Further work should discuss complementarity with Māori well-being frameworks. Identifying common indicators would help consolidate and prioritise the data needed to measure and track well-being. A co-development process for identifying and/or integrating Māori values into the process would add value to process and resulting indicator set.

- The process for designing indicators of supply and benefit to people needs further development and the consideration of factors such as diversity of the community, accessibility to an ES/NCP for well-being, and equity. Specific case studies (e.g. policy evaluation, monitoring, or reporting) could be used to further refine and test the revised indicator component of the process.

10 Acknowledgements

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11 Glossary of terms

Biodiversity: The variety of all life on earth (Maes et al. 2013)

Drivers (in DPSIR): Phenomena (e.g. economic and population growth) that provide the context for changing pressures

Ecosystem Services: There are several definitions for ecosystem services. They are all similar, with the most common being:

- The benefits that people obtain from ecosystems (MEA 2005)
- The direct and indirect contributions of ecosystems to human well-being (TEEB 2010).
- The contributions that ecosystems make to human well-being, and distinct from the goods and benefits that people subsequently derive from them (CICES v5.1)

Ecosystem functions: The capacity or the potential to deliver ecosystem services (Maes et al. 2013)

Human well-being: A perspective informed by a person's access to basic materials for a good life, freedom and choice, health and physical well-being, good social relations, security, peace of mind and spiritual experience (IPBES 2014)

Impact (in DPSIR): The ecological, economic, social, and cultural consequences of changes in the state of the environment

Indicator: Observed value representative of a phenomenon to study. In general, indicators quantify information by aggregating different and multiple data. The resulting information is therefore synthesised (Maes et al. 2013). An indicator that is usually quantitative, is a single variable with some logical connection to the process or object of concern (Ash et al. 2010).

Natural Capital: The stock of renewable and non-renewable natural resources (e.g. plants, animals, air, water, soils, minerals) that combine to yield a flow of benefits to people (Natural Capital Coalition 2016)

Nature's Contributions to People (NCP): All the positive and negative contributions of living nature (diversity of organisms, ecosystems, and their associated ecological and evolutionary processes) to people's quality of life (Diaz et al. 2018)

Pressure (in DPSIR): The natural or human influences on the environment that can explain changes in the state of an environment

Resilience: Capacity of a system (forest, city, economy) to deal with change and to continue to develop, not only withstanding shocks and disturbances (such as climate change or financial crisis) but also using such events to catalyse renewal and innovation (Stockholm Resilience Centre 2011). (from Roberts et al. 2015).

Response (in DPSIR): Actions by groups (and individuals) in society, as well as government attempts to prevent, compensate, ameliorate, or adapt to changes in the state of the environment

State (in DPSIR): The physical, chemical, and biological characteristics of the environment and how these characteristics are changing

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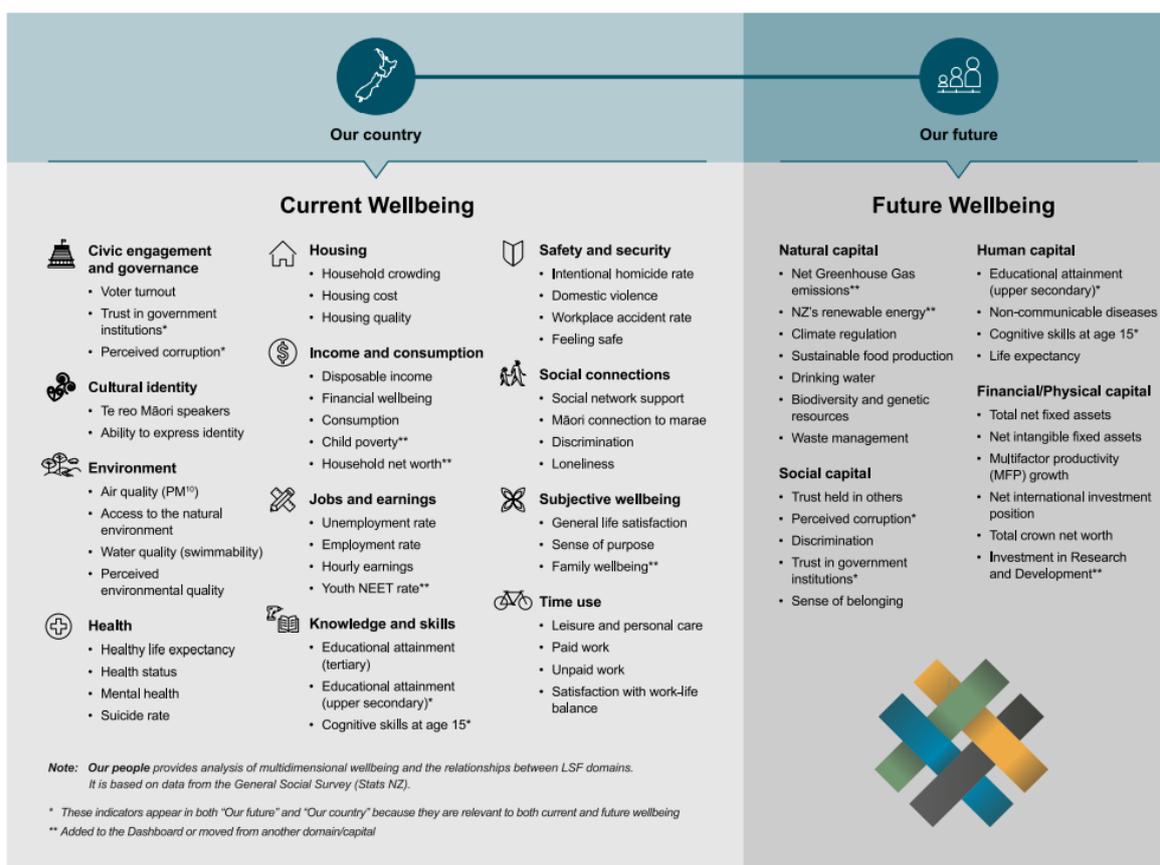
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Appendix 1. Indicators from the Living Standards Framework



Indicators from the dashboard as of December 2019 (The Treasury 2019).

Table 15. Natural capital indicators from Treasury and assigned PSI category

Indicator	Category	PSIR category
Air quality	Current well-being – Environment	State
Access to the natural environment	Current well-being – Environment	Impact
Water quality	Current well-being – Environment	State
Perceived environmental quality	Current well-being – Environment	Impact
Net greenhouse gas emission	Future well-being – natural capital	Pressure
NZ's renewable energy	Future well-being – natural capital	Response
Climate regulation	Future well-being – natural capital	Impact
Sustainable food production	Future well-being – natural capital	State
Drinking water	Future well-being – natural capital	Impact
Biodiversity and genetic resources	Future well-being – natural capital	State
Waste management	Future well-being – natural capital	Response

Appendix 2. From the MEA to IPBES frameworks

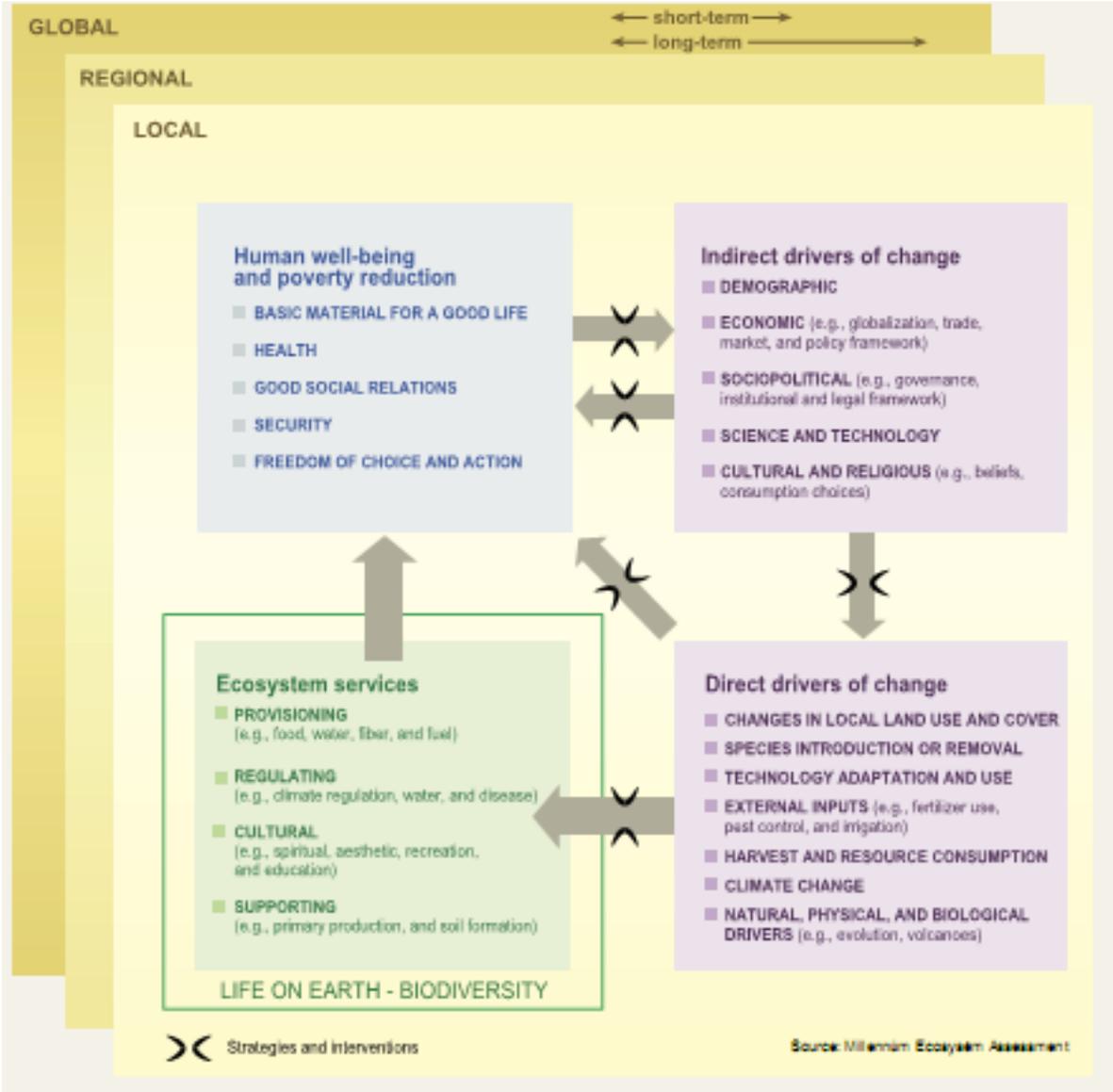


Figure A2.1. The Millennium Ecosystem Assessment framework (MEA 2005).

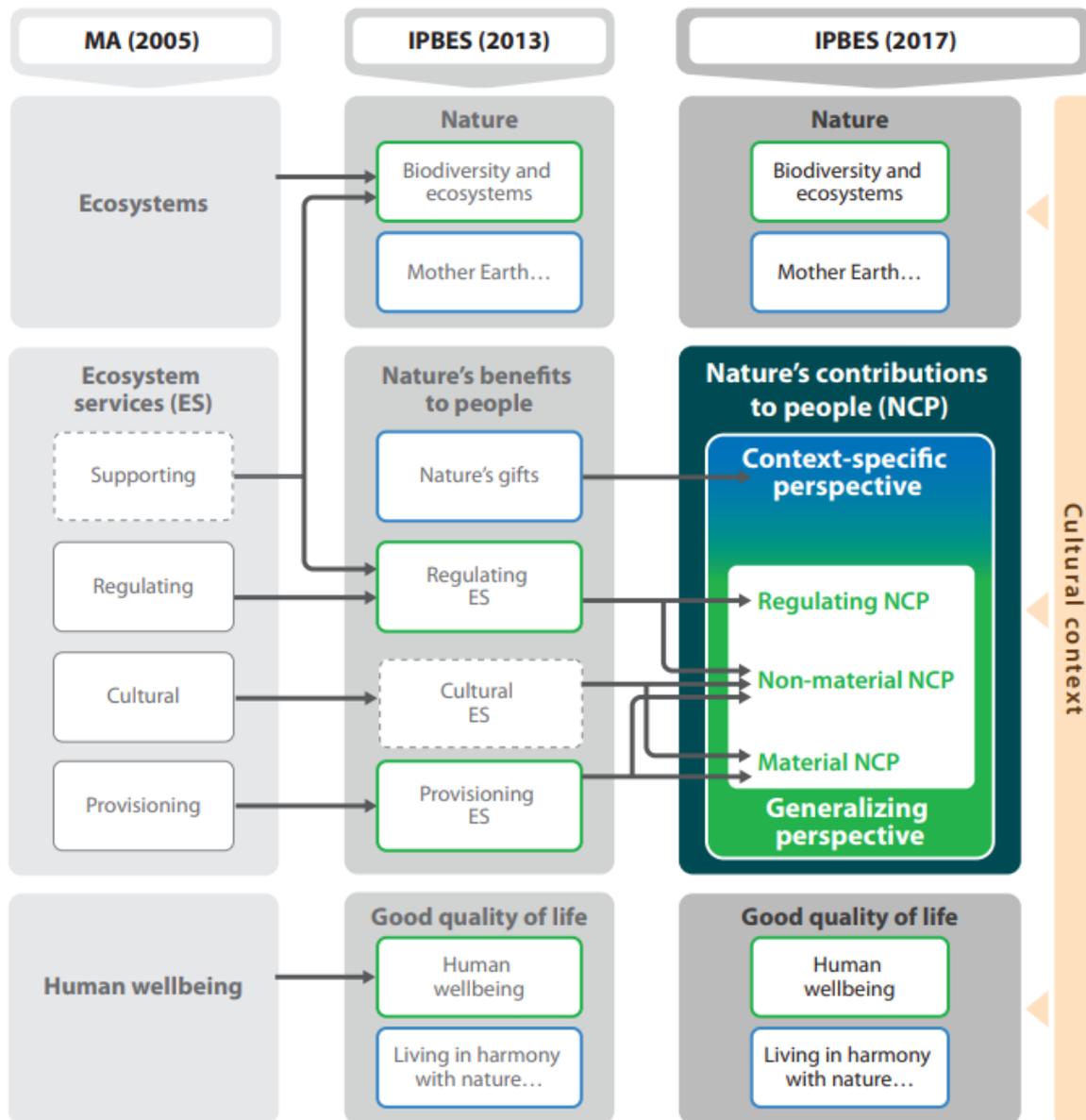
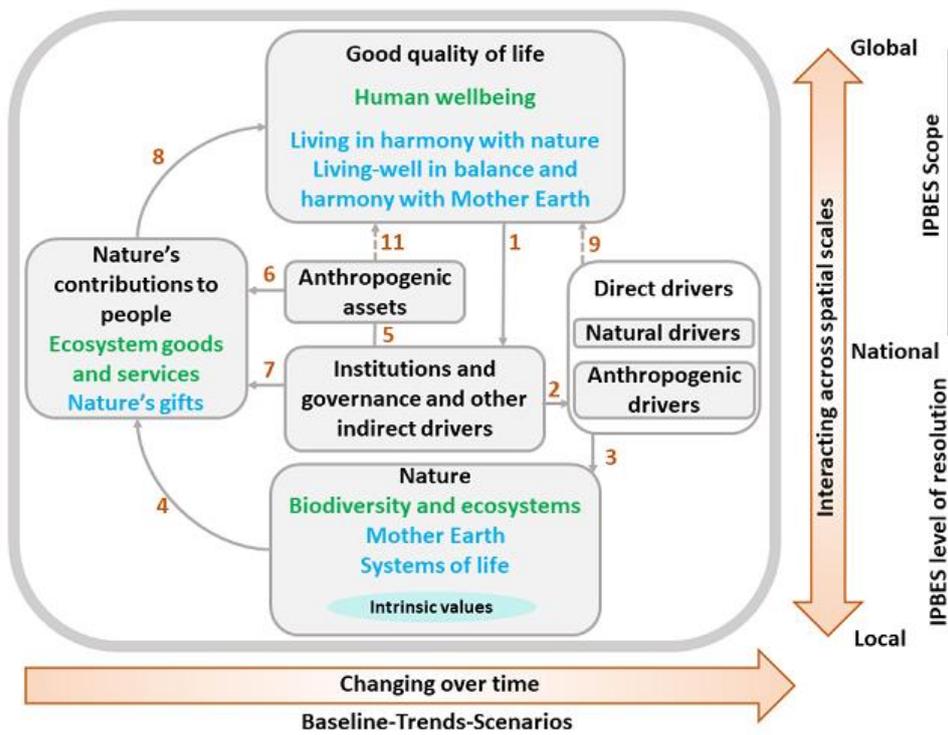


Figure A2.2. Evolution of terminology from MEA (2005) to IPBES (2017) (Díaz et al. 2018).



Díaz et al., 2015

Figure A2.3. IPBES conceptual framework (Díaz et al. 2015).

Appendix 3. IPBES Nature's Contribution to People definitions and categories

	NCP Name	Definition
1	Habitat creation and maintenance	The formation and continued production, by ecosystems, of ecological conditions necessary or favourable for living beings important to humans
2	Pollination and dispersal of seeds	Facilitation by animals of movement of pollen among flowers, and dispersal of seeds, larvae, or spores of organisms beneficial or harmful to humans
3	Regulation of air quality	Regulation (by impediment or facilitation) by ecosystems, of atmospheric gasses; filtration, fixation, degradation, or storage of pollutants
4	Regulation of climate	Climate regulation by ecosystems (including regulation of global warming) through effects on emissions of greenhouse gases, biophysical feedbacks, biogenic volatile organic compounds, and aerosols
5	Regulation of ocean acidification	Regulation, by photosynthetic organisms of atmospheric CO ₂ concentrations and so seawater pH
6	Regulation of freshwater quantity, location, and timing	Regulation, by ecosystems, of the quantity, location and timing of the flow of surface and groundwater
7	Regulation of freshwater and coastal water quality	Regulation – through filtration of particles, pathogens, excess nutrients, and other chemicals – by ecosystems of water quality
8	Formation, protection, and decontamination of soils	Formation and long-term maintenance of soils including sediment retention and erosion prevention, maintenance of soil fertility, and degradation or storage of pollutants
9	Regulation of hazards and extreme events	Amelioration, by ecosystems, of the impacts of hazards; reduction of hazards; change in hazard frequency
10	Regulation of organisms detrimental to humans	Regulation, by ecosystems or organisms, of pests, pathogens, predators, competitors, parasites, and potentially harmful organisms
11	Energy	Production of biomass-based fuels, such as biofuel crops, animal waste, fuelwood, and agricultural residue
12	Food and feed	Production of food from wild, managed, or domesticated organisms on land and in the ocean; production of feed
13	Materials and assistance	Production of materials derived from organisms in cultivated or wild ecosystems and direct use of living organisms for decoration, company, transport, and labour
14	Medicinal, biochemical, and genetic resources	Production of materials derived from organisms for medicinal purposes; production of genes and genetic information
15	Learning and inspiration	Opportunities for developing capabilities to prosper through education, knowledge acquisition, and inspiration for art and technological design (e.g. biomimicry)
16	Physical and psychological experiences	Opportunities for physically and psychologically beneficial activities, healing, relaxation, recreation, leisure, and aesthetic enjoyment based on close contact with nature.
17	Supporting identities	The basis for religious, spiritual, and social-cohesion experiences; sense of place, purpose, belonging, rootedness or connectedness, associated with different entities of the living world; narratives and myths, rituals and celebrations; satisfaction derived from knowing that a particular landscape, seascape, habitat or species exist
18	Maintenance of options	Capacity of ecosystems, habitats, species or genotypes to keep human options open in order to support a later good quality of life

Appendix 4. Equivalence between classifications systems

We reviewed three well-established classifications for ecosystem services (MEA, IPBES, CICES). There are other classification systems that are available, including the Final Ecosystem Goods and Services (FEGS-CS) used by the USA. The various classifications have been developed to serve various purposes (natural capital accounting, policy assessment, reporting). Each classification system has its own level of complexity but intend to have a comprehensive set of ES or NCP that can be reported against (Table 15). The goal of these classifications varies, with the MEA and IPBES more intended towards raising awareness, policy making, and communication rather than accounting and valuation purposes. For instance, Diaz et al. (208) recognise that the categories of NCP are overlapping and interlinked, giving as an example food as a material NCP, yet also a symbolic element of non-material NCP.

Table 16. Comparison between classification systems

	Pros	Cons	Purpose
MEA	Simple, easy to communicate	Original classification using supporting services	Communication, policy making and public awareness
TEEB	Simple, easy to communicate	Original classification with habitat services	Valuation of biodiversity
CICES	Comprehensive, underpins the SEEA work for System of National Account	Complex, difficult to communicate	Accounting (SEEA), development of measurable indicators
IPBES	Comprehensive, follows international approval by governments Easy to communicate Meant to include indigenous perspective	Novel concept of NCP is still in its infancy. Classification may still evolve as it is context-dependent	Communication, policy making and public awareness

The Millennium Ecosystem Assessment (2005) was the major initiative to popularise the concept of ecosystem services. They had four categories: provisioning services; regulating services; supporting; and cultural services. This categorization has been used extensively as it provides an easy communication tool. Since then, supporting services were first re-classified as habitat services (De Groot et al. 2012) with further general agreement that they are in fact ecosystem functions (La Notte et al. 2017). The CICES has been developed by the EU and has the highest level of details (Czúcz et al. 2018). It is based on a nested hierarchy and was originally developed as part of the System of Environmental and Economic Accounting (SEEA) led by the United Nations Statistical Division (UNSD). Its evolution and revision have progressed since 2013 through online consultation. Diaz et al. (Díaz et al. 2018) identified 18 categories for reporting NCP. The NCP are organised similarly to the MEA without supporting services. The three groups regulating, material, and nonmaterial are partly overlapping.

Material contributions are 'substances, objects, or other material elements from nature that directly sustain people's physical existence and material assets. They are typically physically consumed in the process of being experienced—for example, when organisms are transformed into food, energy, or materials for ornamental purposes'. They are equivalent to the provisioning services from the MEA. Nonmaterial contributions are 'nature's effects on subjective or psychological aspects underpinning people's quality of life, both individually and collectively' and regulating contributions are 'functional and structural aspects of organisms and ecosystems that modify environmental conditions experienced by people and/or regulate the generation of material and nonmaterial contributions'. Culture services are not a category as they 'permeate[s] through and across all three broad NCP groups rather than being confined to an isolated category' (see Appendix 2). This would support a suggestion from Harmsworth et al. (2013) that culture, especially for Māori, should not be an isolated category, but should underpin the material and non-material NCP.

The CICES, on the other hand, is very comprehensive, with 90 classes of ES in the latest version 5.1. The aim is to facilitate the links between the environment and the economy through an accounting system, where ecosystem assets and their services are tracked and monitored similarly to other economic assets with direct connections to the System of National Accounts (Hein et al. 2015). To avoid double-counting, the CICES classification requires non-overlapping categories and clear measurements. Following consultation within the EU, the latest version has included the contribution from biotic and abiotic ecosystems.

Table 17. Equivalence between MEA categories, IPBES NCP categories and CICES group level categories (v5.1)

ES categories	MEA Ecosystem service categories (2005)	TEEB (2012)	IPBES NCP	IPBES NCP name (2020) (see appendix 3 for definitions)	CICES version 5.1 equivalent (at group level) (2018)
Provisioning	Food (crops, livestock, aquaculture)	Food	12	Food and feed	Cultivated terrestrial plants or aquatic plants or reared animals for nutrition, materials or energy (1.1.1, 1.1.2, 1.1.3, 1.1.4)
	Fibre (timber/wood fibres, other fibres, e.g. hemp, cotton, silk)	Raw materials	13	Materials and assistance	Cultivated terrestrial plants or aquatic plants or reared animals for nutrition, materials or energy (1.1.1, 1.1.2, 1.1.3, 1.1.4)
	Wild foods (incl. capture fisheries)	Raw materials	12	Food and feed	Wild plants (terrestrial and aquatic) for nutrition, materials or energy (1.1.5)
	Freshwater	Freshwater	NA	<i>Hydrological NCP are conceived as regulating services</i>	Surface water or ground water or other aqueous ecosystems used for nutrition, materials or energy
	Fuel /energy	Raw materials	11	Energy	Cultivated terrestrial plants or aquatic plants or reared animals for nutrition, materials or energy (1.1.1, 1.1.2, 1.1.3, 1.1.4)
	Biochemical, natural medicines & pharmaceuticals	Medicinal resources	14, 18	Medicinal, biochemical and genetic resources Maintenance of options	Genetic material from plants, algae or fungi; animals, organisms (1.2.1, 1.2.2, 1.2.3)
	Genetic resources	Habitat services: Maintenance of genetic diversity	14, 18	Medicinal, biochemical and genetic resources Maintenance of options	Genetic material from plants, algae or fungi; animals, organisms (1.2.1, 1.2.2, 1.2.3)
	Ornamental resources	Ornamental resources	13	Materials and assistance	Cultivated terrestrial plants or aquatic plants or reared animals for nutrition, materials or energy (1.1.1, 1.1.2, 1.1.3, 1.1.4)

ES categories	MEA Ecosystem service categories (2005)	TEEB (2012)	IPBES NCP	IPBES NCP name (2020) (see appendix 3 for definitions)	CICES version 5.1 equivalent (at group level) (2018)
Regulating	Air quality maintenance	Air purification	3	Regulation of air quality	Mediation of wastes or toxic substances of anthropogenic origin by living processes 2.1.1 Mediation of nuisances of anthropogenic origin 2.1.2
	Climate regulation	Climate regulation	4	Regulation of climate	Atmospheric composition and conditions 2.2.6
	Water regulation	Regulation of water flows	6	Regulation of freshwater quantity, location, and timing	Water conditions 2.2.5 Regulation of baseline flows and extreme events 2.2.1
	Water purification & waste treatment	Waste-water treatment	7	Regulation of freshwater and coastal water quality	Mediation of wastes or toxic substances of anthropogenic origin by living processes 2.1.1
	Erosion control	Erosion prevention	8	Formation, protection, and decontamination of soils	Regulation of soil quality 2.2.4 Regulation of baseline flows and extreme events 2.2.1
	Disease regulation Biological control	Biological control	10	Regulation of organisms detrimental to humans	Pest and disease control 2.2.3
	Pollination	Pollination	2	Pollination and dispersal of seeds	Lifecycle maintenance, habitat, and gene pool protection 2.2.2
	Natural hazard regulation (storm protection)	Moderation of extreme events	5, 9	Regulation of hazards and extreme events Regulation of ocean acidification	Regulation of baseline flows and extreme events 2.2.1
Cultural	Recreation & ecotourism	Recreation Tourism	16	Physical and psychological experiences (incl. Tourism and aesthetics)	Physical and experiential interactions with natural environment 3.1.1
	Ethical & spiritual values (incl. cultural heritage, sense of place, aesthetics)	Spiritual experience Sense of place	17	Supporting identities	Spiritual, symbolic, and other interactions with natural environment 3.2.1
	Inspirational & educational values	Aesthetic	15	Learning and inspiration	Intellectual and representative interactions with natural environment 3.1.2

ES categories	MEA Ecosystem service categories (2005)	TEEB (2012)	IPBES NCP	IPBES NCP name (2020) (see appendix 3 for definitions)	CICES version 5.1 equivalent (at group level) (2018)
Supporting services	Nutrient and water cycling	N/A			
	Primary production (e.g. photosynthesis)	N/A		<i>Included in regulating and provisioning NCPs</i>	
	Production of atmospheric oxygen	N/A			
	Provisioning of habitat	<i>Habitat services:</i> lifecycle maintenance Gene pool protection	1, 18	<i>Regulating:</i> Habitat creation and maintenance Maintenance of options	<i>No supporting services in CICES</i>
	Soil formation and retention	<i>Regulating:</i> maintenance of soil fertility	8	<i>Regulating:</i> Formation, protection, and decontamination of soils	

Appendix 5. Additional information for the well-being workshop and list of participants

The workshop comprised three sessions:

- 1 Scene setting – Outlining the context (well-being framework from the Treasury and environmental reporting), clarification of terms and providing an overview of the process
- 2 Prioritisation – Demonstration followed by group session to test the ecosystem service prioritisation approach for the assign well-being domain.
- 3 Indicator identification – Demonstration followed by group session to test approach to identify appropriate ecosystem service indicators for the respective well-being domain.



**Manaaki Whenua/MfE workshop on
Environmental stewardship and well-being (26th feb 2020)**

OBJECTIVE

Co-develop and test a process to identify relevant natural capital/Ecosystem Services indicators for well-being.

VENUE AND DATE

Ministry for the Environment, meeting room 1A (Matairangi).
26th February – 9-2pm

AGENDA

Time	Order of events
9:00 – 9:15	Round the table intro – coffee
9:15-10:00	Welcome & overview of the workshop <ul style="list-style-type: none">• Introduction to project• Aim of the workshop
10:00-10:30	Morning tea
10:30-10:45	Topic 1: Prioritisation process to select and rank Ecosystem Services per domain <ul style="list-style-type: none">• Demonstration: short presentation
10:45-11:15	BREAKOUT SESSION
11:15-11:45	Report back and discussion
11:45-12:30pm	Lunch
12:30-12:45	Topic 2: identify appropriate metrics/indicators for some wellbeing case study domains <ul style="list-style-type: none">• Demonstration: short presentation
12:45-1:15	BREAKOUT SESSION
1:15-1:45	Report back and discussion
1:45-2pm	Summary and debrief – way forward

Table A3. List of participants

Name	Organisation
Anne-Gaelle Ausseil (organiser)	Manaaki Whenua – Landcare Research
Alison Collins (organiser)	MfE
Suzie Greenhalgh (organiser)	Manaaki Whenua – Landcare Research
Pam Booth (organiser)	Manaaki Whenua – Landcare Research
Warren Gray (organiser)	MfE
Gary Bedford	Taranaki Regional Council
Drew Bingham	MfE
Deb Burgess	MfE
Charlie Clark	MfE
Fiona Curran-Cournane	MfE
Nancy Golubiewski	MfE
Ed Hearnshaw	PCE
Carl Howarth	MfE
Andrew McCarthy	PCE
Beckie Prebble	MfE
Silkie XX	Treasury
Gerald Rys	MPI
Cassandra Spearin	PMCSA intern student
Adam Tipper	StatsNZ
Elaine Wright	DOC

Detailed discussion of challenges and observations from the prioritisation process workshop

Health domain

Overall, participants believed all three ecosystem services (air quality regulation, ethical and spiritual and drinking water) contribute directly to the health of an individual and there are few or no substitutes for any of the ecosystem services (median scores of 4, 4.5 and 5) (Fig. A3.1). However, there was some disagreement on the extent of the impact ethical and spiritual services have on health (median score of 4.5). Half the participants thought the ethical and spiritual services provided by the environment impacted the health of most of the country or at least 75% of the population. However, three of the eight participants thought the ethical and spiritual services provided by the environment impacted 50% or less of the country and/or population.

Participants were asked to write down the thought processes they used to determine scores. They used the language from the scoring system (see Table 8) to describe their thinking of how air quality regulation and provision of drinking water influences health, but had more difficulty applying the same language to describe the relationship between ethical and spiritual ecosystem services and health well-being.

Air quality

Almost all participants said that air quality regulation has a 'direct' impact on health or is 'important for health' and that the effects were 'local', 'impact health temporarily', 'small' or impact 'some places'. One participant, however, said that while air quality had a direct impact, the effects were 'varied because particulates not an issue in New Zealand'. This language mirrors a 4 in the scoring system for nature of impact.

Participants described the extent of the impact of air quality regulation on health in terms of regions, urban or rural, 'local issues', and cities. While the median score was a 4, the majority of participants were split between a rating of 3 (7–10 regions or 30–50% of population) and 5 (14–16 regions or >75% of population). For example, a participant who gave the rating of 4 thought that since air quality regulation was a 'local issue' but impacted 'everyone', a rating of 4 was the most appropriate. Of the participants who gave a rating of 3, the comments from two participants mirrored the descriptions of the ratings, e.g. 'urban only part of 8 regions'. The comments from participants who gave a rating of 5 were less clearly related to the descriptions for the scoring. For example, one participant thought that since 'most ecosystems produce some pollen or filter some pollutant' a rating of 5 would be most appropriate.

Participants thought there were no technological alternatives (rating of 5) or if alternatives exist, they were 'expensive' (rating of 4). Most participants also thought there were no substitutes for 'natural air', but people could seek better air if they moved somewhere else or took medicines (e.g. 'for allergies'), improved local air by changing 'user density', incentivised 'electric cars', or changed 'transport corridors'.

Ethical and spiritual

Participants described the nature of the impact of ethical and spiritual ecosystem services on health through the lens of 'mental health', 'mentally uplifting', relieving 'anxiety' and tourism. Some participants also viewed this ecosystem service as creating a sense of 'connection', 'stewardship', and 'identity', which influences health through improved mental health and reduced anxiety. These participants noted that while this connection is important, it may or may not be direct and is probably dependent on the experiences of a specific group, 'e.g. Māori, trampers, gardeners'. However, all but one participant said that the ethical and spiritual ecosystem service has a direct impact (score of 4 or 5) on health.

Mirroring language used in the comments for the nature of the impact, participants described the various groups who would be impacted by the relationship between ethnical and spiritual ecosystem service and health, e.g. Māori, tourists. Participants who specified groups who are impacted tended to give lower ratings (2 or 3) which reflected the scoring system, i.e. 20–30% of population has a rating of 2 or 3. However, for some participants there was a disconnect between the comments and the final rating given, e.g. '15%' translated into a rating of 5, or little to no contextualising comments for the final ratings, e.g. '4 or 5 population affected'.

Overall, participants thought there were 'some alternative options' for different 'elements' of the ethical and spiritual ecosystem service, but that the score would be highly subjective depending on the user. Several participants also said that the ecosystem service may be somewhat substitutable over time as 'attitudes', 'attributes/beliefs' and people's minds change. This language, consistent with language used in the nature of the impact and extent of impact described above, led participants to give a final rating of 4 or 5.

Drinking water

Participants described the nature of the impact of provisioning of drinking water as 'necessary for life', 'direct', and 'big/large'. Interestingly, this logic led some participants to give a score of 4 (direct and small) and other participants gave a score of 5 (direct and large), suggesting that while participants were mostly in agreement that provisioning of drinking water was direct, the magnitude of the impact on health was debatable. However, participants were in agreement that the provisioning of drinking water impacted everyone's health (rating of 5 for extent of impact).

There was some disagreement between participants about whether there were alternatives to provisioning of drinking water and/or there existed a technological substitute. Some participants who gave a rating of 5 said that there were 'other sources' such as 'salt water', while other participants who gave the same rating said there were no substitutes that did not require 'significant capital investment'. Additionally, a participant who gave a rating of 4 said that while there was a technological substitute for the ecosystem services, e.g. 'water treatment plant', there might be no alternatives as 'drought may limit supply [of water]'.

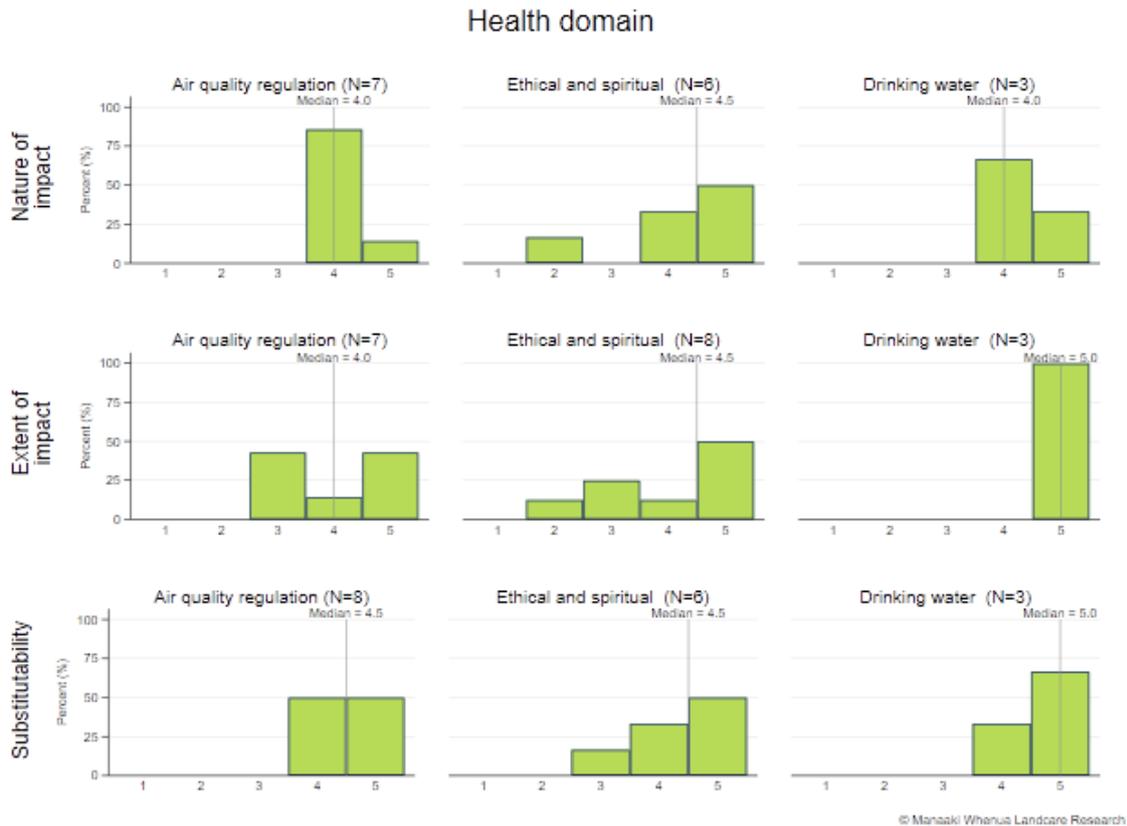


Figure A3.1. Distributions of scores to the Nature of impact, Extent of impact and Substitutability of Air quality regulation, Ethical and spiritual and Drinking water ecosystem servicers for the Health domain. Refer to Table 3 for definitions of the ratings.

Subjective well-being domain

Overall, participants believed all three ecosystem services (recreation and tourism, climate regulation, and food) directly, and to a large degree, impacted the subjective well-being of individuals (median scores of 5, 4.5, and 4.5, respectively) (Fig. A3.2). Regardless of the nature and size of the impact, it was thought all three ecosystems services impact the subjective well-being of most the country or at least 75% of the population (medians = 5). Participants thought there were several substitutes for recreation and tourism (median = 2.5) and food ecosystem services (median = 3.5), but few substitutes for climate regulation (median = 5). It should also be noted that three of eight participants believed there were few or no substitutes for the recreation and tourism services provided by nature (rating of 4 or 5) and many reported during the discussion that there were no substitutes for food in terms of the impact on subjective well-being.

Recreation and tourism

Participants described the nature of the impact of recreation and tourism on subjective well-being as direct and large because 'lifestyles in NZ often relate to the outdoors' and New Zealanders' 'quality of life, happiness, [and] emotional [and] mental [state] directly relate to the ability to receive this [ecosystem] service'. Participants described the many recreation activities that contribute to subjective well-being, e.g. hiking, swimming,

boating, hunting, sunsets/sunrises, etc., all of which draw tourism. However, despite relative agreement that recreation and tourism have a direct impact on subjective well-being (a score of 4 or 5), there was disagreement as to the scale of that impact (small or large). One respondent, who gave a rating of 4, said that they did not think a rating of 5 was appropriate since recreation was not 'fundamental to livelihood' even if it was 'central to enjoyment'.

Almost all participants said that the recreation and tourism ecosystem services impacted nearly everyone's subjective well-being (rating of 5 for extent of the impact). However, a few respondents mentioned that while the extent of the impact may be large or all of the country, the impact was 'highly variable' and could differ depending on 'urban or rural locations' or 'travel costs and personal mobility'. These concerns are reflected in participant's technological substitutability/alternatives comments, e.g. 'In theory could...travel overseas at high cost' (rating of 4), 'lots of likely options elsewhere but...accessibility important' (rating of 2), and 'emotional, perceptive (unique)' (rating of 3). Additionally, most participants appeared to have difficulty settling on a final substitutability rating because while there are alternative recreation locations and activities or technological substitutes, e.g. VR and indoor ski fields, these substitutes could be very personal and may be inadequate for some people. One common theme across participants who gave a lower rating was the list of possible alternatives and whether different groups might consider these sufficient substitutes.

Climate regulation

Participants described the nature of the impact of climate regulation on subjective well-being through 'reducing climate anxiety' and 'climate fears'. While some participants thought that the impact was direct (rating of 4 or 5), others thought that climate regulation was more an indirect signal to people to be 'more optimistic about the future' (rating of 2). Additionally, participants who thought there was a direct impact also thought the effect would impact the whole country (rating of 5). This is in comparison to participants who thought the impact of climate regulation on subjective well-being was indirect and small who also thought the extent would 'vary from person to person and 'the demand for users to experience subjective WB for climate regulation to mitigate climate change' would also vary across people (no rating given). However, participants did not think there were alternatives or substitutes (rating of 5) or if there were substitutes, they would be a public cost and/or of different quality (rating of 3).

Food provision

Unfortunately, there were few comments associated with ratings on the nature of the impact, extent of the impact, and substitutability of the provisioning of food ecosystem services on subjective well-being. This is due to workshop time constraints, which prevented participants from engaging in discussion of this ecosystem service. However, participants scores did suggest that food provisioning impacted all the country and there were several possible substitutes for the ecosystem service, such as lab food and industrial farming.

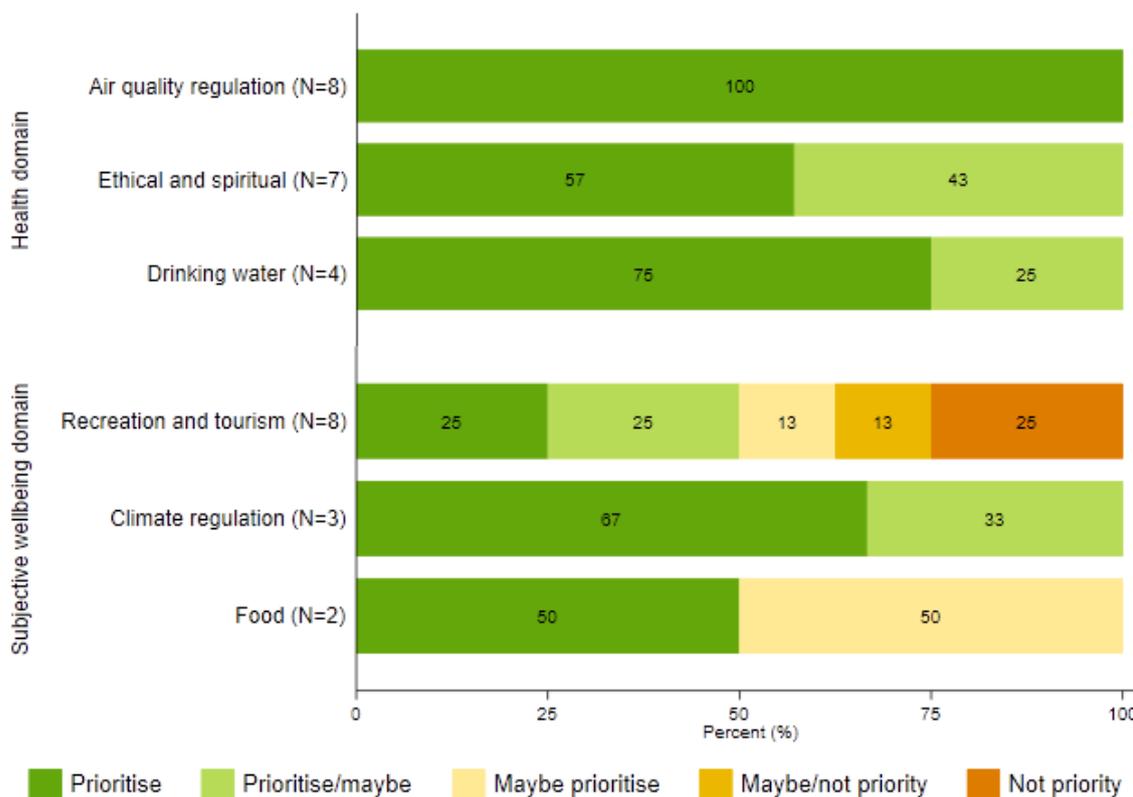


Figure A3.2. Distributions of scores to the nature of impact, extent of impact and substitutability of Recreation and tourism, Climate regulation, and Food ecosystem services to the subjective well-being domain. Refer to Table 3 for definitions of the ratings.

Outcome of prioritisation exercise

Prioritising the importance of each ecosystem service for a well-being domain was determined from participant's impact and substitutability scores. Three different methods for aggregating the score are discussed in Section 6.2. The results presented in Figure A3.3 use the predefined matrix method (see Table 9) to prioritise the importance of an ecosystem service for a well-being domain.

While most participants gave definitive impact and substitutability scores, some participants were more uncertain and gave a range of possible scores (e.g. the extent of the impact of recreation on subjective well-being is small (1) to all of the country (5)). When determining the final prioritisation score for each ecosystem service, a range of final scores were calculated, taking into consideration possible ranges in participant's impact and/or substitutability scores. For most participants these impacts and/or substitutability score ranges did not influence whether the ecosystem service was a priority (Dark green in Fig. A3.3), may be a priority (Yellow) or not a priority (Red). However, for a few participants these impacts and/or substitutability scores ranges influenced whether the ecosystem service was a priority for that well-being domain. When this occurred, the participant's final prioritisation score was classified as priority/maybe a priority (Light green in Fig. A3.3) or may be a priority/not a priority (Orange).



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Figure A3.3. Final outcome from workshop participant's scores determining whether the ecosystem service should be prioritised for identifying indicators as they relate to the Health or Subjective well-being domains. See Tables 8 and 9 for matrix of ratings used to determine prioritisation outcome.

Health domain

All participants thought air quality regulation should be prioritised to identify indicators related to the health domain, while the majority of participants thought ethical and spiritual (57% of participants) and provision of drinking water (75% of participants) should be prioritised for identifying indicators related to the health domain. In general, whether the ecosystem services should be prioritised to identify indicators related to health was more heavily influenced by the substitutability of the ecosystem service (for air quality regulation and drinking water) or extent of impact of the ecosystem service on health (for ethical and spiritual).

The final prioritisation scores for participations was mostly driven by the belief that the ecosystem service was not easily substitutable within the health well-being domain. Three participants were unsure about the exact substitutability of air quality regulation. These individuals thought that while alternative options were 'low/somewhat' or people could 'move elsewhere' (a substitutable score of 3 or 4), either a technological substitute exists but is 'expensive' or 'no [technological] substitute' exists (a substitutable score of 4 or 5). However, after factoring in these ranges, air quality regulation was still considered a priority for identifying indicators.

There was disagreement on the extent of the impact of ethical and spiritual service on the health leading to different prioritisation scores for participants. Some participants thought that only a small proportion of New Zealand's population was impacted (e.g. 20 to 30%) or only specific groups of people with 'spiritual connections to place' would be impacted. This resulted in lower extent scores (2 or 3) in-line with the rubric. While these lower extent scores did not have a huge impact on the final prioritisation level, for some respondents this lower extent score brought down the average impact/extent score used in the predefined matrix method (Table 9) to determine the final prioritisation level in Figure A3.3 (i.e. may be a priority instead of a priority).

The prioritisation scores for the provisioning of drinking water for some participants was influenced by the perceived alternatives/substitutability of the ecosystem for health, i.e. there may be some technological substitutes. Three respondents thought there were technological substitutes such as 'water treatment' plants (substitutability score of 2 to 4), but these might require 'significant capital investment' (substitutability score of 5). However, even after taking these into consideration, the provisioning of drinking water is a priority for 75% of respondents.

Subjective well-being domain

Most participants thought that climate regulation (67%) and food (50%) should be prioritised to identify indicators related to the subjective well-being domain, while a quarter of participants thought that recreation and tourism should be prioritised. Whether the ecosystem services should be prioritised for identifying indicators was heavily influenced by the substitutability of the ecosystem services for subjective well-being.

There was disagreement on whether substitutes or alternatives existed for recreation and tourism service. Participants whose prioritisation score meant that recreation and tourism should be prioritised thought that while there might be some alternatives or technological substitutes, those alternatives would be very personal or might not be accessible to 'many people as frequently due to time/cost' and any technical substitutes might not be adequate for some people. These thoughts led these participants to give a substitutability score of at least 3, which meant indicators for recreation and tourism should be identified. However, other participants thought there were many technological substitutes and/or alternatives available, e.g. substitutability was a 'grey scale', 'very personal', could be more costly for urban areas, and/or was dependent on accessibility and the spatial distribution of those alternatives. This logic led these participants to give a substitutability score of 2, which meant that identifying indicators for recreation and tourism should not be a priority.

Some participants thought there were possible technological substitutes or alternatives for climate regulation on subjective well-being (range of scores from 1 to 4), Consequentially, this lower substitutability score meant that these participants were unsure whether identifying indicators should be a priority. Additionally, other participants thought the impact of climate regulation on subjective well-being ranged from indirect and large to direct and large (score of 3 or 5). However, this range did not influence their final determination on whether indicators should be identified.

While participants thought food provisioning has a direct impact on subjective well-being, one thought there were no technological substitutes (a score of 5) while the other

participate thought there were some alternatives of different quality (score of 2). This second participant thought these substitutes included 'lab food' and loss of the provision could be overcome by 'industry farming'. This thought process meant identifying indicators for food provisioning was less of a priority.

Table A5. Strengths, Weaknesses, Challenges and Opportunity analysis of the nature-well-being process

Strength	Weakness
<p>Storytelling: Raise profile of investment to nurture environment</p> <p>Translate science into policy and create impact</p> <p>Get better information on benefits of nature, how natural environment affect people and in what ways, with more specific measurements/indicators common understanding</p> <p>Good to participate in groups, as perspectives can change, and task can be challenging at first</p> <p>Weigh positive/negative outcomes</p> <p>Get people to think more holistically</p> <p>Prompting people with different perceptions</p> <p>Process driven by policy and immediate political issues.</p>	<p>Anthropocentric</p> <p>Difficult to separate state and supply</p> <p>How can we interpret the absence of ES for a well-being?</p>
Challenges	Opportunities
<p>Terminology:</p> <ul style="list-style-type: none"> • clarity needed, language barrier issue • Common understanding and definition (well-being) • Defining values and value system • need to relate the ES back to the definition of what it means for people <p>Buy-in:</p> <ul style="list-style-type: none"> • Why hasn't the concept of ES not picked up? • What can it bring that is different from before? <p>Different perspectives:</p> <ul style="list-style-type: none"> • how to make it work for a diverse society (depends on who you are) • Te ao Māori: integrate people into environment <p>WB is at the end: need links back to pressures</p> <p>Resourcing:</p> <ul style="list-style-type: none"> • Who is leading and how to take it forward • Hard choice on funding allocation <p>Attribution:</p> <ul style="list-style-type: none"> • How can we separate human interaction from ecosystem services • Causality studies and interpretation of surveys 	<p>Managing measure rather than outcomes</p> <p>Good indicator on benefits from nature fits well with the "beyond GDP" idea</p> <p>Fiscal allocation Treasury to the environment for budget and investment decisions</p> <p>NZ admired for taking a well-being approach, this can support this development</p> <p>How to connect local to global issues (food security)</p> <p>DOC Outcome monitoring framework: how it lines up and how programmes connect for indicators</p> <p>Broaden the thinking, look to Pacific Islands</p> <p>Relate info to policy question</p> <p>Improve on lack of info on use/benefit side</p> <p>Process might be easier through specific case studies (e.g. Auckland, BOP, etc.)</p> <p>This is the right moment, PCE review, LSF. Should aim for a few wins, achievable target then start reporting on it regularly.</p> <p>Defined who the end-users are to support the work and monitor delivery package</p> <p>Start with the outcome (what we'd like to achieve)</p> <p>Link with international commitments (SDG, CBD reporting) and continue learning from key initiatives (IPBES).</p>

Challenges (cont.)	Opportunities (cont.)
<p>Need to define the WHO (beneficiary, service provider) and WHAT (which aspect of ES are we discussing)</p> <p>Prioritisation: hard to quantify nature of impact</p> <p>Indicators:</p> <ul style="list-style-type: none"> • multiple measures needed, but complex. There is value in getting one number • Defining boundaries for indicators • Subjective vs objective measures (e.g. benefits) • Scale: reporting national not representing regional and group variability <p>imbalance in data: some measurable via \$, others not, need other ways</p>	<p>Better link the WBES approach with the policy frameworks proposed (e.g. NPS-FM values, objectives and limits)</p>

Appendix 6. Support information for the priority scoring

Health

ES/NCP	Health: Our mental and physical health		
	<p>Does [ES/NCP] impact on people’s (can split by sector e.g. urban, famers, etc) [well-being domain] directly or indirectly and what is the size of that impact (small/large)?</p> <p>What is the extent of that impact or how many people are affected (based on number of regions or population)?</p>	<p>Is there a substitute for the [ecosystem service] service important for [well-being domain]?</p> <p>If yes, is there a cost-effective substitute or a similar alternative option?</p>	<p>Include in assessment*</p>
Erosion control	<p>Nature of impact: indirect and small through giving access to walking tracks (e.g. coastal track impacted by erosion on Cape Palliser, may be nat haz reg.)</p> <p>Rating 1</p>	<p>No (1)</p>	<p>No</p>
<p>Nat hazard regulation (flood, drought, fires, slips)</p>	<p>Magnitude = 2, extent = 2</p> <p>Some natural hazards can affect health (e.g. flooding can injure people and lead to some water borne diseases (may not be in NZ))</p> <p>Urban: loss of life or injuries (direct), mental stress due to flooding and slips (infrastructure), loss of life and infrastructure due to coastal storm surges (direct)</p> <p>Farmers: loss of life or injuries (direct), mental stress (indirect) associated to flooding and slips (pasture and infrastructure), metal stress associated with pasture and livestock loss (indirect)</p> <p>Tourist: loss of life or injuries (direct) due to slips on coastal tracks or along rivers</p> <p>N = Direct and large across the NZ = 5</p>	<p>Flood. Nb of regions (Northland, BOP, MW, Gis, West Coast): 5 (P2) at S4 (NOTE data available from Insurance association)</p> <p>In floodplains– stop banks etc but may increase problem downstream, or pumps</p> <p>Coastal storm surge: Northland, Gisborne, BOP, Wellington 4 regions (P2) at S3</p> <p>Sea walls, managed retreat</p> <p>Drought: HB, Northland, Canterbury 3 (P2) at S1 or S2</p> <p>Dams, imported feed, genetics $5/16 \times 4 + 4/16 \times 3 + 3/16 \times 2 = 2.4$ (out of poss 15)</p> <p>Rescale to 5: $2.4/3 = 0.8$</p>	<p>Yes</p>
Water regulation	<p>2: affects timing/flows – impact similar to flooding above</p> <p>N = indirect and large. Water regulation is necessary for good income from agriculture (mental health)</p> <p>Nature = 2, Extent = 5, Population = 5</p>	<p>3: dams can regulate flows</p> <p>Substitutability = 3</p>	<p>yes</p>

ES/NCP	Health: Our mental and physical health		
	Does [ES/NCP] impact on people's (can split by sector e.g. urban, famers, etc) [well-being domain] directly or indirectly and what is the size of that impact (small/large)? What is the extent of that impact or how many people are affected (based on number of regions or population)?	Is there a substitute for the [ecosystem service] service important for [well-being domain]? If yes, is there a cost-effective substitute or a similar alternative option?	Include in assessment*
Air quality regulation	4: poor air quality affects many aspects of health through dust, particulates 3 regions (Auckland, BOP, Canterbury) Nature = 5, Extent = 3, population = 4 Air domain report 2018: Human activities – eg burning fuels for home heating, vehicle exhaust from combustion engines, emissions from industrial processes, power generation, agriculture, pesticides, and dust from unpaved roads and unpaved areas such as quarries, farms, or construction sites. Natural sources – eg wind-blown dust, pollen, smoke from wildfires, sea salt, and ash and gases from volcanic activity Potential framework: 3 main pollutants for ex Supply: qty of pollen. Area of wind-pollinating vegetation. Demand: nb of people with asthma, hay fever	Substitutability = 5: no real substitutes for good air quality	yes
Climate regulation	4: affects heat stress, exposure, etc Urban: heat strokes Farmers: heat strokes during harvesting Ecoanxiety from climate change Nature = indirect and large, direct, and small proportion	4: few substitutes for climate regulation.	yes
Pollination	Nature = indirect and small	Can substitute pollination with chemicals	no
Water purification	Nature=5: people want to swim in rivers for their mental and physical health Extent = 5, Population = 5 affects everyone Water-borne diseases	Substitutability = 3: water can be treated (at a cost)	yes
Biological control	Nature = indirect and small (2). Control of disease for animals might affect mental health for farmers (TB for cows).	Substitutability = 1: lots of chemically based substitutes and pharmaceuticals for treating disease.	No
disease regulation	Nature: direct and big (5). Physical health is affected by disease regulation. Note: we should bear in mind the global impact of lack of disease regulation through spread of zoonotic diseases like COVID19.	Substitutability = 1: lots of chemically based substitutes and pharmaceuticals for treating disease.	maybe
Recreation and ecotourism	4: recreation is important for mental health (and nature has been shown to improve health and increase recovery after illness)	3: virtual reality can substitute for the real thing	maybe

ES/NCP	Health: Our mental and physical health		
	Does [ES/NCP] impact on people's (can split by sector e.g. urban, farmers, etc) [well-being domain] directly or indirectly and what is the size of that impact (small/large)? What is the extent of that impact or how many people are affected (based on number of regions or population)?	Is there a substitute for the [ecosystem service] service important for [well-being domain]? If yes, is there a cost-effective substitute or a similar alternative option?	Include in assessment*
Ethical & spiritual	4: many aspects of spirituality are important for mental health, in particular N = direct and big	4: few, if any, substitutes available for nature-based spirituality	yes
Inspirational and educational	Direct benefit to mental health? Affects everyone but not everyone sensitive to inspirational value for mental health N = 4	Not sure. Can't substitute inspiration from nature, but can substitute educational benefits with some virtual experiences. Would say a 3?	Yes
Food	4: good healthy and natural food is important for physical and mental health	4: few substitutes for food (but food can be imported) (note substitutability based on a rating 1-5, not wording in Table)	Yes
Fibre	Nature: indirect and small (2). Wool provides warmth to avoid getting cold	1: lots of synthetic fibre substitutes for clothing	No
Wildfoods	Nature: 1. Not important		No
Freshwater	5: drinking water is a human health necessity, and this water must be clean to maintain health N=5, E and P = 5	Substitutability=3: drinking water is needed to maintain health but could be imported from elsewhere (quantity) or treated (quality)	yes
Pharmaceuticals etc	Nature: Indirect and big (3). Nature can provide some natural products that could be used in pharmaceuticals. 70 per cent of drugs used for cancer are natural or are synthetic products inspired by nature (IPBES 2019)	Substitutability = 1. Lots of pharmaceutical substitutes not originated from NZ.	No
Fuel (renew) & energy	3: Via heating/cooling, health can be impacted. However, NZ's relatively mild climate for most of the country makes this less of a problem. May change if temperature extremes change Nature =1	2: substitute renewables with fossil or nuclear fuels (note: climate policy is reducing fossil use and nuclear not really an option in NZ), or use other non-energy means (e.g. more blankets for heat)	No
Ornamental resources	Nature = no importance		No
Genetic resources	2: indirectly through greater diversity providing more options for health-related remedies	Some alternatives options are available from overseas and medical supply (3)	Maybe
Habitat creation and maintenance	Provision of habitat for biodiversity: good for mental health, and intrinsic value people put on nature It will depend on how many people value nature for its indigenous biodiversity	S = 5 not substitutable considering endemism.	yes

Time use

ES/NCP	Time use: The quality and quantity of people's leisure and recreation time (that is, people's free time where they are not working or doing chores).		
	Does [ecosystem service] impact on people's (can split by sector e.g. urban, famers, etc) time use directly or indirectly and what is the size of that impact (small/large)?	Is there a substitute for the [ecosystem service] service important for [well-being domain]?	Include in assessment*
	What is the extent of that impact or how many people are affected (based on number of regions or population)?	If yes, is there a cost-effective substitute or a similar alternative option?	
Erosion control	<p>1 (or maybe 2) Slips may indirectly impact on all people (roads, houses, walkways etc). Likely indirect and small and more one-time events here. Impact would be having to clean up slips or no longer use a walk or take a different road. So, these activities would take away from leisure time and impacts will only be felt in areas that people use/live. Slips are will occur across all regions but restricted to steep slope areas</p> <p>1 (or maybe 2) Surficial erosion and farmers. More soil erosion may mean that land quality has deteriorated and land management increases. This takes more time and takes away from leisure/rec</p>		No
Natural hazard regulation (flood, drought, fires, slips)	<p>Slips as above.</p> <p>Nature = 3 – Floods: Similar to slips. Impacts are going to be sporadic. Big impacts but infrequent and spatially constrained. Likely the nature of impact will differ across the country and how many folks are affected. Extent = 3 as some parts of the country highly affected while others are not</p> <p>Drought (as above). Impact on farmers rather than general population. Regular droughts at certain times of the year and certain areas. When drought comes then more time spent managing the drought rather than leisure/rec. Urban areas – may be inconvenient for gardening</p> <p>Fires = 1 or 2. Not much of country affected, relatively rare and impact is not being about to use an area after a fire for recreation or time taken to fight the fire.</p>	Regional councils or sometimes central government funding is necessary to deal with natural hazards (3–4)	Maybe
Water regulation	<p>Ties with recreation.</p> <p>Nature 4: sporadic impacts of water regulation where when low flows then may not be able to use water resources or quality of leisure time poorer (esp. if have algae blooms)</p> <p>Extent 3 or 4: usually on a problem during summer (low flows) or post winter (high flows)</p>	<p>Substitutability: 1. Other places to swim (alternative river and beaches sites).</p> <p>Dams on many rivers regulates flow</p> <p>Pools also provide a substitute</p>	Yes
Air quality regulation	<p>Nature 2: Indirect and could be big but likely not an issue in NZ Effect is via health</p> <p>Extent 4/5: only areas with high pollen counts or air pollutants (black C)</p>	Sub 1: Do other things for leisure or recreation than going outside	No

ES/NCP	Time use: The quality and quantity of people's leisure and recreation time (that is, people's free time where they are not working or doing chores).		
	Does [ecosystem service] impact on people's (can split by sector e.g. urban, farmers, etc) time use directly or indirectly and what is the size of that impact (small/large)? What is the extent of that impact or how many people are affected (based on number of regions or population)?	Is there a substitute for the [ecosystem service] service important for [well-being domain]? If yes, is there a cost-effective substitute or a similar alternative option?	Include in assessment*
Climate regulation	Nature 1: not important		No
Pollination	Nature 1: not important		No
Water purification	Ties with recreation Nature 2: sporadic impacts of water quality where may not be able to use water resources or quality of leisure time poorer (esp. if have algae blooms) Extent 4: usually only a problem during summer when low flows impact on water quality Indirect impacts through having to deal with water quality issues instead of spending time doing leisure/rec		No
Biological control	Nature: indirect and small (2)		No
Disease regulation	Nature: indirect and big (4) COVID19 (zoonotic disease that occurred due to lack of disease regulation https://www.millenniumassessment.org/documents/document.283.aspx.pdf) indirectly affected NZ but has completely thrown work life balance	Substitutability: lockdown was a central government intervention to suppress COVID19 transmission	Maybe
Recreation and ecotourism	Nature: 5. The ability to recreate will affect work-life balance as no recreation means leisure time could be impaired Extent 5. Impact across whole country	Sub 4: Many alternatives but quality of experience is different e.g. going to the movies, etc.	Yes
Ethical & spiritual	Person specific as people's connection to nature will matter for their work-life balance. Māori may rate this higher as a population than other ethnicities Nature 4/5 Extent 5	Sub 5. No substitutes as still need other places in nature to get some feeling. Also, some people have close connections to a place, e.g. Māori VR could give you visual and sound sensing but missing the other sensors (smell and touch), which means there is no substitute	Yes
Inspirational and educational	Person specific. Nature 4: Direct but small Examples a painter who draws inspiration from nature for leisure or work Interaction with children during leisure time learning about nature and taking inspiration from nature (e.g. building huts) Extent is small as not a lot of folks are painters	Sub (in terms of nature): 2. Likely other options with similar experience withing proximity	Yes

ES/NCP	Time use: The quality and quantity of people's leisure and recreation time (that is, people's free time where they are not working or doing chores).	
	Does [ecosystem service] impact on people's (can split by sector e.g. urban, farmers, etc) time use directly or indirectly and what is the size of that impact (small/large)? What is the extent of that impact or how many people are affected (based on number of regions or population)?	Is there a substitute for the [ecosystem service] service important for [well-being domain]? If yes, is there a cost-effective substitute or a similar alternative option? Include in assessment*
Food	Person specific but indirect Nature 2: recognise though that a lot of people's leisure time is focused on food and beverages Extent: 2	No
Fibre	Person specific but indirect Nature 2: recognise though that some people's leisure time may involve fibres, e.g. Knitting holidays or spend leisure time with sewing, etc. Extent: 1	No
Wildfoods	Person specific and direct Nature 4: hunting/fishing is important to many people for leisure time. Commercial fishers will spend more time at work if there are less fish around. Māori consider wildfoods important for leisure time (collection of watercress, tawa, etc.) Extent 3. Not all people collect wildfoods for leisure or rely on fishing etc for work	Sub 3: likely any alternatives of similar quality is some distance away No
Freshwater	Nature 1: not important	No
Pharmaceuticals etc	Nature 1: not important	No
Fuel (renew) & energy	Nature 1: not important	No
Ornamental resources	Person specific and indirect Nature 2: Kids collect shells and driftwood, but still likely small impact Extent 2: not all kids or people engage in these activities	Sub 1: can purchase options No
Genetic resources	Nature 1: not important	No
Habitat creation and maintenance	Nature: indirect and small (3). Creation of habitat can help provide recreational areas close to work, helping increasing time spent within nature	Substitutability 1. Lots of other options No

Knowledge and skills

ES/NCP	Knowledge and skills: People's knowledge and skills		
	<p>Does [ecosystem service] impact on people's (can split by sector, e.g. urban, farmers, etc.) [well-being domain] directly or indirectly and what is the size of that impact (small/large)?</p> <p>What is the extent of that impact or how many people are affected (based on number of regions or population)?</p>	<p>Is there a substitute for the [ecosystem service] service important for [well-being domain]?</p> <p>If yes, is there a cost-effective substitute or a similar alternative option?</p>	<p>Include in assessment*</p>
Erosion control	<p>Nature 1: Not important</p> <p>Potentially some indirect impacts related to managing the land to reduce soil erosion</p>		No
Natural hazard regulation (flood, drought, fires, slips)	<p>Nature 1: Not important</p> <p>Potentially some indirect impacts related to managing natural hazards</p>		No
Water regulation	<p>Nature 1: Not important</p> <p>Potentially some indirect impacts related to managing the regulation of water timing and flows</p>		No
Air quality regulation	<p>Nature 1: Not important</p> <p>Potentially some indirect impacts related to managing air quality</p>		No
Climate regulation	<p>Nature 1: Not important</p> <p>Potentially some indirect impacts related to managing the regulation of climate</p>		No
Pollination	<p>Nature 1: Not important</p> <p>Potentially some indirect impacts related to managing pollination services</p>		No
Water purification	<p>Nature 1: Not important</p> <p>Potentially some indirect impacts related to managing for purifying water (i.e. improving water quality) and learning about poor water quality issue related to health impacts (e.g. heavy metal poisoning)</p>		No
Biological control	<p>Nature 1: Not important</p> <p>Potentially some indirect impacts related to managing biological control and disease regulation</p>		No
disease regulation	<p>Nature 1: Not important</p> <p>Potentially some indirect impacts related to managing biological control and disease regulation</p>		No

ES/NCP	Knowledge and skills: People's knowledge and skills		Include in assessment*
	<p>Does [ecosystem service] impact on people's (can split by sector, e.g. urban, farmers, etc.) [well-being domain] directly or indirectly and what is the size of that impact (small/large)?</p> <p>What is the extent of that impact or how many people are affected (based on number of regions or population)?</p>	<p>Is there a substitute for the [ecosystem service] important for [well-being domain]?</p> <p>If yes, is there a cost-effective substitute or a similar alternative option?</p>	
Recreation and ecotourism	<p>Nature 2: indirect and small. Extent 1: likely <10% of population (score with 50% weightings = 1.5)</p> <p>Recreation and eco-tourism services are important for some people's knowledge and skills. They may be teachers of recreation activities or guides for nature. However, this is likely to be a small group of people</p>	<p>Sub 1 - 4: there are other ways to learn similar skills or pick up that knowledge (e.g. books, VR)</p>	Maybe
Ethical & spiritual	<p>Nature 5: direct and big. Extent 1: mostly Māori and potentially other Pacific peoples (score with 50% weightings = 3)</p> <p>Ethical and spiritual services are important for some people's knowledge and skills. This will be particularly the case for Māori people (and potentially other indigenous peoples) where their knowledge is closely tied to nature</p>	<p>Sub 5: there are no substitutes for indigenous peoples in terms of what they draw from their rohe</p>	Yes
Inspirational and educational	<p>Nature 5: Direct and big. Extent 1: only would apply to a small portion of the population (score with 50% weightings = 3)</p> <p>Inspiration and educational services are important for some people who may draw knowledge for design from nature or whose knowledge system is nature based (e.g. Mātauranga Māori). There could be implications for brain drain if this service is degraded</p>	<p>Sub 2 or 3: likely some similar alternatives available. It may be that books or recorded history could be used for education, and maybe inspiration (e.g. how a leaf works for thinking about energy solutions and the skills needed to replicate these functions) but for others no.</p> <p>For MāoriSub 5: there are no substitutes for indigenous people in terms of what they draw from their rohe</p>	Yes
Food	<p>Nature 1: Not important</p> <p>Potentially some indirect impacts related to growing food</p>		No
Fibre	<p>Nature 1: Not important.</p> <p>Potentially some indirect impacts related to growing fibre</p>		No
Wildfoods	<p>Nature 4: Direct and small; Extent 1 or 2: only affects a portion of the population (e.g. Indigenous people and hunters/fishers/etc.)</p> <p>There is cultural knowledge around traditional hunting and gathering skills as well as the knowledge to hunt/fish/etc using contemporary knowledge and equipment</p>	<p>Sub 2-3: there are likely some substitutes e.g. gathering from different areas or potentially different food sources that could teach similar skills</p>	Yes

ES/NCP	Knowledge and skills: People's knowledge and skills		Include in assessment*
	<p>Does [ecosystem service] impact on people's (can split by sector, e.g. urban, farmers, etc.) [well-being domain] directly or indirectly and what is the size of that impact (small/large)?</p> <p>What is the extent of that impact or how many people are affected (based on number of regions or population)?</p>	<p>Is there a substitute for the [ecosystem service] service important for [well-being domain]?</p> <p>If yes, is there a cost-effective substitute or a similar alternative option?</p>	
Freshwater	Nature 1: Not important Potentially some indirect impacts related to the harvest of wildfoods.		No
Pharmaceuticals etc	Nature 5: Direct and big; Extent 1: really only would apply to small portion of the population who use/make/sell pharmaceuticals, etc. Sub 1-5: depends on the type of pharmaceutical etc as there could be some similar alternatives available to provide ability to learn similar skills or gain similar knowledge. In other instances, there are none NB. this is a maybe, but decision was not to include as small compared with other ES		No
Fuel (renew) & energy	Nature 1: Not important Potentially some indirect impacts related to the production of fuels and energy		No
Ornamental resources	Nature 1: Not important Potentially some indirect impacts related to the use of ornamental resources		No
Genetic resources	Nature 1: Not important Potentially some indirect impacts related to the use of genetic resources		No
Habitat creation and maintenance	Indirect and small (2). Like Inspiration and educational services, creation of habitat is important for some people who may draw knowledge for design from nature or whose knowledge system is nature based (e.g. Mātauranga Māori)		Maybe

Social connections

ES/NCP	Social connections: Having positive social contacts and a support network		
	Does [ecosystem service] impact on people's (can split by sector e.g. urban, famers, etc) [well-being domain] directly or indirectly and what is the size of that impact (small/large)? What is the extent of that impact or how many people are affected (based on number of regions or population)?	Is there a substitute for the [ecosystem service] service important for [well-being domain]? If yes, is there a cost-effective substitute or a similar alternative option?	Include in assessment*
Erosion control	Nature of impact: 1 not important. Or indirect and small (2). Lack of erosion control may hinder connecting with people (blocked roads, e.g. Kaikoura earthquake aftermath)		No
Natural hazard regulation (flood, drought, fires, slips)	Nature: Indirect and small (2). Lack of hazard regulation may hinder connecting with people (blocked roads, e.g. Kaikoura earthquake aftermath)		No
Water regulation	Nature: not important 1. Regulation of flows doesn't impact on social connection		No
Air quality regulation	Nature: not important or at most indirect and small 1. Regulation of air doesn't impact on social connection or it would be through regulation of air in green space (urban trees)		No
Climate regulation	Nature: not important or at most indirect and small 1. Regulation of climate doesn't impact on social connection		No
Pollination	Nature: not important 1. Pollination doesn't impact on social connection		No
Water purification	Nature: indirect and small 2. Clean water for swimming helps social connection with friends	Lots of subst.	No
Biological control	Nature: not important 1		No
Disease regulation	Nature: indirect and big 2-3. Not being sick helps social connection with friends (see COVID19 impacts)		No
Recreation and ecotourism	Nature 4: Direct and small depending on person. Extent 1: less than 10% of pop (score with 50% weightings = 2.5) Social connections may be centred around nature-based recreation for some people Recreation in nature helps positive social connection. Extent: everyone 5	Sub 2 or 3: Likely substitute areas or options available in the proximity.	No

ES/NCP	Social connections: Having positive social contacts and a support network		
	Does [ecosystem service] impact on people's (can split by sector e.g. urban, famers, etc) [well-being domain] directly or indirectly and what is the size of that impact (small/large)? What is the extent of that impact or how many people are affected (based on number of regions or population)?	Is there a substitute for the [ecosystem service] service important for [well-being domain]? If yes, is there a cost-effective substitute or a similar alternative option?	Include in assessment*
Ethical & spiritual	<p>Nature 4: Direct and small. Extent 2: 10–30% of pop (likely to be a greater proportion than for recreation above) (score with 50% weightings = 3)</p> <p>Social connections and how they are attached to nature will be important for some people, particularly Māori</p> <p>Probably indirect and small (2) as spiritual connection to nature may help connect people with similar viewpoints and interest (environmental groups)</p> <p>Person dependent. Extent all of NZ (5)</p>	<p>For Māori ...sub 5: there is no substitutes for loss of specific sites/areas within a rohe</p> <p>[we should acknowledge that this has already been lost in some areas and this is where the grief is most found and an important part of the Treaty Settlement processes. So further losses will be felt even more]</p>	Yes
Inspirational and educational	<p>Nature 1: not important. Person dependent. <10% of pop</p> <p>Potentially could be some impact around the social connections that nature-based education may provide</p> <p>Direct and small (4) as education on nature helps social connection and supports network for nature-lover groups (marine education centre, cleaning beach groups, community groups) and kids' education</p>		No
Food	<p>Nature 2: indirect/direct and small (2-4). Extent 4: likely affects most folks (score with 50% weightings = 3.5)</p> <p>The impact is around the consumption of food rather than provision of food. Food is an important component of social connections for many people</p> <p>Social connection through food. A % of pop into food from nature (3). Person dependent</p>	<p>Sub 1-3: likely other similar substitutes close by or further away</p>	No
Fibre	<p>Nature 2: indirect and small. Extent 1: likely less than 10% (score with 50% weightings = 1.5)</p> <p>The impact is around the use of fibre rather than growing or harvest of fibre, e.g. woodwork groups or knitting circles</p> <p>Social connection through knitting groups. Direct and small (4), small % of pop (1)</p>	<p>Sub 13: likely other similar substitutes close by or further away</p>	No

ES/NCP	Social connections: Having positive social contacts and a support network		
	Does [ecosystem service] impact on people's (can split by sector e.g. urban, famers, etc) [well-being domain] directly or indirectly and what is the size of that impact (small/large)? What is the extent of that impact or how many people are affected (based on number of regions or population)?	Is there a substitute for the [ecosystem service] important for [well-being domain]? If yes, is there a cost-effective substitute or a similar alternative option?	Include in assessment*
Wildfoods	Nature 3: direct and small. Extent 1: likely less than 10% (score with 50% weightings = 2) While direct there are likely other components that contribute to a person's social connections and support network Should acknowledge that for some (small portion of the population) the social contacts etc around hunting/harvest/gathering of wildfoods could be important	Sub 2 of 3: likely other options in proximity or at distance that can use	No
Freshwater	Nature: indirect and small 2. Clean water for swimming helps social connection with friends	Lots of subst.	No
Pharmaceuticals etc	Social connection through naturopathy. A % of pop into medicines from nature (1). Person dependent. Indirect and small (depends on people) (2)		No
Fuel (renew) & energy	Social connection through bonfires? 1-2		No
Ornamental resources	Nature 2: indirect and small. Extent 1: likely less than 10% (score with 50% weightings = 1.5). Social connection through collection of shells etc. A % of pop into ornamentals from nature (Māori probably different) (1). Person dependent The impact is around the use of ornamental resources rather than collection of ornamental resources, e.g. crafting groups	Sub 1: likely substitutes or same quality could be sourced	No
Genetic resources	Nature 1: not important		No
Habitat creation and maintenance	Indirect and small (depends on people) (2). Creating habitat may be done through environmental groups and communities (restoration) creating social connections. It could also indirectly provide recreational areas, but this would be through another ES	NA	No

Civic engagement and governance

ES/NCP	Civic engagement and governance: People’s engagement in the governance of their country and their civic responsibilities, how ‘good’ New Zealand’s governance is perceived to be, and the procedural fairness of society.		
	Does people’s (can split by sector, e.g. urban, famers, etc.) civic engagement and governance impact on [ecosystem service] directly or indirectly and what is the size of that impact (small/large)? What is the extent of that impact or how many people are affected (based on number of regions or population)? [Note: the format of the question was changed to better reflect the intent of this well-being domain]	Is there a substitute for the [ecosystem service] service important for [well-being domain]? If yes, is there a cost-effective substitute or a similar alternative option?	Include in assessment*
Erosion control	Nature 4.5: Direct and small/big. Extent 2: likely 10–30% of population (score with 50% weightings = 3.25) This is in relation to environmental governance and policy. The NPSFM is an area where community engagement, governance and collaboration around decision-making is important. Sediment in water is one aspect of the NPSFM and thus both the laws and people’s engagement in the regional/catchment practices is and will impact on erosion control services Note: Treaty rights and responsibilities would be tied to this	N/A. There is no substitute for governance and civic responsibility for the provision of erosion control. Governance covers both the formal laws and community/society codes of behaviour	Maybe (scores between 3 and 4 considered as maybe)
Natural hazard regulation (flood, drought, fires, slips)	Nature 4.5: Direct and small/big. Extent 4: likely 50–75% of population (score with 50% weightings = 4.25) Climate adaptation and how communities and people are increasingly engaged in these discussions as natural hazards (and concern about increasing hazard events) increase. This is seen through national interest, regional council planning and community actions. Extent based on number of regions assessing risk and people affected by hazards	N/A. There is no substitute for governance and civic responsibility for the provision of natural hazard regulation. Governance covers both the formal laws and community/society codes of behaviour.	Yes (scores above 4 considered as a yes)
Water regulation	Nature 4.5: Direct and small/big. Extent 3: likely 30-50% of population (score with 50% weightings = 3.75) This is in relation to environmental governance and policy. The NPSFM is an area where community engagement, governance and collaboration around decision-making is important. Engagement in the development and implementation (e.g. community processes at catchment scale) of the NPSFM will directly affect water regulation services and the expectation of the quality of that services. Other political drivers such as the Zero Carbon Bill and 1 Billion Trees and corresponding societal response will also impact on water regulation Note: Treaty rights and responsibilities would be tied to this	N/A. There is no substitute for governance and civic responsibility for the provision of natural hazard regulation. Governance covers both the formal laws and community/society codes of behaviour	Maybe (scores between 3 and 4 considered as maybe)

ES/NCP	Civic engagement and governance: People’s engagement in the governance of their country and their civic responsibilities, how ‘good’ New Zealand’s governance is perceived to be, and the procedural fairness of society.	
	Does people’s (can split by sector, e.g. urban, famers, etc.) civic engagement and governance impact on [ecosystem service] directly or indirectly and what is the size of that impact (small/large)? What is the extent of that impact or how many people are affected (based on number of regions or population)? [Note: the format of the question was changed to better reflect the intent of this well-being domain]	Is there a substitute for the [ecosystem service] service important for [well-being domain]? If yes, is there a cost-effective substitute or a similar alternative option? Include in assessment*
Air quality	Nature 4: Direct and small. Extent 2: likely 10–30% of population (score with 50% weightings = 3) While air quality is not currently a big issue in NZ air quality is impacted by governance, e.g. banning of wood burners has improved air quality in Christchurch and Rotorua. Civic engagement has not that large for air quality in comparison to other issues	No (scores less than 3 is considered as no)
Climate regulation	Nature 4.5: Direct and small/big. Extent 3: likely 30–50% of population involved in positive climate regulation action (score with 50% weightings = 3.75) This is in relation to environmental governance and policy. The aspect of climate regulation noted here is global climate regulation and laws (i.e. climate policy) and engagement of the population in climate action (particularly related to natural capital) and also debating climate policy. Solutions to climate regulation and who bears the responsibility of reducing climate impacts is a key governance issue. Other policy/actions also influence climate regulation. For example, 1 Billion Trees programme may increase sequestration rates in NZ thus affecting climate regulation. Wilding pine control, on the other hand, may reduce sequestration (even those positive benefits for biodiversity, water regulation and aesthetic values) Note: Treaty rights and responsibilities would be tied to this	N/A. There is no substitute for governance and civic responsibility for the provision climate regulation. Governance covers both the formal laws and community/society codes of behaviour
Pollination	Nature 2: In direct and small. Extent 1: likely less than 10% of population involved. Planting of pollinator attractor plants is being driven by some people’s engagement and civic responsibility. However, this is likely only by a small portion of the population. No legal framing related to pollination.	No

ES/NCP	Civic engagement and governance: People’s engagement in the governance of their country and their civic responsibilities, how ‘good’ New Zealand’s governance is perceived to be, and the procedural fairness of society.		
	Does people’s (can split by sector, e.g. urban, famers, etc.) civic engagement and governance impact on [ecosystem service] directly or indirectly and what is the size of that impact (small/large)? What is the extent of that impact or how many people are affected (based on number of regions or population)? [Note: the format of the question was changed to better reflect the intent of this well-being domain]	Is there a substitute for the [ecosystem service] service important for [well-being domain]? If yes, is there a cost-effective substitute or a similar alternative option?	Include in assessment*
Water purification	<p>Nature 5: Direct and big. Extent 3: likely 30-50% of population (score with 50% weightings = 4)</p> <p>This is in relation to environmental governance and policy. The NPSFM is an area where community engagement, governance and collaboration around decision-making is important. Water quality is one aspect of the NPSFM.</p> <p>Poor water quality has also driven many people to increase their civic engagement, form community groups and take individual action to improve water quality by improving water purification services.</p> <p>Note: Treaty rights and responsibilities would be tied to this</p>	<p>N/A. There is no substitute for governance and civic responsibility for the provision of water purification services. Governance covers both the formal laws and community/society codes of behaviour</p>	<p>Yes (scores above 4 considered as a yes)</p>
Biological control	<p>Nature 4: Direct and small. Extent 1: likely < 10% of population (score with 50% weightings = 2.5)</p> <p>High use of chemicals and residue issues have led some people to start taking or to ask for actions to reduce chemical use and other means to control weeds, pests, and diseases. This has led to banning of some chemicals and greater exploration of natural approaches (e.g. weed biocontrol or beneficial insect plantings). Social licence is important for some control mechanisms (e.g. insecticide use) and has driven actions to find more natural solutions. However, some natural solutions (e.g. diseases to control rabbits) have resulted in civic action to not sure those approaches</p>	<p>N/A. There is no substitute for governance and civic responsibility for the provision of biological control services. Governance covers both the formal laws and community/society codes of behaviour</p>	<p>No</p>
Disease regulation	<p>Disease regulation is an ES that has been degraded due to land-use change, increasing prevalence to zoonotic diseases overseas. COVID19 is not a NZ-specific issue. In NZ, the zoonotic diseases are leptospirosis, staphylococcus, salmonella, affecting rural communities (13% StatsNZ)</p> <p>Nature: direct and small. Population 13% (rural population)</p>		<p>No</p>

ES/NCP	Civic engagement and governance: People’s engagement in the governance of their country and their civic responsibilities, how ‘good’ New Zealand’s governance is perceived to be, and the procedural fairness of society.		Include in assessment*
	Does people’s (can split by sector, e.g. urban, famers, etc.) civic engagement and governance impact on [ecosystem service] directly or indirectly and what is the size of that impact (small/large)? What is the extent of that impact or how many people are affected (based on number of regions or population)? [Note: the format of the question was changed to better reflect the intent of this well-being domain]	Is there a substitute for the [ecosystem service] service important for [well-being domain]? If yes, is there a cost-effective substitute or a similar alternative option?	
Recreation and ecotourism	Nature 2: Indirect and small. Extent 2: likely 10–30% of population (score with 50% weightings = 2) In some parts of NZ, the over-use of some natural areas is causing concern with local populations, which has led to some actions by local communities to control tourism A more direct impact is the influence of hunting/fishing/shooting season regulations these recreational activities. However, these regulations are designed to maintain healthy populations to allow the activities to continue over time	N/A. There is no substitute for governance and civic responsibility for the provision of recreation and ecotourism services. Governance covers both the formal laws and community/society codes of behaviour	No
Ethical & spiritual	Nature 2: Indirect and small. Extent 1: likely <10% of population (score with 50% weightings = 1.5) Involvement in community actions or planning processes related to the use of natural resources, could for some, increase their ethical values (e.g. social relations and sense of place) or their spiritual values (e.g. reconnection with their whenua)	N/A. There is no substitute for governance and civic responsibility for the provision of ethical and spiritual services. Governance covers both the formal laws and community/society codes of behaviour	No
Inspirational and educational	Nature 1: not important		No
Food	Nature 2: Indirect and small. Extent 2: likely 10–30% of population (score with 50% weightings = 2) The governance of natural resources and civic actions can influence what and how food is grown. For example, civic actions (e.g. dirty dairying campaign) and water regulations is changing how agricultural land is management and the type of foods grown (e.g. pressure to move some land out of pastoral uses)	N/A. There is no substitute for governance and civic responsibility for the provision of food. Governance covers both the formal laws and community/society codes of behaviour	No
Fibre	Nature 2: indirect and small. Extent 1: likely <10% of population (score with 50% weightings = 1.5) The governance of natural resources and civic actions can influence what and how trees are grown or wools is produced. For example, civic actions (e.g. dirty dairying campaign) and water regulations and climate policy is likely to convert some agricultural land to forestry. Location of exotic forest and forest harvest practices are being driven by a mix of policy but also outcries from local communities around the issues with exotic forestry (e.g. wilding pines, loss of employment and post-harvest damage)	N/A. There is no substitute for governance and civic responsibility for the provision of fibre. Governance covers both the formal laws and community/society codes of behaviour	No

ES/NCP	Civic engagement and governance: People’s engagement in the governance of their country and their civic responsibilities, how ‘good’ New Zealand’s governance is perceived to be, and the procedural fairness of society.		
	Does people’s (can split by sector, e.g. urban, famers, etc.) civic engagement and governance impact on [ecosystem service] directly or indirectly and what is the size of that impact (small/large)? What is the extent of that impact or how many people are affected (based on number of regions or population)? [Note: the format of the question was changed to better reflect the intent of this well-being domain]	Is there a substitute for the [ecosystem service] service important for [well-being domain]? If yes, is there a cost-effective substitute or a similar alternative option?	Include in assessment*
Wildfoods	<p>Nature 2: direct and small. Extent 2: likely 10-30% of population (score with 50% weightings = 2)</p> <p>There could be some issues in relation to environmental governance and policy. Mahinga kai is a value/objective within the National Objectives Framework of the NPSFM. Thus, policy and people/community values are likely to lead to improved water conditions that better supports mahinga kai. This would be indirect</p> <p>A more direct impact is hunting/fishing/shooting season regulations impact on access to some wildfoods. However, arguably his is related to recreation services</p> <p>Note: Treaty rights and responsibilities would be tied to this.</p>	<p>N/A. There is no substitute for governance and civic responsibility for the provision of wildfoods. Governance covers both the formal laws and community/society codes of behaviour</p>	No
Freshwater	<p>Nature 4: indirect and small. Extent 1: likely <10% of population (score with 50% weightings = 2.5)</p> <p>There could be some issues in relation to environmental governance and policy and the provision of safe drinking water. While historically this has not been an issue some recent cases like Havelock North have arisen raising the profile of drinking water in NZ. This is a consideration in the NPSFM where community engagement, governance and collaboration around decision-making is important</p> <p>Note: Treaty rights and responsibilities would be tied to this.</p>	<p>N/A. There is no substitute for governance and civic responsibility for the provision of freshwater. Governance covers both the formal laws and community/society codes of behaviour</p>	No
Pharmaceuticals etc	<p>Nature 1: not important</p>		No
Fuel (renew) & energy	<p>Nature 1: not important</p>		No
Ornamental resources	<p>Nature 1: not important</p>		No
Genetic resources	<p>Nature 1: not important</p> <p>Note: Genetic modification is not considered as this service relates to the genes and genetic resources in nature (not the manipulation of genes)</p>		No
Habitat creation and maintenance	<p>Governance for land tenure has strong impact on creation of habitat. DOC’s responsibility is to maintain habitat Nature: direct and big</p>		Yes

Environmental quality

ES/NCP	Environmental quality: The natural and physical environment and how it impacts people today		Include in assessment*
	<p>Does [ecosystem service] impact on people's (can split by sector e.g. urban, famers, etc) [well-being domain] directly or indirectly and what is the size of that impact (small/large)?</p> <p>What is the extent of that impact or how many people are affected (based on number of regions or population)?</p>	<p>Is there a substitute for the [ecosystem service] service important for [well-being domain]?</p> <p>If yes, is there a cost-effective substitute or a similar alternative option?</p>	
Erosion control	<p>Erosion degrades the quality of the land 5 Nature of impact: direct and small (4). Everywhere, mainly hillcountry (5). Protects from land degradation processes for other ecosystems. Mainly useful for productive land Extent = local occurrences but happens everywhere, 5</p>	<p>Tech options to reduce erosion, but it would still be seen as a stopgap OR seeing infrastructure that reduces erosion could impact perception of quality if it's not done with that in mind. Private cost or RC cost depending on where the erosion is occurring. Could be expensive though. NA. No subst of ES for environmental quality (anywhere)</p>	Yes
Natural hazard regulation (flood, drought, fires, slips)	<p>e.g. If a slip occurs it could be because of natural forces and/or man-made interventions that weakened the soil structure. Therefore, the perception could be an area more prone to slips is indicative of poor quality. 5 for some hazards and 4 for others depending on the region Flooding: flood plains (natural), but more frequent floods or more severe floods could be connected with CC & natural hazard reg. Drought: people know there are droughts, but it the change from normal that could infer degrading quality Nature of impact: direct and big (5). Regulation of fire, drought important for environment quality, helps resilience of spp. Extent = local, but different hazards in regions 5</p>	<p>RC or gov intervention and could be expensive Dams, sea walls, but does it affect env quality?</p>	Yes

ES/NCP	Environmental quality: The natural and physical environment and how it impacts people today		Include in assessment*
	Does [ecosystem service] impact on people's (can split by sector e.g. urban, farmers, etc) [well-being domain] directly or indirectly and what is the size of that impact (small/large)? What is the extent of that impact or how many people are affected (based on number of regions or population)?	Is there a substitute for the [ecosystem service] service important for [well-being domain]? If yes, is there a cost-effective substitute or a similar alternative option?	
Water regulation	Nature of impact 5. Really important for natural capital, stock of fish Drainage: increased runoff could infer poor quality (e.g. too much pavement) 4 Extent = local occurrences, 1	Not sure there are substitutes for some Could build a dam and then that would become a way to signal quality, but it could also cause downstream environmental issues like cutting off fish runs OR could be a large signal of drought issues. Could have to RC or gov intervention Dams. Negative impact (fish passage) Replace roads, sidewalks with more green space & permeable pavement	Yes
Air quality	Air in non-urban zones tend to be preferred because it's cleaner: 5 Nature of impact 2. Indirect and small? Mainly directed towards people, not environment Extent = urban zones primarily (2) but 3 in terms of population proportion	RC/gov intervention for redevelopment to reduce pollution. 3-4 Personal behavioural change to reduce own impact 1	No (BUT potential future value)
Climate regulation	Change from normal, or expectations infers a degrading environmental quality. 5 Nature of impact 5. Regulation of climate important to avoid CC impacts on natural ecosystems Extent: countrywide 5	Not possible without global action	Yes
Pollination	The severe absence of natural pollination gets attention because we take it for granted, but this is more of a signal around biodiversity loss. We could see fewer wildflower, or our food costs go up or we are negatively impacted through existence value. Probably more indirect effect, 2/3 Nature of impact 5. Pollination essential for natural ecosystems Extent = no boundaries, 5	Mechanical pollination for crops, but would have to solve cause of loss: insecticides, pesticides, habitat loss, climate change, etc. 5 There is no substitute for pollination of non-managed ecosystems (natural) by native bees, wind, etc. Personal behavioural change to reduce own impact 1	Yes

ES/NCP	Environmental quality: The natural and physical environment and how it impacts people today		Include in assessment*
	<p>Does [ecosystem service] impact on people's (can split by sector e.g. urban, farmers, etc) [well-being domain] directly or indirectly and what is the size of that impact (small/large)?</p> <p>What is the extent of that impact or how many people are affected (based on number of regions or population)?</p>	<p>Is there a substitute for the [ecosystem service] service important for [well-being domain]?</p> <p>If yes, is there a cost-effective substitute or a similar alternative option?</p>	
Water purification	<p>Through recreation and freshwater: clean water provides direct benefits through rec & drinking water</p> <p>Nature of impact 5. Water purification essential for freshwater habitats</p> <p>Water is calming, but we associate weird smells and/or bad look of water with environmental degradation. We don't want to be around water that smells or looks unclean, so, 5</p> <p>Extent = countrywide</p>	<p>Alternative locations (4)</p> <p>Could implement tech/plantings to make natural filtration process more robust (e.g. Riparian plantings, filters for industrial waste)</p> <p>there is no substitute to perceived environmental quality if pure water quality is not available</p>	yes
Biological control/disease regulation	<p>A higher prevalence of invasive species infers degrading environmental quality (perception) through man-made interventions. 5</p> <p>Nature of impact 5. essential for natural ecosystems quality</p> <p>Could also say: lack of biological control (e.g. increase use of chemical for crop pathogens, etc.) has high impact (direct and big) on perceived env quality</p> <p>Extent = countrywide</p> <p>Ecosystems (e.g. bio-agent) influence disease/pest in humans and husbandry, impact on perceived environmental quality by avoiding using chemicals</p>	<p>Pest control measures: some are personal, some RC can do, central gov biosecurity/DOC, control or eradication could be prohibitive expensive depending on species</p> <p>subst. would be artificial/induced (e.g. chemical, mechanical) control and how it impacts on perceived env. Quality (which is variable, depending on the person)</p> <p>Mammal pest control: 1080.</p> <p>Weeds: pesticides</p> <p>Insect: insecticides</p> <p>Virus: vaccines (so no subst, as biologically based)</p>	yes
Recreation and ecotourism	<p>Rec allows us to experience and rank the quality of the environmental. We wouldn't want to go hiking in a place with degrading quality. Not sure if rec impacts quality except when there is too much. 2/4</p> <p>Nature of impact: direct and small (4).</p> <p>Recreation services impacting on environmental quality? great walks. Too many tourists impacts on perceived naturalness.</p> <p>Extent: countrywide</p>	<p>Alternative rec places allows us to experience quality differently (4)</p>	yes

ES/NCP	Environmental quality: The natural and physical environment and how it impacts people today		Include in assessment*
	Does [ecosystem service] impact on people's (can split by sector e.g. urban, farmers, etc) [well-being domain] directly or indirectly and what is the size of that impact (small/large)? What is the extent of that impact or how many people are affected (based on number of regions or population)?	Is there a substitute for the [ecosystem service] service important for [well-being domain]? If yes, is there a cost-effective substitute or a similar alternative option?	
Ethical & spiritual	Your sense of connection with the land would probably lead you to take care of the environment more. Lack of sense of place might lead you to not care for the land. 3/5 Nature of impact: (4–5). Person dependent. Perception of environmental quality depends on spiritual connection Extent = the culture tends to care for the land, 5	No real alternative	yes
Inspirational and educational	Poor environmental quality would probably lead to less inspiration. Taking too much from nature (e.g. everyone takes a rock) would eventually degrade the environment and make those in the future less well off. 3/5 ? 1 to 4: Education does not impact on environmental quality. Inspiration vs environmental quality: person dependent. Opposite: environmental quality affects inspiration Extent = population specific, 1/2	Some alternatives probably exist, 3/4	yes
Food	Food production could negatively impact the perception of quality; however, people also receive a benefit from seeing corn grow or sheep on good looking land (e.g. minimum pugging). 3/5 Provision of food impacting on perceived environmental quality: 4–5. Question on sustainable food production, impact food system on water quality Mitigation of negatives would be changing land management practices (1 or 5 depending on structure) Extent 1–2	No	yes
Fibre	Same as food Provision of fibre (timber) impacting on perceived environmental quality: 4–5. Question on sustainable timber production, impact wood production system on water quality Mitigation of negatives would be changing land management practices (1 or 5, depending on structure)	no	yes

ES/NCP	Environmental quality: The natural and physical environment and how it impacts people today		Include in assessment*
	Does [ecosystem service] impact on people's (can split by sector e.g. urban, farmers, etc) [well-being domain] directly or indirectly and what is the size of that impact (small/large)? What is the extent of that impact or how many people are affected (based on number of regions or population)?	Is there a substitute for the [ecosystem service] service important for [well-being domain]? If yes, is there a cost-effective substitute or a similar alternative option?	
Wildfoods	We see poor environmental quality with a loss of wildfoods (e.g. fisheries declines), but that loss is also due to degrading environmental quality. Probably through biodiversity loss, or species loss 2/3 Human-related. Provision of wildfood vs perceived env quality. impact direct and big Extent = pop specific 1 or 2	Solve cause of biodiversity loss in area: insecticides, pesticides, habitat loss, climate change etc. 5 Personal behavioural change to reduce own impact 1	yes
Freshwater	Clean water provides direct benefits through rec & drinking water High 4–5. Need freshwater quality for perceived env quality Water is calming, but we associate weird smells and/or bad look of water with environmental degradation. We don't want to be around water that smells or looks unclean, so, 5 Extent = countrywide	Alternative locations (4), filtration tech for drinking water, watershed management change (RC/gov) Could implement tech/plantings to make natural filtration process more robust (e.g. Riparian plantings, filters for industrial waste) but that's through water purification	yes
Pharmaceuticals etc	If we take too much then it would degrade quality for future generations 3, probably no real impact though 1 Low 1–2. For health WB, not perceived env quality. Extent = population/sector specific 1 or 2		no
Fuel (renew) & energy	Renewables: building things can impact the perception of unspoiled land, but renewable infrastructure could also be a benefit as we see society utilising the environment instead of degrading it. 3 Low 1–2. For material WB, not perceived env. quality From plants/animals: If we take too much then it would degrade quality for future generations or would impact quality through other means (e.g. erosion control), 3 Extent = for those living near sources, 1 or 2		No
Ornamental resources	If we take too much, then it would degrade quality for future generations 3/5 Low 1–2. For material WB, not perceived env quality Extent = countrywide	Personal behavioural change 1	No

ES/NCP	Environmental quality: The natural and physical environment and how it impacts people today		Include in assessment*
	<p>Does [ecosystem service] impact on people's (can split by sector e.g. urban, farmers, etc) [well-being domain] directly or indirectly and what is the size of that impact (small/large)?</p> <p>What is the extent of that impact or how many people are affected (based on number of regions or population)?</p>	<p>Is there a substitute for the [ecosystem service] service important for [well-being domain]?</p> <p>If yes, is there a cost-effective substitute or a similar alternative option?</p>	
Genetic resources	<p>High? 4-5. Need good genet res. for perceived env quality.</p> <p>Lower genetic resources would infer a degrading environment, but it doesn't necessarily impact environmental quality. 1</p> <p>thinking of genetic resource as options for resilience....maintenance of options. If you lose genetic resources, then you may lose future environmental quality; overlaps with other well-beings as well. perception of loss of biod and genetic resources and the importance for env. quality</p>	No	Yes
Habitat creation and maintenance	<p>Similar to genetic resources. Direct and big. No</p> <p>Loss of habitat is a direct symptom of perceived loss of env. Quality. 5</p> <p>Extent: countrywide</p>	No	Yes

Safety and security

ES/NCP	Safety and security: People's safety and security (both real and perceived) and their freedom from risk of harm and lack of fear		
	Does [ecosystem service] impact on people's (can split by sector, e.g. urban, farmers, etc.) [well-being domain] directly or indirectly and what is the size of that impact (small/large)? What is the extent of that impact or how many people are affected (based on number of regions or population)?	Is there a substitute for the [ecosystem service] important for [well-being domain]? If yes, is there a cost-effective substitute or a similar alternative option?	Include in assessment*
Erosion control	Nature 4: Direct and small; Extent 3 or 4: relates to the extent of coastal erosion Coastal erosion can affect housing and people in those areas could have safety and security concerns	Sub 1-3: depends on what erosion trying to control but sea walls and coastal erosion schemes can be cost-effectively used.	No
Natural hazard regulation (flood, drought, fires, slips)	Nature 4: Direct and small. Extent 1: likely <10% of population but covers all regions (5) (score with 50% weightings = 2.5) Disasters related to nature are increasing on the forefront of people's minds. While direct, it is likely still affecting on a small portion of the populations but in all regions of the country. However, these impacts are sporadic rather than continual	Sub 1-5: this is natural hazard and area specific, e.g. bunds around houses vs flood control schemes	Yes, this was a maybe but decided to include due to likely increase in nat hazards
Water regulation	Nature 1: not important		No
Air quality regulation	Nature 1: not important		No
Climate regulation	Nature 4: Direct and small; Extent depends on where infrastructure is and the effects of extreme events Climate change and lack of climate regulation can affect infrastructure and exacerbate extreme events. These can impact on a person's sense of security This more of a potential future risk, e.g. sea level rise, and of extreme events (rather than natural hazards), e.g. wind injuries related to climate and increases in violent crimes and assaults with temperature (NSW, Korea, Finland, Chicago; https://www.theguardian.com/news/2019/aug/02/we-atherwatch-a-heatwave-can-lead-to-a-crime-wave).	Sub 5: there is no cost-effective substitute for climate regulation in this context	Yes, tracking ES as the impacts are potential
Pollination	Nature 1: not important		No
Water purification	Nature 2: indirect and small. Extent 1: likely <10% of population (score with 50% weightings = 1.5) Some concerns are around clean drinking water. However, this relates to the 'freshwater' provisioning service	Sub 1-3: situation dependent but relates to drinking water. See drinking water	No
Biological control	Nature 2: indirect and small. Extent 1: likely <10% of population (score with 50% weightings = 1.5) Potentially there are some livestock and crops concerns but this would affect the income and wealth well-being rather than the personal security	Sub 1: in most instances we have chemical substitutes for most things of concern in NZ	No

ES/NCP	Safety and security: People's safety and security (both real and perceived) and their freedom from risk of harm and lack of fear		Include in assessment*
	Does [ecosystem service] impact on people's (can split by sector, e.g. urban, farmers, etc.) [well-being domain] directly or indirectly and what is the size of that impact (small/large)?	Is there a substitute for the [ecosystem service] service important for [well-being domain]?	
	What is the extent of that impact or how many people are affected (based on number of regions or population)?	If yes, is there a cost-effective substitute or a similar alternative option?	
Disease regulation	Nature 2: indirect and small. Extent 1: likely <10% of population (score with 50% weightings = 1.5) Nature-based diseases affecting safety for humans in NZ is not big	Sub 1: in most instances we have chemical substitutes for most things of concern in NZ	No
Recreation and ecotourism	Nature 1: not important		No
Ethical & spiritual	Nature 1: not important		No
Inspirational and educational	Nature 1: not important		No
Food	Nature 2: indirect and small. Extent 1: likely <10% of population (score with 50% weightings = 1.5) While food security is not a huge concern currently in NZ, it may be something of a concern in the future	Sub 1: currently able to buy food from other countries. As long as trade is not disrupted and food production in other countries is not affected, this is low risk	No
Fibre	Nature 1: not important		No
Wildfoods	Nature 1: not important		No
Freshwater	Nature 1: not important Freshwater (i.e. drinking water) is important for health but not safety		No
Pharmaceuticals etc	Nature 1: not important		No
Fuel (renew) & energy	Nature 1: not important Does have energy security concerns; but not personal security		No
Ornamental resources	Nature 1: not important		No
Genetic resources	Nature 1: not important		No
Habitat creation and maintenance	Nature 1: not important		No

Subjective well-being

ES/NCP	Subjective well-being: Overall life satisfaction and sense of meaning and self		Include in assessment*
	Does [ecosystem service] impact on people's (can split by sector e.g. urban, farmers, etc.) [well-being domain] directly or indirectly and what is the size of that impact (small/large)? What is the extent of that impact or how many people are affected (based on number of regions or population)?	Is there a substitute for the [ecosystem service] service important for [well-being domain]? If yes, is there a cost-effective substitute or a similar alternative option?	
Erosion control	Nature 1: not important		No
Natural hazard regulation (flood, fires, drought, slips)	Nature 1: not important		No
Water regulation	Nature 1: not important		No
Air quality regulation	2: Indirect and small: people living in areas with air quality issues that affect health which decreases their overall life satisfaction Urban population more affected than rural population PM10 (use cardiac hospitalisations, respiratory hospitalisations and restricted activity days – not premature deaths) Pollen season is 34 weeks ¹² . Grass is major pollen hazard from Oct to after Xmas	Depends on pollutant Pollen – 5 (many diffuse sources; tend to treat symptom not the source) PM10: – power plants/cars 1 – fires 1 (however, the technology to reduce pressure does not necessarily eliminate so cumulative impacts are a problem) Natural environment can mitigate, e.g. trees in urban areas reduce PM10 in air	Maybe
Climate regulation	5: growing anxiety about climate crisis directly affects life satisfaction. All of population. National but number per region is likely unknown. Likely more of an issue for younger generations.	4: while technologies to reduce GHGs or improve climate regulation (e.g. sequester carbon) are available, the scale of mitigation needed is beyond the individual or the community	Yes
Pollination	Nature 1: not important		No

¹² <https://blog.metservice.com/pollen>

ES/NCP	Subjective well-being: Overall life satisfaction and sense of meaning and self		
	Does [ecosystem service] impact on people's (can split by sector e.g. urban, farmers, etc.) [well-being domain] directly or indirectly and what is the size of that impact (small/large)? What is the extent of that impact or how many people are affected (based on number of regions or population)?	Is there a substitute for the [ecosystem service] service important for [well-being domain]? If yes, is there a cost-effective substitute or a similar alternative option?	Include in assessment*
Water purification	<p>3: indirect and big. Manifests through inability to recreate in water ways (seasonal effect) and through clean drinking water (year-round)</p> <p>Likely effects urban populations in terms of drinking water as rural population has own water supply (often rainwater). Some exceptions when drinking water comes from groundwater</p> <p>Regions/rivers/beaches affected for recreation: Manawatu Waikato Many HB rivers Te Waihora</p> <p>Drinking water: most of country uses treated water. Regions where not all municipal water is treated are in areas of Hawke's Bay & Canterbury</p>	<p>4: water treatment plants for drinking water</p> <p>5: cleaning water for recreation purposes is not affordable. However, people may have substitute areas to recreate</p>	Maybe
Biological control	Nature: indirect and small (2). The sense of subjective well-being is remotely linked to the capacity of ecosystem to regulate disease		No
Disease regulation	Nature: indirect and small (2). The sense of subjective well-being is remotely linked to the capacity of ecosystem to regulate disease		No
Recreation and ecotourism	<p>5: directly affects life satisfaction</p> <p>All of NZ population</p>	<p>5: While many recreational substitutes are available (e.g. gym), these substitutes are not likely to provide the same experience or level of satisfaction as nature-based recreation</p>	Maybe
Ethical & spiritual	<p>5: directly affects life satisfaction</p> <p>All of NZ population</p>	<p>5: there is no technological substitute for the sense of place that a person feels for an area.</p>	Yes
Inspirational and educational	<p>2: Indirect for those people whose jobs (which would contribute to life satisfaction) depends on nature for innovation.</p> <p>Only affects those who design technology or use nature</p>		No
Food	<p>2: Indirect and large: all people's life satisfaction would be indirectly affected by poor food provision</p> <p>All of NZ population</p>	<p>1: Food can be imported</p>	Yes

ES/NCP	Subjective well-being: Overall life satisfaction and sense of meaning and self		
	Does [ecosystem service] impact on people's (can split by sector e.g. urban, farmers, etc.) [well-being domain] directly or indirectly and what is the size of that impact (small/large)? What is the extent of that impact or how many people are affected (based on number of regions or population)?	Is there a substitute for the [ecosystem service] service important for [well-being domain]? If yes, is there a cost-effective substitute or a similar alternative option?	Include in assessment*
Fibre	2: Indirect and small: people who jobs rely on timber/wool or directly consume timber/wool will be affected as lack of access to these goods could affect sense of self-worth or provide frustration when product is no longer available Portion of NZ population working in respective industries or consuming these goods	1: Fibre (timber, wool) can be imported or other materials (e.g. brick) used	No
Wildfoods	1: indirect and small. Affect people that are hunting or fishing		No
Drinking water	2: Indirect and large: Manifests through lack of available clean drinking water (year-round) Likely effects urban populations in terms of drinking water as rural population has own water supply (often rainwater). Some exceptions when drinking water comes from groundwater. Drinking water: most of country uses treated water. Regions where not all municipal water is treated is in areas of Hawke's Bay & Canterbury Areas where water shortages are an issue may also start experiencing problems	4: Dams and water storage. Purchase of water from other countries could also be option	Maybe
Pharmaceuticals etc	Nature 1: not important		No
Fuel (renew)	2: Indirect and small: people who jobs rely on renewable fuels or directly consume renewable fuels will be affected as lack of access to these goods could affect sense of self-worth or provide frustration when product is no longer available If a person has switched to these goods for sustainability reasons, then this will directly affect life satisfaction	1: petroleum products	No
Ornamental resources	Nature 1: not important		No
Genetic resources	2: Indirect and small: people who jobs rely on genetic resources will be affected and therefore impact on life satisfaction Those whose jobs use genetic resources	Unknown.	No
Habitat	4: knowing that habitats exist may directly affect life satisfaction and the sense of peace a person has. Likely smaller compared with other aspects that affect life satisfaction	5: there is no technical substitute for habitat and the role it plays with people life satisfaction	Yes

Cultural identity

ES/NCP	Cultural identity: Having a strong sense of identity, belonging and ability to be oneself, and the existence value of cultural taonga		
	Does [ecosystem service] impact on people’s (can split by sector, e.g. urban, famers, etc.) [well-being domain] directly or indirectly and what is the size of that impact (small/large)? What is the extent of that impact or how many people are affected (based on number of regions or population)?	Is there a substitute for the [ecosystem service] service important for [well-being domain]? If yes, is it a cost-effective substitute or a similar alternative option?	Include in assessment*
Erosion control	Nature 2: indirect and small. Extent 1: likely <10% of population (score with 50% weightings = 1.5) There could be some impacts based on how soil erosion may affect a person’s sense of place	Sub 1: many individuals can do something about erosion control cost-effectively. This could be looked in two ways: does the ability to control erosion (e.g. by planting trees, bunds, etc.) mean there is a cost-effective substitute that will fix the area and hence improve cultural identity; OR does the lack of erosion control mean cultural identity in one special place is lost. If cultural identity was to place not what a place looked like, then a damaged place still holds cultural identity and sense of place, but a person may not be happy about it. Technical substitutes relate to the first approach and are there ways to control erosion that would preserve cultural identify/ This would be yes (noting that slips are natural hazards).	No
Natural hazard regulation (flood, drought, fires, slips)	Nature 4: indirect and small. Extent 1: likely <10% of population (score with 50% weightings = 3) There could be some impacts based on how natural hazards may affect a person’s sense of place, e.g. impact of natural hazards on culturally sensitive areas like a pa, cemetery/urupā, or Māori archaeology	Sub 1-5: this is natural hazard and area specific, e.g. bunds around houses vs flood control schemes	Yes, (particularly Māori) It is a maybe depending on context. Decided to include as a second tier ES
Water regulation	Nature 4: Direct and small. Extent 1: likely <10% of population (score with 50% weightings = 2.5) There could be some impacts based on how low or high flows may affect a person’s sense of place. For Māori, the maui of the water can be affected, which is important for cultural identity	Sub 1-5: there is likely other places with stream flows that may provide similar senses of identify or technologies/solutions like augmented flows	Yes (particularly Māori) decided to include back on maui of the water consideration

ES/NCP	Cultural identity: Having a strong sense of identity, belonging and ability to be oneself, and the existence value of cultural taonga		Include in assessment*
	Does [ecosystem service] impact on people's (can split by sector, e.g. urban, famers, etc.) [well-being domain] directly or indirectly and what is the size of that impact (small/large)?	Is there a substitute for the [ecosystem service] service important for [well-being domain]?	
	What is the extent of that impact or how many people are affected (based on number of regions or population)?	If yes, is it a cost-effective substitute or a similar alternative option?	
Air quality regulation	Nature 4: Direct and small. Extent 1: likely <10% of population (score with 50% weightings = 2.5) The smell of a place is often important for identify. Thus, having clean, unpolluted airs is important	Sub 5: no real substitutes/alternatives for good air quality	Yes (All NZers)
Climate regulation	Nature 4: Direct and small (but potential). Extent 1: likely <10% of population (score with 50% weightings = 2.5) Cultural heritage may be affected by climate and therefore the resilience of these sites (which are important for cultural heritage) is important. May also be some changes to traditional and cultural activities (e.g. celebrations or activities in certain times and places that may no longer be possible due to changes in local or global climate)	Sub: no real cost-effective substitute/alternative	Yes (particularly Māori)
Pollination	Nature 3: Indirect and small. Extent 1: likely <10% of population (score with 50% weightings = 2) Pollination can indirectly impact on cultural identity where the loss of pollinators may mean certain species (important for indigenous people) don't flower or no longer exist	Sub 1 – 5: Depends on what species are affected by the loss of this service. Some species may have many alternative pollinators while others may not	No (concern is covered via habitat creation)
Water purification	Nature 3 or 4: indirect and big/direct small. Extent 3: 30–50% of population affected (score with 50% weightings = 3) There could be some impacts based on how water quality may affect a person's sense of place. For instance, algal growth may negatively affect a person's sense of place. Other affect could be indirect through ability to swim. Ability to swim in natural places is important for many New Zealanders	Sub 1-5: there are likely other places with water quality that provide similar senses of identify. Score will depend on the place in question and the cultural significance it may hold (is it to the place or the activity at that place?)	Maybe, Perhaps tier 3 indicator if this well-being (issue picked up in other WBs)
Biological control	Nature 1: not important		No
Disease regulation	Nature 1: not important		No
Recreation and ecotourism	Nature 4: Direct and small. Extent 3: likely at least 30–50% of population (score with 50% weightings = 3.5) Part of many NZers identity is to be able to walk/tramp/fish/hunt. Thus, impacts that change recreational opportunities may affect a person's identify, e.g. ability to walk in a specific forest or undertake a specific type of activity (e.g. hunting)	Sub 2-4: is location dependent on whether other alternative options are available nearby	Yes (all NZers)

ES/NCP	Cultural identity: Having a strong sense of identity, belonging and ability to be oneself, and the existence value of cultural taonga		
	Does [ecosystem service] impact on people's (can split by sector, e.g. urban, famers, etc.) [well-being domain] directly or indirectly and what is the size of that impact (small/large)? What is the extent of that impact or how many people are affected (based on number of regions or population)?	Is there a substitute for the [ecosystem service] service important for [well-being domain]? If yes, is it a cost-effective substitute or a similar alternative option?	Include in assessment*
Ethical & spiritual	Nature 5: Direct and big. Extent 2: likely at least 10-30% of population (conservative) (score with 50% weightings = 3.5) Ethical and spiritual services directly underpin cultural identity for many people	Sub 5: location is tied to the sense of identify (including ecological quality of that location)	Yes (all NZers)
Inspirational and educational	Nature 5: Direct and small. Extent 1: likely <10% of population (score with 50% weightings = 3) Māori, in particular, may rely on using nature as an educational avenue to build the cultural identify of their youth (or reconnection of older generations)	For MāoriSub 5: there would be no substitutes for loss of certain parts of their rohe [we should acknowledge that this has already been lost in some areas and this has been noted as an issue (e.g. through Treaty Settlements). So further losses will be felt even more]	Yes
Food	Nature 3: indirect and big. Extent 2: likely 10-30% of population (score with 50% weightings = 2.5) Farmers have a strong sense of identify and connect to others who provide the food for the nation. Many are owners of the land, so the connection is stronger	Sub 2 or 3: As long as farmland of similar quality is available then this well-being could be provided by other areas	Yes (all NZers)
Fibre	Nature 3: indirect and big. Extent 2: likely 10-30% of population (score with 50% weightings = 2.5) Farmers (wool)/foresters (timber) have a strong sense of identify and connect to others who provide the food for the nation. Many farmers are owners of the land, so the connection is stronger. Māori forester owners may have similar connections to the land.	Sub 2 or 3: As long as farm/forest land of similar quality is available then this well-being could be provided by other areas	Yes (all NZers)
Wildfoods	Nature 4: Direct and small. Extent 2: likely 10-30% of population (score with 50% weightings = 3) Māori, in particular, may rely on wildfoods to underpin their identify. Each iwi have specific taonga and their sense of reciprocity relates to the ability to feed guests wildfoods from their taonga. Hunters/fishers may also tie their cultural identify to wildfood harvest	For MāoriSub 5: while the often now purchase food from grocery store for marae activities they always note that they don't have wildfoods left in the rohe to harvest	Yes (all NZers)
Freshwater	Nature 1: not important Drinking freshwater in rivers, provision of freshwater for recreation, can be part of cultural identity but this is indirect		No

ES/NCP	Cultural identity: Having a strong sense of identity, belonging and ability to be oneself, and the existence value of cultural taonga		Include in assessment*
	<p>Does [ecosystem service] impact on people's (can split by sector, e.g. urban, farmers, etc.) [well-being domain] directly or indirectly and what is the size of that impact (small/large)?</p> <p>What is the extent of that impact or how many people are affected (based on number of regions or population)?</p>	<p>Is there a substitute for the [ecosystem service] service important for [well-being domain]?</p> <p>If yes, is it a cost-effective substitute or a similar alternative option?</p>	
Pharmaceuticals etc	<p>Nature 4: Direct and small. Extent 1: likely <10% of population (score with 50% weightings = 2.5)</p> <p>Māori, for example, may have their cultural identity tied to being able to use Rongoa</p>	<p>Sub 1-5: depends as could be other alternatives available for native medicines</p>	Maybe, perhaps a second tier indicator
Fuel (renew) & energy	<p>Nature 1: not important</p> <p>Some species, e.g. manuka, may be important for smoking foods and relates to cultural identity. This would be indirect.</p>		No
Ornamental resources	<p>Nature 4: Direct and small. Extent 1: likely <10% of population (score with 50% weightings = 2.5)</p> <p>Māori, in particular, may rely on ornamental resources to honour people or as a sign of seniority, e.g. greenstone (pounamu) may be given as a gift of gratitude to someone who has helped you or to a family member. Kiwi feather cloaks (Kahu kiwi) were made to represent prestige and mana (status and authority). Flax weaving is an important cultural tradition</p>	<p>For MāoriSub 3-5: in some instance a resource could be found a distance away (e.g. greenstone) while in other cases it may no longer be available (e.g. huia feathers as species is now extinct)</p>	Yes (particularly Māori)
Genetic resources	<p>Nature 4: Direct and small. Extent 4: likely 50–75% of population (score with 50% weightings = 4)</p> <p>Cultural identity could be tied to the genetic diversity of NZers' natural environment and the importance of taonga species for all Nzers</p>	<p>Sub 4: likely few substitutes for loss of genetic resources</p>	Yes (particularly Māori)
Habitat creation and maintenance	<p>Nature 4: Direct and small. Extent 4: likely 50–75% of population (score with 50% weightings = 4)</p> <p>Cultural identity tied to the native habitat diversity of NZers' natural environment and the importance of taonga species for all Nzers</p>		Yes

Income and wealth

ES/NCP	Income and wealth (income and consumption is terms in the LSF doc): People's disposable income from all sources, how much people spend and the material possessions they have.		
	Does [ecosystem service] impact on people's (can split by sector e.g. urban, famers, etc) [well-being domain] directly or indirectly and what is the size of that impact (small/large)? What is the extent of that impact or how many people are affected (based on number of regions or population)?	Is there a substitute for the [ecosystem service] service important for [well-being domain]? If yes, is there a cost-effective substitute or a similar alternative option?	Include in assessment*
Erosion control	Farmers: income depends on the land (lose unstable land, spend more on reinforcing land) -indirect as through other ES like Food production Landowners: lose unstable land, spend more on reinforcing land, danger to infrastructure – indirect as through infrastructure/housing Urban, nonlandowners: no impact Nature: 1 to 2 Region, population and geography specific (could be <10–30%) Extent: 1 to 2	Cost-effective control of erosion exists Control would be at an individual scale Sub: 1	No
Natural hazard regulation (flood, drought, fires, slips)	Impact is through how natural hazards impact on income generation or the value of property/resources owned. For example, droughts reduce agricultural production which affects income generation (indirect in this case) Floods though directly affect infrastructure which directly affects wealth. In all instances, the impact is sporadic rather than continual. Directly impact property (material goods), land values (wealth), and indirectly someone's job or place of work. Nature (current): 3, 4, or 5 Potential impact: The incidence of some natural hazards may increase with climate change. Different natural hazards impact different parts of the country, however it would impact the income of a small proportion at any given time Extent: 2	Flood schemes (private (2) and sometimes public (3)) but cost to mitigate would be smaller than income loss For example, farm/household water storage is affordable for private individual (1). Flood control schemes, however, require RC or central govt investment (4). Some require public investment to fix after the event (3/4) Sub: 1 to 5 depending on the size and frequency of the natural hazard being mitigated.	Maybe. Second tier: Potential as the magnitude of impact could increase over time due to extreme events (similar to Personal Security). Places like Hawke's Bay are saying that drought is having a larger impact on income/jobs than does Covid.

ES/NCP	Income and wealth (income and consumption is terms in the LSF doc): People's disposable income from all sources, how much people spend and the material possessions they have.		
	<p>Does [ecosystem service] impact on people's (can split by sector e.g. urban, famers, etc) [well-being domain] directly or indirectly and what is the size of that impact (small/large)?</p> <p>What is the extent of that impact or how many people are affected (based on number of regions or population)?</p>	<p>Is there a substitute for the [ecosystem service] service important for [well-being domain]?</p> <p>If yes, is there a cost-effective substitute or a similar alternative option?</p>	Include in assessment*
Water regulation	Farmers: drought or change in water flows indirectly impact income through Food production or through Nat hazard regulation. Drainage and pugging issues indirect through Food production Nature: 2 Extent: 1 local issue	Cost-effective ways to regulate water (e.g. weirs, diversion channels) and alternative water sources exists Some projects may require PC or central to pay for (eg dams), however through natural hazard Sub: 1 or 2	No
Air quality	Indirect through Health WB Nature: 1 to 2	Mitigation works indoors and is of different quality Sub: 4	No
Climate regulation	Indirect through nat. haz regulation or indirect and small because someone would spend more on mitigation of temp issues Nature: 2 Extent: 1 likely impacts a small proportion of population	Personal tech mitigation 1 Mitigation would work indoors and only to a point 4 Sub 1-5 depending on what is needed to regulate effects of climate (e.g. greenhouses, irrigation) or not possible (growing grains in greenhouses is prohibitively expensive)	Maybe. Potential as the magnitude of impact could increase over time due to extreme events (similar to Personal Security). Places like Hawkes Bay are saying that drought is having a larger impact on income/jobs than Covid. Tracking indicator. How climate would impact infrastructure (e.g. melting roads with higher heat)?
Pollination	Impact is indirect as it would be impact of pollination services on food and fibre production Nature: 2 Extent = local issue probably 1	Personal tech mitigation 1 Sub 1: can use artificial pollination approaches or managed pollinators like bees	No

ES/NCP	Income and wealth (income and consumption is terms in the LSF doc): People's disposable income from all sources, how much people spend and the material possessions they have.		
	Does [ecosystem service] impact on people's (can split by sector e.g. urban, famers, etc) [well-being domain] directly or indirectly and what is the size of that impact (small/large)? What is the extent of that impact or how many people are affected (based on number of regions or population)?	Is there a substitute for the [ecosystem service] service important for [well-being domain]? If yes, is there a cost-effective substitute or a similar alternative option?	Include in assessment*
Water purification	Impact is indirect as it would be impact of poor water quality on food production or spending on infrastructure (e.g. water treatment facilities) Nature: 2 Extent = local 1	Cost-effective ways to purify water exists (e.g. water treatment plants or technology). Cost depends on scale. Mitigation would also be potentially of different quality Sub 1-3	No
Biological control	Farmers: spend more money on pest control, medication, treatment and prevention for diseases. Direct and potentially large 5 Landowners: pest management costs. Direct, most likely small (could be large for some) 4 Impact is indirect as it would be impact of biological control on food and fibre production Everyone else: Disease regulation through health, so indirect 2 Nature: most likely a 2 or 3 Extent: 1 local impacts	Private costs, some are cost effective 1 Pest management alternatives available, but expensive and of different quality (potentially) 2 or 3 Sub: 1-3	Maybe, while farmers/landowners can spend individually, collectively it is very expensive and may require RC/central to make control cost effective
Disease regulation	Nature: indirect and small (2). Income would be through sick leave		No
Recreation and ecotourism	Those in industry are impacted, but through their jobs and earnings. 3 People may have to spend more to go somewhere else for tourism or rec activities. Direct and potentially large because NZ is an outdoor culture 5 Eco-tourism is a direct contributor to the income and wealth of individuals and regions Nature 3 or 5: Direct and small/big. Extent 1 to 2: likely affects <10% of NZers' income and wealth at any given time, could be larger as tourism type is country-wide industry	Sub 1-4: other forms of income could be generated but they could be quite different forms of wealth generation	Yes
Ethical & spiritual	No relevant 1 Nature 1: not important		No

ES/NCP	Income and wealth (income and consumption is terms in the LSF doc): People's disposable income from all sources, how much people spend and the material possessions they have.		
	Does [ecosystem service] impact on people's (can split by sector e.g. urban, famers, etc) [well-being domain] directly or indirectly and what is the size of that impact (small/large)? What is the extent of that impact or how many people are affected (based on number of regions or population)?	Is there a substitute for the [ecosystem service] service important for [well-being domain]? If yes, is there a cost-effective substitute or a similar alternative option?	Include in assessment*
Inspirational and educational	<p>Scientists/researchers: indirect or direct depending on field. if indirect then small, if direct then large. But through jobs and earnings. 2</p> <p>Artists: direct or indirect depending on style. if indirect then small, if direct then large. But through job and earnings. 2</p> <p>Impact is through how nature inspires ideas which then create wealth or educational opportunities that create income (this is income as opposed to skills). Examples are outdoor education operators. This latter example is more direct.</p> <p>Nature: 2 or 3 Extent: small proportion of population 1</p>	<p>Sub 1: alternatives exist either in nature or via other media (e.g. literature)</p>	No
Food	<p>Primary industries: livelihood is dependent on food provision, a degrading ES would mean less income and wealth 4</p> <p>Restaurants: indirect through earnings and stability of income 3</p> <p>Others: cost, quality and availability of food 2</p> <p>Nature: 4 to 5</p> <p>Extent 3: likely affects 30–50% of NZers' income and wealth [note: this is New Zealanders not New Zealand]</p>	<p>Substitute other types of food, crops but could be of different quality, e.g. import of food</p> <p>Sub 1 – 3: Could generate wealth/income in other ways. However, this may involve substantial investment or re-training</p>	Yes
Fibre	<p>Primary industries through earnings 3</p> <p>Others: cost, quality, and availability of products. Direct, small 4</p> <p>Fibre production generates incomes both directly and indirectly. It is direct for foresters and mill owners and indirect for retail or builders, etc.</p> <p>Nature: 4 to 5</p> <p>Extent 3: likely affects 30–50% of NZers' income and wealth [note: this is New Zealanders not New Zealand]</p>	<p>Substitute other types of food, crops</p> <p>Sub 1 – 3: Could generate wealth/income in other ways. However, this may involve substantial investment or re-training</p>	Yes

ES/NCP	Income and wealth (income and consumption is terms in the LSF doc): People's disposable income from all sources, how much people spend and the material possessions they have.		
	Does [ecosystem service] impact on people's (can split by sector e.g. urban, famers, etc) [well-being domain] directly or indirectly and what is the size of that impact (small/large)? What is the extent of that impact or how many people are affected (based on number of regions or population)?	Is there a substitute for the [ecosystem service] service important for [well-being domain]? If yes, is there a cost-effective substitute or a similar alternative option?	Include in assessment*
Wildfoods	Māori & other groups reliant on foraging: direct and large 5 Others: not important 1 Note, that commercial fishing etc of wild species is captured under food above Nature: 1 (or 5) Extent: 1 population specific,	Farming of goods, so some alternatives 1 or 2 No substitute for some goods though (impacts through other well-beings) Sub: 1 or 2 (or possibly 5 for some groups)	No
Freshwater	Indirect through Health WB 2 Spend more on cleaning, filtering, and alternatives. Direct & large 5 Impact is on the availability of clean stock water where the stock provide income. Nature: 2 (possibly 5) Extent: local 1	Many cost-effective solutions for filtering water available Sub: 1 to 3	No
Pharmaceuticals etc	Farmers: indirect through food provision 2 Māori & other who use natural medicine: indirect 2 Extent: small proportion of population	Some alternatives, potentially of different quality or a distance away Some natural medicines don't have alternatives Sub: 1 to 3	Maybe because of the growing industry of natural medicines (e.g. mānuka honey for antibacterial). Risk/exposure framework. Thinking about this from a potential perspective. Rongoa (traditional medicines) is a growing industry providing income and wealth in NZ

ES/NCP	Income and wealth (income and consumption is terms in the LSF doc): People's disposable income from all sources, how much people spend and the material possessions they have.		
	Does [ecosystem service] impact on people's (can split by sector e.g. urban, famers, etc) [well-being domain] directly or indirectly and what is the size of that impact (small/large)? What is the extent of that impact or how many people are affected (based on number of regions or population)?	Is there a substitute for the [ecosystem service] service important for [well-being domain]? If yes, is there a cost-effective substitute or a similar alternative option?	Include in assessment*
Fuel (renew) & energy	Direct and large because we need fuel of some sort Renewable energy production generates incomes both directly and indirectly. It is direct for workers in the industry and indirect for companies who need energy to run their business (i.e. All orgs). Nature 5: Direct and cumulatively big Extent 5: likely affects most NZers' income and wealth directly or indirect. Direct extent is likely <10% of NZers [note: this is New Zealanders not New Zealand]	Alternative fuel sources, renewables. Expensive for some industries and people to transition. Sub 3-4: central government would need to support alternatives. Interconnected grid means can move electricity around	Maybe. Policy/regulation changes could impact infrastructure choice. There are currently cost-effective substitutes for non-renewables but the policy direction has made some (e.g. nuclear) alternatives not available. If we change the available substitutes at policy changes then it becomes a yes
Ornamental resources	Ornamental resources are used in jewellery making and handicrafts. Indirect through jobs and earnings 1 or 2 Nature 2: Direct and small. Extent 1: likely affects <10% of NZers' income and wealth [note: this is New Zealanders not New Zealand]	Sub 1: alternative sources could be found and typically at low cost	No
Genetic resources	Direct impact on primary industries through food and fibre production. 2 Potentially large if genetic diversity decreased causing health and quality issues in products. But through earnings 2 Nature 2: Indirect and small. Extent 1: likely affects <10% of NZers' income and wealth	Import diversity if not found locally Sub 1: could bring genetic resources from other places or do gene manipulation [acknowledge GM is tricky in NZ]	No
Habitat creation and maintenance	Direct and small (4) via Jobs for Nature. The government has invested \$1.1 billion to support 11,000 job creation within the DOC estate to maintain native vegetation ¹³		Maybe as we are in exceptional times for post-Covid economic recovery

¹³ <https://www.treasury.govt.nz/sites/default/files/2020-06/b20-cab-20-sub-0219-4283397.pdf> and <https://www.doc.govt.nz/news/media-releases/2020-media-releases/investment-to-create-11000-environment-jobs-in-our-regions/#:~:text=David%20Parker%20said,-Jobs%20for%20Nature%20programme,assets%20on%20public%20conservation%20land.>

Jobs and earnings

ES/NCP	The quality of people's jobs (including monetary compensation) and work environment, people's ease and inclusiveness of finding suitable employment, and their job stability and freedom from unemployment		
	Does [ecosystem service] impact on people's (can split by sector, e.g. urban, famers, etc.) [well-being domain] directly or indirectly and what is the size of that impact (small/large)? What is the extent of that impact or how many people are affected (based on number of regions or population)?	Is there a substitute for the [ecosystem service] service important for [well-being domain]? If yes, is there a cost-effective substitute or a similar alternative option?	Include in assessment*
Erosion control	Indirect and small. Erosion impacting on productive land, thus reducing proportion of earnings (1-2)	Yes, moving stock, change in land use. 1	No
Natural hazard regulation	Indirect and small. Risk of nat hazards impacting on earnings (2) Potentially someone's job or place of work is lost or they have to move. 5 Extent = whole country is vulnerable to come natural hazard 5	Flood schemes (private and sometimes public 2/3) Public to fix after the fact 3 or 4	maybe
Water regulation	Direct and small (4) via availability of water for irrigation to increase earnings	Yes, dams. 1	No
Air quality	Arguably bad air quality influences work environment (office swelling) 4 Important for quality of job (outdoor jobs), would reach small portion of population sensitive to air quality (so indirect via health) 2	Indirect by improving health through filtration, emissions reductions (1 or 3) Mitigation only works for indoors and of different quality, or you move (4)	No
Climate regulation	Similar to air quality. Spend more money on temperature regulation, cloths or items to stay dry/keep cool etc. too hot or too cold negatively impacts work environment 4/5 Indirect and small (2). CC could affect jobs opportunities. Shift in land use. Indirect through natural hazard regulation 1 or 2 Extent = country wide 5	Personal tech mitigation 1 Company mitigation 2 Mitigation works to a point and inside	No
Pollination	Indirect and small (2). Would affect jobs in pollination services (beekeeping)	Subst via artificial pollination 1-2	No
Water purification	Indirect and small (2). Can't see any direct relationship with jobs, would be through health issues	Subst water treatment plants 1-2	no
Biological control	Indirect and small (2). Possibly through pest control jobs?		No
Disease regulation	Indirect and small (2). Can't see any direct relationship with jobs, would be through health issues		No

ES/NCP	The quality of people's jobs (including monetary compensation) and work environment, people's ease and inclusiveness of finding suitable employment, and their job stability and freedom from unemployment		Include in assessment*
	Does [ecosystem service] impact on people's (can split by sector, e.g. urban, farmers, etc.) [well-being domain] directly or indirectly and what is the size of that impact (small/large)? What is the extent of that impact or how many people are affected (based on number of regions or population)?	Is there a substitute for the [ecosystem service] service important for [well-being domain]? If yes, is there a cost-effective substitute or a similar alternative option?	
Recreation and ecotourism	Those in industry: direct and large 5 Yes, provision of tourism opportunities creates jobs and earnings (5) Extent = hit some regions harder, but most of the country 5	Some alternatives and potentially a distance away and some may have no alternatives Subst to some extent, VR etc. Not same experience (4)	yes
Ethical & spiritual	No relevant 1 Indirect and small (2). Can't see any direct relationship with jobs, would be through mental health issues		No
Inspirational and educational	Scientists/researchers: indirect or direct depending on field. if indirect then small, if direct then large. 2/5 Direct and small (4). Jobs for artists. Artists: direct or indirect depending on style. if indirect then small, if direct then large. 2/5 Extent = small proportion of pop	Some alternatives and potentially a distance away and some may have no alternatives () VR learning Subst: artists may find other sources of inspiration 2	Maybe
Food	Primary industries: direct and large 5 Yes, provision of food through our land resources provides jobs in primary industry (5) Extent = country 5	Substitute other types of food, crops, GMOs	yes
Fibre	Primary industries: direct and large 5 Yes, provision of fibre through our land resources/timber production provides jobs in primary industry (5) Extent = country 5	Substitute other types of food, crops GMOs	yes
Wildfoods	Primary industries: direct and large 5 Indirect and small (2). Can't see any direct relationship with jobs, would be through work-life balance Extent = population specific, possum fur, hunting service companies	Farming of goods instead of relying on ecosystem No substitute for some goods though (impacts through other well-beings)	No
Freshwater	Yes, provision of freshwater through our land resources provides jobs in primary industry (5)		yes

ES/NCP	The quality of people's jobs (including monetary compensation) and work environment, people's ease and inclusiveness of finding suitable employment, and their job stability and freedom from unemployment		Include in assessment*
	Does [ecosystem service] impact on people's (can split by sector, e.g. urban, farmers, etc.) [well-being domain] directly or indirectly and what is the size of that impact (small/large)? What is the extent of that impact or how many people are affected (based on number of regions or population)?	Is there a substitute for the [ecosystem service] service important for [well-being domain]? If yes, is there a cost-effective substitute or a similar alternative option?	
Pharmaceuticals etc	Still small? Unknown level of pharmaceuticals potential for job creation. (2) Farmers: fertiliser, have to buy. Direct and potentially large Pharma industry: direct and large 5 Extent = small	Some alternatives No alternatives for some natural medicines	No
Fuel (renew) & energy	Wind power. Creating jobs (4)	Subst. not only wind/hydropower 2	No
Ornamental resources	Direct if artist or income dependent (4/5) Jobs in selling pounamu jewellery (4) Extent = local, small	Alternatives 1, maybe none for some goods Subst. other ornamentals. Not the same 2	maybe
Genetic resources	Direct impact on primary industries. Potentially large if genetic diversity decreased causing health and quality issues in products (4/5) For future potential (mānuka honey DNA) (2) Extent = local	Import diversity if not found locally	No
Habitat creation and maintenance	Exceptional circumstances: Jobs for nature.... Otherwise probably indirect and small		Maybe

Housing

ES/NCP	Housing: The quality, suitability, and affordability of the homes we live in.		
	Does [ecosystem service] impact on people's (can split by sector, e.g. urban, farmers, etc.) [well-being domain] directly or indirectly and what is the size of that impact (small/large)? What is the extent of that impact or how many people are affected (based on number of regions or population)?	Is there a substitute for the [ecosystem service] service important for [well-being domain]? If yes, is there a cost-effective substitute or a similar alternative option?	Include in assessment*
Erosion control	Directly impact land values, the stability/safety of the house or buildings (e.g. susceptibility to slips, slow movement of land). Large impact on quality, suitability and potentially affordability (expensive to fix or insure) Yes, erosion control helps quality of housing on hills. But potentially indirect as through Nat haz reg Nature: 3 or 4 Extent = countrywide issue	Infrastructure, individual or user groups (1/2) RC/gov if large enough area (3), but still relatively cost effective Sub: 1-3	No
Natural hazard regulation (flood, drought, fires, slips)	Directly impact and large Yes, nat haz reg helps quality, suitability of housing. Nature: Direct and small to big (coastal houses, where people live). 4 Extent = different hazards in different places, but countrywide 5	Flood schemes (private and sometimes public 2/3) Public to fix after the fact 3 or 4	Yes
Water regulation	Flooding risk: direct impact in suitability and affordability, but indirect and small (2) (housing in flood plains.) Through nat haz regulation. Water runoff, drainage of water away from house: direct impact in suitability and affordability 4 Nature: 4 Extent = localised issue 1	Private infrastructure Sub: 1 or 2	No
Air quality	Good surrounding air quality is an amenity for housing prices: direct impact in affordability, but it is more of a signal of overall healthiness of home. Indirect and large 3 Probably higher price houses where air quality is good, regulated by surrounding vegetation 3 Poor internal air quality (e.g. mould) leads to poorer health: direct impact on suitability but through health 2 Housing close to highways – noise and particulates; mould affects housing which affects quality of housing 4 Nature: 3 or 4 Extent = urban areas, potentially agricultural areas during crop harvest, homes near roads, high pollen areas	Private costs through filtration, emissions reductions 1 Mitigation only works for indoors and of different quality, or you move (4) Sub: 1 to 4	Yes

ES/NCP	Housing: The quality, suitability, and affordability of the homes we live in.		
	Does [ecosystem service] impact on people's (can split by sector, e.g. urban, farmers, etc.) [well-being domain] directly or indirectly and what is the size of that impact (small/large)? What is the extent of that impact or how many people are affected (based on number of regions or population)?	Is there a substitute for the [ecosystem service] service important for [well-being domain]? If yes, is there a cost-effective substitute or a similar alternative option?	Include in assessment*
Climate regulation	Houses not built for the climate deteriorate or require ore maintenance which impacts suitability and costs. 4 Climate change impacts, e.g. sea level rise directly impacts homes, but that mechanism is through natural disaster regulation so indirect, 2 Nature: 2 or 4 Extent: localised but probably impacting <50% of population 2 or 3	Personal tech mitigation 1 Sub: 1	No
Pollination	No impact 1 Not important for affordable housing (1)		No
Water purification	A house dependent on its own well would be negatively impacted, but through freshwater availability. Indirect. Nature: 1 or 2 Extent: personal, 1	Indirect by improving health through filtration, reduce cause (1 or 3 or 4 if need central to manage cause) you reduce health costs but increase other costs Sub: water tanks, drinking water treatment systems 1	No
Biological control/ disease regulation	Pests are annoying and potentially a health & safety issue (e.g. rats) indirectly 2 Nature: 1 or 2 Extent = local, 1	Private costs, group costs and potentially RC or central costs to mitigate personal loss Termites/borers affect housing stock, cost-effective substitutes. More reliant on treatments than on biological control. More of an issue for older homes where the timbers were not treated Sub: 1	No
Recreation and ecotourism	Through jobs and income impact housing prices 3 Affordability of housing depends on proximity to recreational areas (more land value) (4-5). Nature: Direct and small (big, all population) Extent = to a different degree through the country, impacts <30% of country 2	Some alternatives and potentially a distance away and some may have no alternatives () Other recreational activities. Not the same experience. People could move to places with similar but different rec options that reduce housing cost Sub: 1-3	Yes, will fall out as a maybe in terms of scoring

ES/NCP	Housing: The quality, suitability, and affordability of the homes we live in.		
	Does [ecosystem service] impact on people's (can split by sector, e.g. urban, farmers, etc.) [well-being domain] directly or indirectly and what is the size of that impact (small/large)? What is the extent of that impact or how many people are affected (based on number of regions or population)?	Is there a substitute for the [ecosystem service] service important for [well-being domain]? If yes, is there a cost-effective substitute or a similar alternative option?	Include in assessment*
Ethical & spiritual	The suitability of a house could be dependent on the spiritual connection with the land, e.g. Māori want to build homes on land they connect with including intergenerational farmers or family houses 5 Others, 1 Nature: 1 or 5 Extent = personal 1	If 5 for people, then probably no alternative	Yes
Inspirational and educational	People sometime say they got the inspiration for a house design from nature, but that wouldn't directly impact quality, suitability or affordability 1 or 2 Housing may be more suitable if close to natural areas for education, inspiration. However, person dependent Nature: Indirect and small (1-2) Extent = personal 1	Inspiration from other things or private things to make housing more suitable Sub: 1	No
Food	Provision of food doesn't impact on quality, suitability and affordability of housing. Nature: 1	No subst.	No
Fibre	Some housing is made from wood so could impact quality, suitability or affordability directly 4 Insulation made from wool, direct impact but small 4 Timber for housing important for quality, affordability Nature: Direct and small (4). Extent: individual, but most housing in NZ has some part made from wood 3	Substitute other types of food, crops Some alternatives of different quality: concrete However, some housing needs may not have suitable substitutes like framing or roofing structure 4 or 5 Sub: 2 or 4	Yes, likely would fall out as a maybe. While some alternatives there are some things that are no/few alternatives, e.g. framing and roofing structure, flooring (esp. in NZ)
Wildfoods	Provision of wildfood could influence some housing pr location of suitability for certain people (hunting, fishing). Nature: Indirect and small (2) Extent: local 1	Subst. other food 1	No

ES/NCP	Housing: The quality, suitability, and affordability of the homes we live in.		
	Does [ecosystem service] impact on people's (can split by sector, e.g. urban, famers, etc.) [well-being domain] directly or indirectly and what is the size of that impact (small/large)? What is the extent of that impact or how many people are affected (based on number of regions or population)?	Is there a substitute for the [ecosystem service] service important for [well-being domain]? If yes, is there a cost-effective substitute or a similar alternative option?	Include in assessment*
Freshwater	Readily access to good quality freshwater impacts housing prices because the cost to connect is lower, filtration costs are lower, through better health (indirect), direct 4 Provision of freshwater important for housing quality 2 Nature: 2 or 4 Extent: localised issue 1	Filtering, trucking in from further away, infrastructure But many subst via water tanks, water infrastructure Sub: 1	No
Pharmaceuticals etc	Not important for housing 1		No
Fuel (renew) & energy	Need fuel to heat housing and cook food so if you don't have access to heating fuel then house isn't suitable Solar energy, wind energy, good for quality/affordability of housing (3) Energy for electricity generation. Direct 4/5 Nature: 3 to 5 Extent: localised but probably impacting <50% of population 2 or 3	Alternative fuel sources, renewables. Expensive for some industries and people to transition May require RC or gov intervention for infrastructure But many subst, from electricity and power companies 1	No
Ornamental resources	How pretty houses are? 1 Not important for housing 1	NA	No
Genetic resources	1 Not important for housing 1	NA	No