The value of public conservation land

An ecosystem services assessment

NZIER report to the Department of Conservation

December 2024

About NZIER

New Zealand Institute of Economic Research (NZIER) is an independent, not-for-profit economic consultancy that has been informing and encouraging debate on issues affecting Aotearoa New Zealand for more than 65 years.

Our core values of independence and promoting better outcomes for all New Zealanders are the driving force behind why we exist and how we work today. We aim to help our clients and members make better business and policy decisions and provide valuable insights and leadership on important public issues affecting our future.

We are unique in that we reinvest our returns into public good research for the betterment of Aotearoa New Zealand.

Our expert team is based in Auckland and Wellington and operates across all sectors of the New Zealand economy. They combine their sector knowledge with the application of robust economic logic, models and data and understanding of the linkages between government and business to help our clients and tackle complex issues.

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Key points

The Department of Conservation (DOC) commissioned NZIER to estimate the value of natural and built capital stocks and flows within DOC-managed public conservation land (PCL).

Research objectives

The objectives of the research were:

- identifying the values and benefits of investment in PCL and assets, including financial, social, cultural and environmental elements
- identifying specific economic metrics to communicate both financial and non-financial values
- estimating the total value people derive from PCL and national parks.

We estimate these values based on their contribution to human wellbeing. This includes revenues generated for DOC and the Crown as proxies for our willingness to pay to conserve or access PCL resources.

Research scope

The scope of the research includes analysis to estimate the contemporary value of PCL to the economy, environment and society based on existing data sources and literature.

Our assessment does not include the value associated with marine ecosystems, as this is out of scope. Our primary focus is, therefore, on the environmental valuation of land-based ecosystems within PCL.

Addressing information gaps by collecting new information was out of scope.

Our results

Using the total economic value and millennium ecosystem services frameworks, we estimate that:

- the ecosystem services on PCL generate a gross value of $16.42 billion per year and a net value of $10.90 billion per year. This consists of the following services:
  - Provisioning services – $2.53 billion
  - Cultural services – $0.47 billion
  - Regulating services – $7.90 billion
  - Supporting services – $5.53 billion
- the value of natural and built asset stocks on PCL is worth $134 billion at present.[1]
- the existence of national parks is worth $12.6 billion to New Zealanders.

[1] Figures are for 2024 but use a variety of different data sources and dates. Please refer to section 5.

Regulating and supporting services contribute most of the ecosystem service flow value on PCL through water storage and retention, nutrient cycling, and flood management. PCL is an important source of water for New Zealand, providing $2 billion worth of ecosystem service flows. The total economic value of recreational activities linked to PCL is estimated at nearly $500 million per year and is mostly associated with the non-market benefits people gain from the environment.

Opportunities for further research

Though we have sought to value all aspects of PCL, there are gaps in the available literature, which limits our ability to do so without further research. To increase New Zealand's understanding of the value of PCL, we recommend developing the following:

- more detailed information on resource extraction from PCL, including food production (commercial and recreational), forestry and mining
- a better understanding of how ecosystem services provide for cultural values to reflect their importance from non-use activities
- a wider set of measures is needed to determine the welfare contribution of PCL, such as existence and bequest values.

Investing in these areas will enable more precise estimates of the value generated by PCL for our wellbeing over time.

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1 Introduction and context

The Department of Conservation manages around a third of New Zealand's land area

The Department of Conservation's (DOC's) role is to manage New Zealand's natural and cultural heritage, and part of this is managing public conservation land (PCL).

PCL makes up 33 percent of New Zealand's mainland land cover classes as of 2018.

Part of DOC's activities is to advocate the conservation of natural and historic resources and to promote the benefits to present and future generations. Part of this is administered by several different Acts, including the Conservation Act 1987, National Parks Act 1980, Reserves Act 1977, Waitangi Endowment Act 1932–33 and Wildlife Act 1953. Most of PCL is managed under the Conservation Act (56.6 percent) and the National Parks Act (34.1 percent).

PCL is highly valued by New Zealanders and international visitors and provides significant economic, environmental, social and cultural benefits. Both Tongariro National Park and Te Wāhipounamu are recognised as World Heritage Sites by UNESCO, highlighting their significant contribution to biodiversity and natural beauty. DOC has 13 national parks that receive millions of visits a year and are large contributors to New Zealand's image and international reputation.

To better understand the value of PCL, particularly national parks, DOC commissioned NZIER to estimate the market and non-market values associated with PCL and its ecosystems.

We focus our research on valuing land and coastal-based ecosystems

Our research objectives include:

- identifying the values and benefits of investment in PCL and assets, including financial, social, cultural and environmental elements
- identifying specific economic metrics to communicate both financial and non-financial values
- estimating the total value people derive from PCL and national parks.

Our assessment does not include the value associated with ocean-based ecosystems, as this is out of scope. Our primary focus is, therefore, on the environmental valuation of land-based ecosystems within PCL. We estimate the values based on their contribution to human wellbeing, which includes revenues generated for DOC and the Crown.

Why use environmental evaluation?

The original and enduring primary purpose of environmental valuation is to allow for environmental impacts to be incorporated into decision analysis, such as cost-benefit analysis (Markandya 2019). Environmental evaluation includes the contribution of the natural environment to assessments of human wellbeing. Although it is an imperfect lens, it adds to understanding the trade-offs when making decisions about policy or investments.

This assessment of the value of PCL creates a base for DOC to show the value of the ecosystems and built assets they manage. It also provides a basis for understanding data gaps and evidence to inform decisions about the management of PCL.

Structure of the report

The structure of the report is as follows:

1. Introduction and context – describes the research objective, scope and context.
2. Methodology – describes the main frameworks for valuing natural capital and ecosystem services.
3. Our approach – describes how the frameworks are used to value PCL.
4. Valuing PCL – provides a detailed description of the composition of the land within PCL and the stocks attributable to it.
5. Discussion and limitations – describes previous DOC studies and data limitations.
6. Conclusion and recommendations – provides a summary and recommended next steps.

2 Methodology – frameworks for valuing natural capital and ecosystem services

Different methodological approaches are listed in the research approach. These include the:

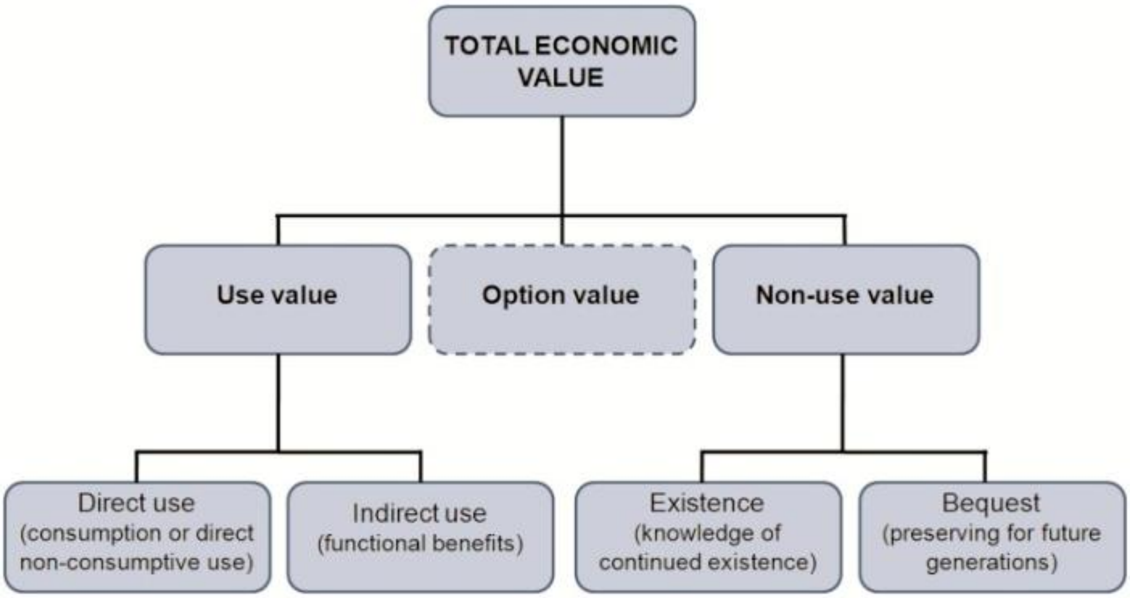
- total economic value
- Millennium Ecosystem Assessment framework
- value of a major adverse effect on the environment
- environmental-economic accounting.

2.1 Total economic value

Total economic value, shown in Figure 1, is a framework to categorise the benefits people derive from natural resources through a series of values:

- **Use value** – benefits associated with direct and indirect use of the resource. Examples of this are the benefits accruing from tourism activities or the value of carbon sequestered.
- **Option value** – the value gained from the ability to use the asset in future. Examples include the ability to harvest forestry in the future.
- **Non-use value** – benefits that do not require the actual use of the ecosystem or asset. These include bequest value and existence value. Examples are the value of passing a national park to future generations and the value of an ecosystem existing in its current state.

Figure 1 Total economic value framework



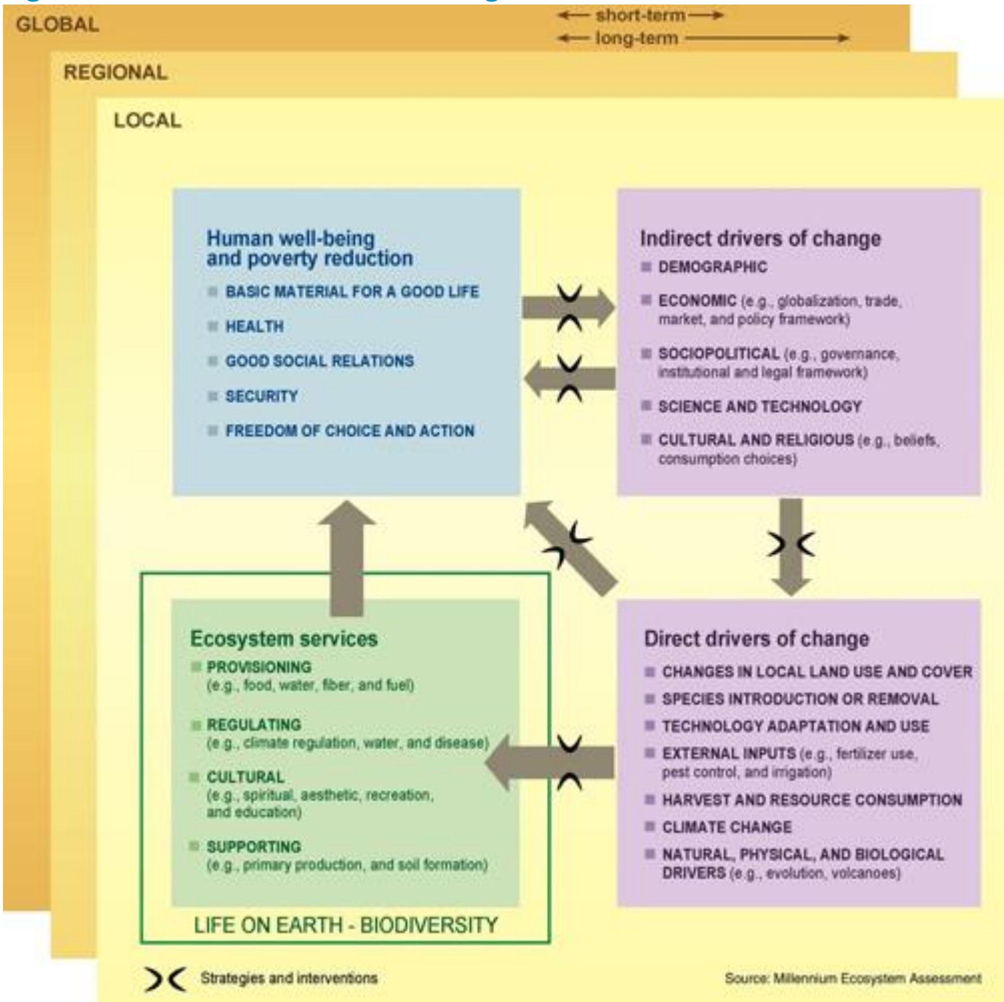
Source: Grant et al. (2013)

Traditional cost-benefit analyses tend only to value economic activities that people gain direct use from, such as harvesting a forest or using land for farming and other activities with market prices linked to the activity. The total economic value framework allows for the assessment of values associated with non-market activities, such as the conservation of a threatened species or recreation activities, so that robust comparison with market activities is possible (Pearce, Atkinson, and Mourato 2006). This expands the idea of 'value' to capture societal expectations where preserving natural resources and ecosystems comes at the cost of lost economic activity.

2.2 Millennium Ecosystem Assessment framework

The Millennium Ecosystem Assessment (MA) framework (Figure 2) provides the basis for aligning ecosystem services with human wellbeing, recognising non-market values such as intrinsic values (Alcamo and Bennett 2003).

Figure 2 Interconnection of wellbeing and environmental elements



Source: Millennium Ecosystem Assessment (2005, iii)

Ecosystem services are categorised into four broad categories:

- **Provisioning services** – goods and services obtained from ecosystems such as food, water, timber and tourism. These services are usually captured in macroeconomic metrics such as gross domestic product (GDP) and market transactions but can also include non-monetary transactions such as foraging for food.
- **Regulating services** – benefits obtained from the regulation of ecosystem processes such as climate, water purification, flood resistance and disease.
- **Cultural services** – intangible benefits people receive from interactions with the environment such as recreation, spiritual enrichment, aesthetic experiences and cognitive benefits.
- **Supporting services** – services necessary for producing other ecosystem services such as photosynthesis of organic matter, oxygen production and soil formation.

The core objective of the MA framework is to identify the ways in which an ecosystem directly and indirectly affects human wellbeing (Alcamo and Bennett 2003). Since wellbeing is multidimensional, economic valuation techniques aim to compare the various aspects of wellbeing through a single unit of measurement, such as monetary values. Total economic value provides the conceptual framework for categorising ecosystem services into their use and non-use values, thereby allowing for equity to be considered when decision makers choose between consuming natural capital for resources or conservation.

A key caveat of ecosystem services is the potential for double counting, especially for supporting services. For example, soil formation enables healthy forest growth, which contributes to timber and carbon sequestration. The advantage of using the MA framework is that it separates supporting services from the other services (particularly regulating), which means that double counting is easily avoided when summing ecosystem service dollar values by excluding the supporting services in the calculation (Patterson and Cole 2013).

The MA framework describes that changes in the value of the benefits are expressed by either the change in the value of the annual flow of benefits or the change in the value of all future flows. Therefore, an irreversible loss of an ecosystem service should also include the loss of the option of using that service in the future.

Valuation techniques described in the MA framework include the revealed preference method, stated preference method and benefits transfer method (Table 1):

- **Revealed preference method** – considers the purchasing habits of consumers who choose to interact with ecosystems within a constrained budget. This includes factors such as travelling to nature reserves or the health costs borne by individuals due to decreased ecosystem conditions.
- **Stated preference method** – involves asking individuals how much they would be willing to pay for the hypothetical use or conservation of goods and services.
- **Benefits transfer method** – seeks to estimate economic values for ecosystem services by transferring available information from studies already completed in another location or context.

Linking wellbeing to ecosystem services can also be challenging as it is not solely linked to incomes as expressed in GDP measures.

The MA framework recognises that wellbeing is multidimensional and should consider aspects such as health, equity and the intrinsic value people place on the environment:

- Health indicators include the impacts that ecosystem services have on human health outcomes, such as environmental health indicators and health impact assessments.
- Poverty and equity encompass five components: basic material for a good life, health, good social relations, security, and freedom and choice. This includes measures such as living standards measurement studies.
- Intrinsic values are the sociocultural values people place on the ecosystems they live in and depend on.

Table 1 Valuation methods and wellbeing indicators described in the MA framework

Detailed description of different indicators.

Approach	Definition
Valuation methods	
Productivity changes	Tracing the impact of change in environmental services on produced goods.
Cost of illness (human capital)	Tracing the impact of change in environmental services on morbidity and mortality.
Replacement cost (and variants, such as relocation cost)	Cost of replacing the lost good or service.
Travel cost method	Deriving demand curves from data on actual travel costs.
Hedonic prices	Extraction effects of environmental factors on the price of goods that include those factors.
Contingent valuation	Asking respondents directly about their willingness to pay for a specified service.
Choice modelling	Asking respondents to choose their preferred option from a set of alternatives with particular attributes.
Benefits transfer	Using results obtained in one context in a different context.
Wellbeing indicators	
Health indicators	Health outcomes attributable to the environment or ecosystem services.
Poverty and equity	Impacts of ecosystem changes are those that pertain to poverty.
Intrinsic value	Ethical, religious, cultural, or philosophical sociocultural values people place on environmental elements.

Source: NZIER

Use of total economic value and the MA framework in New Zealand

Patterson and Cole (2013) performed a rapid assessment using the MA framework to estimate the total economic value of New Zealand's land-based ecosystems. The authors used a combination of publicly available information sources such as Stats NZ and adapted values derived from academic literature to estimate economic values for ecosystem services in New Zealand.

The authors proposed an indicative net total economic value for New Zealand's land-based ecosystems to be NZ$56.7 billion in 2012. They also provided a breakdown of the various use and non-use values across several standard ecosystems such as agriculture, forests and wetlands, among others.

Table 2 shows various ecosystem services categorised into use and non-use values. Use values are gained from direct interaction with ecosystem services, whereas passive or non-use values do not require the actual use of the ecosystem services for benefits to be gained.

Table 2 Categorisation of ecosystem services into use and non-use values

Value	Ecosystem service	Description
Use values	Provisioning services value	Direct provision of goods and services.
	Regulating services value	Life and habitat supporting regulation of environmental biophysical and ecological processes.
	Cultural services value	Contribution to human health and wellbeing by providing services.
	Supporting services value	Ecological and biophysical processes that support the provisioning and regulating services of ecosystems.
Passive values (non-use)	Option value	An individual's willingness to pay to preserve an ecosystem against its potential use at a later date.
	Existence value	An individual's willingness to pay to preserve an ecosystem with no intention of its use by them.
	Bequest value	An individual's willingness to pay to preserve an ecosystem for the benefit of future generations.

Source: Patterson and Cole (2013)

It is important to note that Patterson and Cole (2013) caution against using supporting services value when calculating use values as doing so is prone to double counting across entire ecosystems. Therefore, they recommend a net calculation with supporting services value excluded.

Provisioning ecosystem services were measured using market values from the System of National Accounts. These include transitionary services such as food or forestry products. However, they posit that the provisioning, supporting, regulating, cultural and passive ecosystem services are not usually associated with market transactions. Therefore, they estimate the value of these systems by collating estimates in the international literature. The non-market techniques they employed include:

- willingness to pay – how much a person is willing to pay to use a given ecosystem
- replacement cost method – the cost of replacing the loss of an ecosystem service with an equivalent service
- willingness to accept – how much a person is willing to be paid to accept the loss of an ecosystem service.

Although the authors list the passive (non-use) values for heritage ecosystems in their estimates, they do not provide use values due to a lack of data at the time, and the use values of heritage ecosystems could be estimated using the individual ecosystem use values already covered. For example, the use value of a national park would factor in the amount of wetland, forest or river it encompasses, and the use values of these ecosystems would aggregate to the overall use value of the national park.

There are several key drawbacks of this approach:

- A severe lack of New Zealand-specific data across the ecosystem services meant that overseas monetised values had to be used as proxies.
- Using overseas values in a New Zealand context makes the underlying assumption that the non-use values that people and cultures in other countries place on their ecosystems are the same or similar to New Zealand's people and cultures.
- Further assumptions needed to be made on the values people in different catchments place on various ecosystems. Patterson and Cole (2013) provide the example that they assumed the entire New Zealand population had existence, bequest and option values for national parks, but only regional populations held these values for forest parks.
- The use of contingent valuation surveys can overstate the total value of ecosystem services as participants typically value the environment in isolation to changes in other goods and services.
- Ecosystem services can be substituted to some extent but are not entirely replaceable. Human wellbeing depends on a basic level of these natural benefits. When supply is low, demand essentially becomes unlimited. This leads to traditional economic models undervaluing ecosystem services as they don't account for the importance these services have when in short supply.
- Conventional economic approaches for valuing ecosystem services rely on people's subjective preferences. However, this approach doesn't account for the complex workings and interconnections within ecosystems. It also assumes people have a solid understanding of these natural systems, which differs across individuals.

2.3 Value of a major adverse effect on the environment

As an attempt to reduce the impact of subjective human preferences for certain ecosystem types, Clough et al. (2018) describe a new approach to environmental valuation for New Zealand – the value of a major adverse effect on the environment (VMAEE). This combines the total economic value of natural environment resources with the value of preventing a fatality approach, which is typically used for valuing safety improvements in public sector initiatives and used in VMAEE to estimate the value of reductions in risk of environmental harm by using the aggregate willingness to pay over a large group of individuals. The VMAEE approach possesses several benefits:

- avoiding misrepresenting the value of natural capital through the use of site-specific values across different types of sites
- allowing for transparent inclusion of public preferences
- focusing on valuing the reduction in the risk of environmental harm rather than valuing the impact of the harm itself.

The stated strength of VMAEE is that it can be used to compare the trade-offs of policies with environmental impacts instead of valuing specific environmental features that may or may not impact a person's willingness to pay to avoid environmental harm.

2.4 Environmental-economic accounting

Environmental-economic accounting aims to provide a balance sheet of natural capital assets similar to how GDP is measured in the System of National Accounts. It looks at placing a monetary value on the potential use of natural assets to illustrate the trade-offs being made by consuming natural capital when producing goods and services (van Zyl and Au 2018).

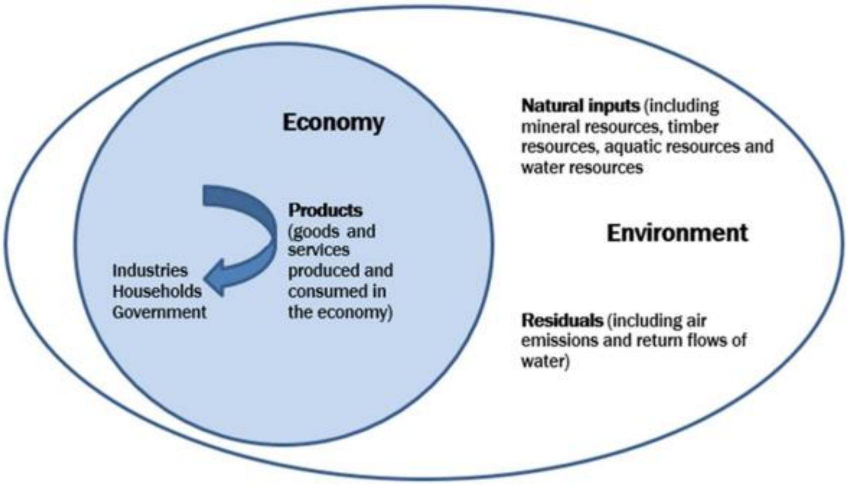
For example, greenhouse gas inventories relating to forests would be reduced if the forests were felled for timber production. Prior to environmental-economic accounting, only the economic value of creating the timber would be monetised.

The System of Environmental-Economic Accounting (SEEA) was adopted by the UN Statistical Commission in 2012 as the international standard for measuring the environment and its relationship with the economy (UNCEEA 2018).

It comprises two parts:

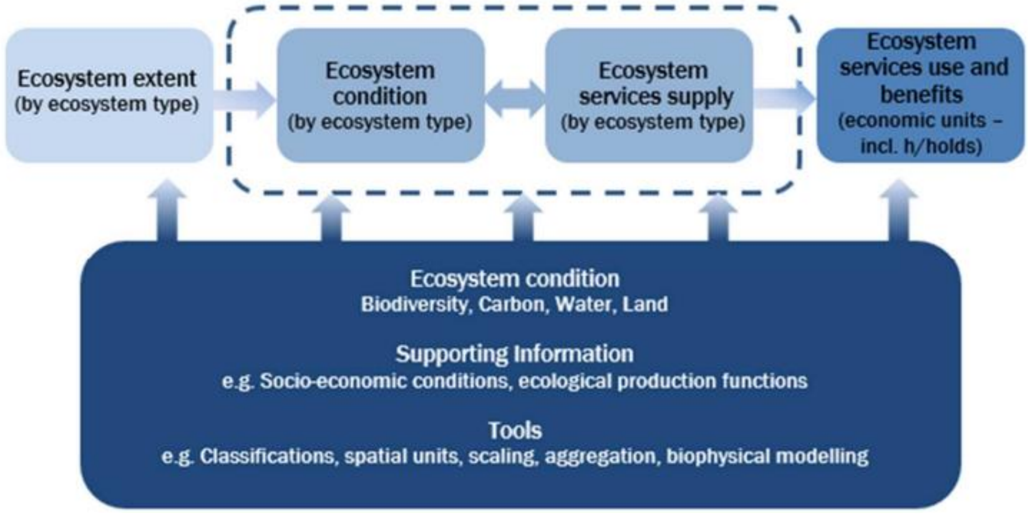
- **SEEA Central Framework (SEEA CF)** – describes the interactions between the economy and the environment and the stocks and changes in stocks of environmental assets. Stocks and flows of natural capital are recorded in both physical and monetary terms through asset accounts. The focus is on the net present value of the benefits accrued to economic owners and the resulting trade-offs between the consumption of natural capital resources and conservation (see Figure 3).
- **SEEA Experimental Ecosystem Accounting** – adopted by the UN Statistical Commission in 2021, it expands on the SEEA CF by measuring the interactions of different types of ecosystems with other potential human wellbeing and economic activity. This allows the expression of societal contributions by ecosystems in monetary terms to more easily compare these contributions to other goods and services (see Figure 4).

Figure 3 Central Framework



Source: UNCEEA (2018, 6)

Figure 4 Experimental Ecosystem Accounting



Source: UNCEEA (2018, 9)

Since 2001, Stats NZ has compiled sets of environmental-economic accounts using the SEEA framework focused on establishing stock and flow accounts (Stats NZ 2020b). Stock accounts estimate the amount of environmental assets through physical units and monetary values to show the increases and decreases in the stocks over time. Flow accounts illustrate the supply of resources into the economy, how these resources are consumed and how they are returned to the environment through waste products.

Stats NZ stock and flow accounts include:

- the marine economy – valuations for economic activities that take place in or use the marine environment to produce goods and services
- renewable energy stock – electricity generation, asset value and resource rent from renewable resources such as hydro, geothermal, solar and wind power sources
- timber stock accounts – total standing timber and annual carbon sequestration.

Stats NZ also compiles environmental activity or transaction accounts that record the range of transactions between economic agents for the protection and preservation of the environment. These include:

- environmental protection expenditure – expenditure by central and local government on activities that prevent, reduce and eliminate pollution as well as other forms of environmental degradation
- environmental taxes – the amount of energy, transport, pollution and resource taxes paid to government for something that has a proven scientific negative impact on the environment.

In the following section, we describe how we use the frameworks discussed above to value PCL.

3 Our approach – how we use these frameworks to value PCL

At a high level, we take these steps to estimate the values associated with PCL:

1. Confine the scope of the study area to national parks and other PCL.
2. Identify stocks and flows present within PCL to create a long list of stocks and ecosystem services to be investigated in the assessment using existing data and research.
3. Determine what is quantified sufficiently and develop a short list of quantifiable and monetisable values.
4. Derive per hectare values for each stock ecosystem service where applicable. Where these values are not available, we attribute a total value relative to PCL.
5. Aggregate the quantified and monetised stocks and flows based on the total amount of each stock and flow within PCL to conservatively estimate the total value.[2]

Table 3 provides a brief overview of the valuation methods used in the evidential basis for our assessment.

Table 3 Valuation methods

Approach	Definition
Productivity changes	Tracing the impact of change in environmental services on produced goods.
Replacement cost	Cost of replacing the lost good or service.
Travel cost method	Deriving demand curves from data on actual travel costs.
Hedonic prices	Estimating values for ecosystem services that directly affect market prices, such as estimating the value of sea views or green space using property prices.
Contingent valuation	Asking respondents directly about their willingness to pay for a specified service.
Choice modelling	Asking respondents to choose their preferred option from a set of alternatives with particular attributes.
Benefits transfer method	Using results obtained in one context in a different context.

Source: NZIER

Our assessment draws from various valuation methods in the established literature to value PCL. The scope of the research included adjusting values appropriately to reflect differences between the original purpose and our purpose or context. The scope of the research excluded primary research to derive original estimates.

[2] The estimate is conservative because it is limited to what was quantifiable in the short list and does not include unquantifiable services identified in the long list.

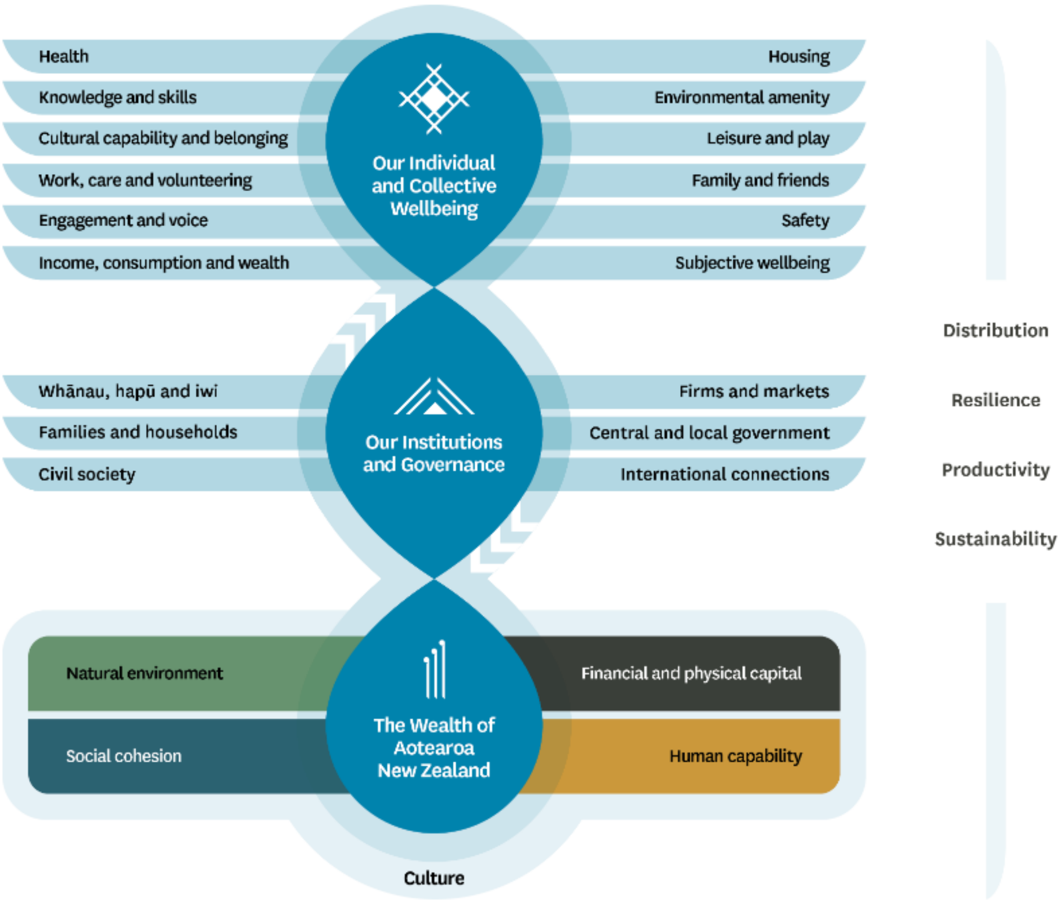
3.1 The Living Standards Framework connects understanding of welfare and the environment

As wellbeing is central to the MA framework, we use the Treasury's (2021) Living Standards Framework (LSF) to identify how PCL contributes to the various aspects of wellbeing.

The LSF is the organising framework for assessing PCL's ecosystem services and non-use value. The LSF is shown in Figure 5 and consists of three levels:

- **Our Individual and Collective Wellbeing** – resources and aspects of our lives identified as important for the wellbeing of individuals, families, whānau and communities.
- **Our Institutions and Governance** – the role our institutions play in safeguarding and building our wealth as well as facilitating the wellbeing of individuals and collectives.
- **The Wealth of Aotearoa New Zealand** – our aggregate wealth as a country. This includes sources of wealth not fully captured in the System of National Accounts.

Figure 5 The Living Standards Framework



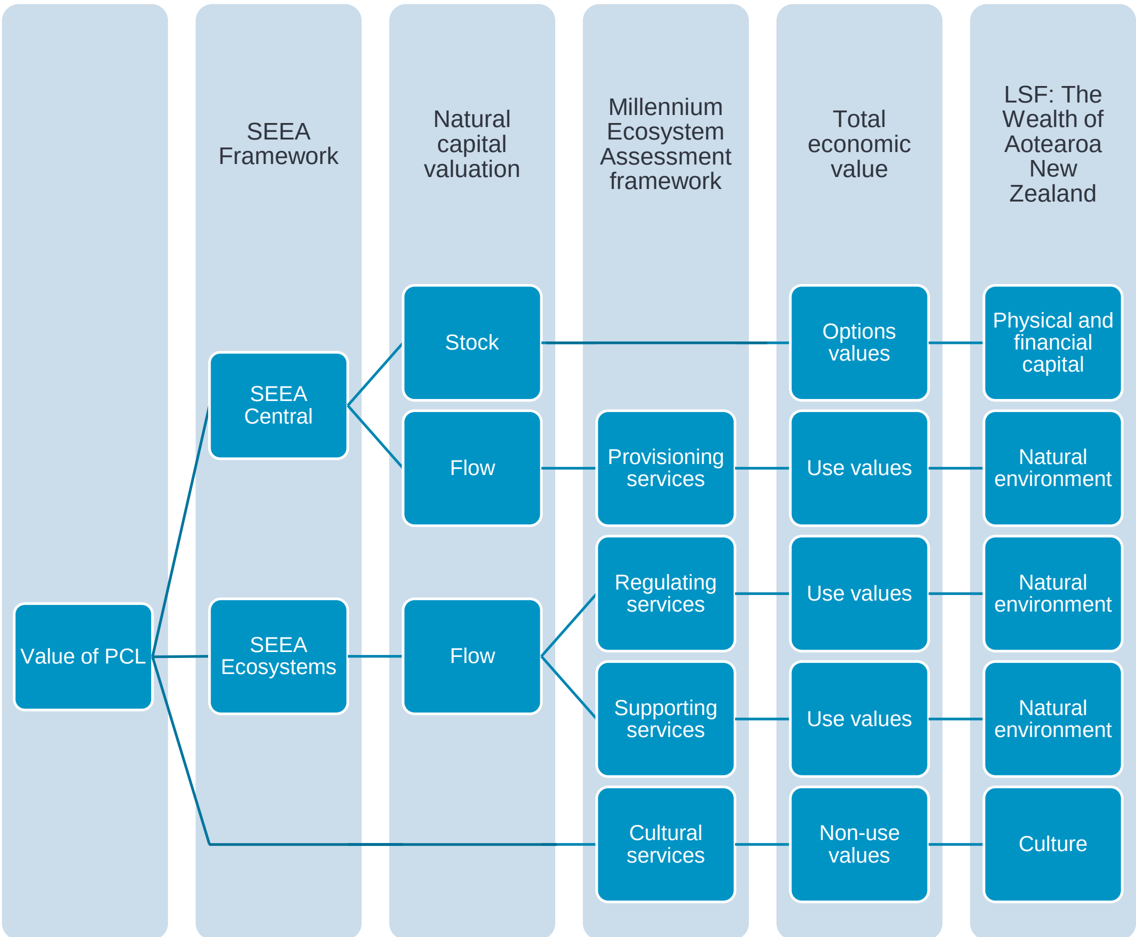
Source: The Treasury (2021)

We focus on the linkages between the value of PCL and the LSF's third level – The Wealth of Aotearoa New Zealand. Guidance on the LSF discusses the linkages between ecosystem services and capital valuation within this level. Provisioning, regulating and cultural ecosystem services are captured within the natural environment wealth aspect, as these services, directly and indirectly benefit humans. The services are flows, and the capital value of nature at a point in time can, in principle, be estimated as the net present value of the future flows of services that nature will provide (The Treasury 2021, 53). The financial and physical wealth aspect includes human-made infrastructure and assets, intangible assets (such as research and development) and financial assets and is focused on parts of the System of National Accounts to which the SEEA framework links natural resources.

3.2 The frameworks we use are interlinked

Figure 6 shows the ways in which the various frameworks we use are interlinked. The SEEA central and ecosystems frameworks provide the method and structure to organise the natural and physical capital stocks and flows through ecosystem services. We then follow the approach of Patterson and Cole (2013) and use the total economic value to assess the benefits people gain from both the use and non-use of PCL and its ecosystems.

Figure 6 Mapping frameworks used in this report



Source: NZIER

The SEEA frameworks do not include passive ecosystem services captured through non-use value because SEEA is primarily concerned with comparing environmental values with economic values captured in the System of National Accounts.

4 Valuing public conservation land

In this section, we estimate the value of the stocks and ecosystem services attributable to PCL. We first describe PCL and its ecosystems and list the stocks and flows we identified, quantified and monetised. We then discuss how we quantify and monetise each of the natural and built capital asset stocks and the provisioning, regulating, supporting and cultural ecosystem service flows.

4.1 PCL is characterised by diverse natural capital and ecosystems

Using the New Zealand Land Cover Database (LCDB) version 5.0, we can identify the composition of PCL and compare it to the national composition. Table 4 captures the breakdown of PCL land by LCDB category type. Over half of PCL is indigenous forest (55 percent), and the remainder consists of tall tussock grassland (16 percent), gravel or rock (7 percent), sub-alpine shrubland (4 percent), and mānuka and kānuka (4 percent). See Appendix A for the full set of land use descriptions.

Although PCL is a third of New Zealand's total land area, it contains a large proportion of our important ecosystems, including 75 percent of total indigenous forestry. Other areas of note include permanent snow and ice, alpine grass and sub-alpine shrubland, of which DOC manages 99 percent, 96 percent and 84 percent of the national coverage, respectively.[3]

Table 4 Land use in New Zealand

Land use in New Zealand compared to PCL in hectares.

Land use type	Total	DOC	Percentage of total
Indigenous Forest	6,307,010	4,756,109	75%
Tall Tussock Grassland	2,335,410	1,351,170	58%
Gravel or Rock	879,278	613,776	70%
Sub Alpine Shrubland	432,966	364,284	84%
Manuka and/or Kanuka	1,167,231	322,510	28%
Broadleaved Indigenous Hardwoods	696,124	235,421	34%
Low Producing Grassland	1,754,076	227,276	13%
Alpine Grass	229,156	198,050	86%
Lake or Pond	364,016	107,583	30%
Permanent Snow and Ice	104,344	103,289	99%
Herbaceous Freshwater Vegetation	129,097	64,671	50%
High Producing Exotic Grassland	8,684,362	59,090	1%
Depleted Grassland	169,501	45,443	27%
Exotic Forest	1,838,310	24,997	1%
Gorse and/or Broom	191,002	20,428	11%
River	82,545	18,021	22%

[3] This data was provided from DOC in correspondence from the GIS team.

Land use type	Total	DOC	Percentage of total
Grey Scrub	110,809	16,760	15%
Sand or Gravel	43,850	16,216	37%
Fernland	70,781	15,819	22%
Landslide	22,743	14,876	65%
Estuarine Open Water	96,477	10,950	11%
Deciduous Hardwoods	99,119	9,825	10%
Mixed Exotic Shrubland	48,815	7,261	15%
Herbaceous Saline Vegetation	18,580	5,266	28%
Flaxland	6,275	3,721	59%
Mangrove	28,172	1,412	5%
Forest - Harvested	199,483	1,268	1%
Surface Mine or Dump	14,403	1,154	8%
Built-up Area (settlement)	196,094	444	0%
Urban Parkland/Open Space	40,949	384	1%
Short-rotation Cropland	368,754	362	0%
Transport Infrastructure	6,099	266	4%
Orchard, Vineyard or Other Perennial Crop	105,093	129	0%
Not land	66	19	29%
Total	26,840,990	8,618,251	32%

Source: NZIER, DOC, Manaaki Whenua – Landcare Research

4.2 There are many stocks and flows associated with PCL but not all can be quantified

Table 5 summarises the stocks and flows identified. Each national park contains different amounts. See Table 13 for a breakdown of the values for each national park.

Table 5 Summary of the stocks and flows of benefit from PCL

Stocks and flows	Identifiable	Quantifiable	Monetisable
Stocks			
Hut assets			✓
Track values	✓		
Minerals	✓		
Soil	✓		
Land values			✓
Standing tree stocks			✓
Water stocks			✓
Biodiversity		✓	

Stocks and flows	Identifiable	Quantifiable	Monetisable
Ecosystem services/flows			
Gas regulation	✓		
Climate regulation			✓
Disturbance regulation			✓
Water provisioning			✓
Water storage and retention			✓
Erosion control and sediment retention			✓
Soil formation			✓
Nutrient cycling			✓
Waste treatment			✓
Pollination			✓
Biological control			✓
Refugia			✓
Food production	✓		
Raw materials	✓		
Genetic resources	✓		
Recreation			✓
Cultural	✓		
Concessions			✓
Energy flows			✓

Source: NZIER

To assess the values associated with each stock and flow, we gather data and information at various levels:

- National – covers the whole of New Zealand and must be apportioned to PCL. Some examples include national-level hydroelectricity generated.
- PCL – examples include total revenues from tourism.
- National park – examples include tourism revenues for each specific national park.
- Ecosystem – examples include the value of carbon sequestered by forestry type for each specific ecosystem.

In the following section, we discuss the data and information we use to generate the stock and flow values for PCL.

4.3 Natural and built capital asset stock values

PCL contains many different types of natural and built capital assets. Some of these stocks provide annual revenues in the form of economic activity, which may also deplete the stock over time. Assets that are not extracted or depleted also provide an option value to be able to use the asset in the future.

Table 6 provides an overview of the monetised assets found in this study, and the following sections provide more information on how these estimates are calculated.

Table 6 Monetised assets in this study

Stock	Measure	Value	Source
Biodiversity	No measure	-	
Land	Opportunity cost value of conservation land	$9.05B	Financial Statements of the Government of New Zealand
Physical assets	Current book value of huts	$67.1M	Department of Conservation
Standing timber	Standing timber stock and price per cubic metre of forestry products	$124.42B	Stats NZ SEEA
Energy stocks	Asset value of energy source attributable to the ice melt from PCL	$0.39B	Stats NZ SEEA
Minerals	No measure	-	
Soil	No measure	-	
Water stocks	No measure	-	

Source: NZIER collated from sources in the table

4.3.1 Biodiversity

The stewardship of biodiversity is at the heart of the purpose driving the stewardship of PCL, making its consideration paramount to any investigation of the value of conservation stocks and flows.

Biodiversity can describe the overall amount of ecological volume or refer to the level of ecological variation. Biodiversity has been defined and measured in several ways, including:

- the combination of all forms of life within an ecosystem
- genetic diversity within a study area or species
- morphological diversity of individuals and populations within a species
- taxonomic diversity of species within an ecosystem
- functional diversity of groups of species within an ecosystem.

(Hanley and Perrings 2019)

From a human wellbeing perspective, biodiversity includes all forms of life and how humans interact with them, whether directly or indirectly (Hanley and Perrings 2019). In the context of these definitions, the value of biodiversity associated with PCL could encompass the total economic value of PCL and its ecosystem services rather than being a subcomponent of the value. Another way of conceptualising biodiversity in the context of environmental valuation and the total economic value framework is biodiversity's option value, insurance value and spillover value.

According to Bartkowski (2017):

- biodiversity's option value arises from biodiversity being a portfolio of options that reduce the uncertainty surrounding future preferences towards ecosystems

- biodiversity's insurance value can reduce the uncertainty surrounding the provision of ecosystem services to risk-averse stakeholders
- biodiversity's spillover value arises from the role of biodiversity in spatial interactions between ecosystems.

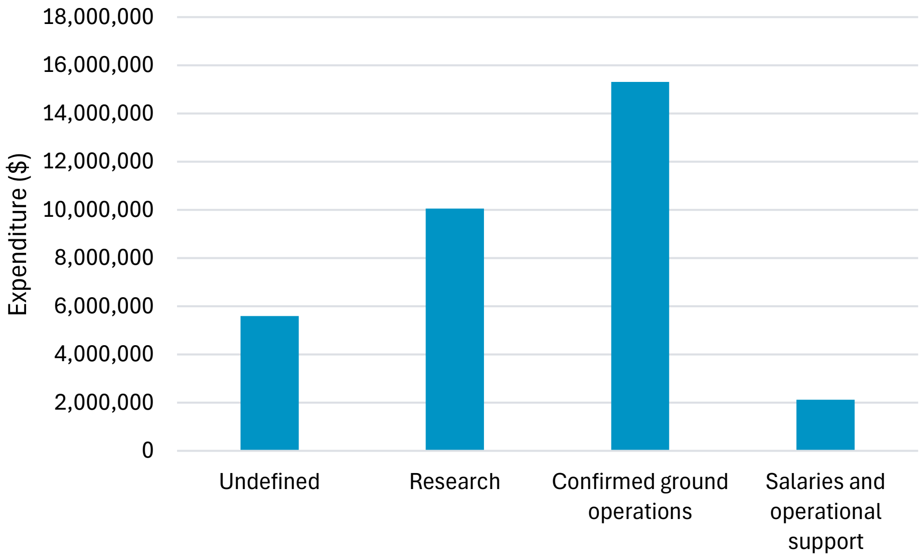
This difference in conceptualisation of the value of biodiversity is more akin to the ecological resilience outcomes from biodiversity, which is an important concept in conservation management and linked to DOC's stewardship role over PCL.

New Zealand makes an important contribution to global biodiversity, with an estimated 80,000 species of native animals, plants and fungi (Ministry for the Environment 2021). Though there are measures of biodiversity in New Zealand, there is little evidence of the total value in monetary terms to PCL, given the conservation of species both on and off PCL. Research often focuses on the willingness to pay to save certain species. For example, through CBAx (The Treasury 2023), there is information on consumers' willingness to pay to prevent the extinction of up to three, six and ten susceptible native species.

New Zealanders value biodiversity and have been shown to be willing to pay for increases in biodiversity in large forests. Yao et al. (2014) estimated the mean willingness to pay per person per year for an increase in kiwi and falcon biodiversity was $37 and $41 adjusted for inflation to 2024 values.

DOC has provided the total annual spend on predator control based on total expenditure across several different activities and DOC regional breakdowns. This includes research, ground operations, and salaries and operational support. Figure 7 shows this breakdown by cost category. Total expenditure was $33 million in predator control. This can be interpreted as part of the value we pay to protect biodiversity.

Figure 7 Predator control by spend



Source: NZIER, DOC

4.3.2 Land

Estimates from the Treasury (2024) place the value of DOC land at an estimated – \$9.05 billion for the year ended 30 June 2024. PCL valuations are based on rateable land valuations, if available, or the rateable valuation of a proxy such as neighbouring land on an indexation basis. Therefore, the value associated is based on its potential alternative use. This is important as it allows the opportunity cost of PCL to be estimated – what else could occur on the land and the value associated with it.

Alternative estimates on the value of protected areas in New Zealand are also available from the World Bank, which valued protected areas at US\$57 billion in 2018 and estimated the value of conservation land as the quasi-opportunity cost of protection areas as the lower returns of cropland and pastureland (World Bank 2024). This method differs from the Treasury as it only applies one alternative land use (cropland and pastureland), whereas the Treasury includes the use of neighbouring lands as suitable alternatives.

4.3.3 Physical assets such as huts and infrastructure

Huts within PCL are important assets as they enable residents and international visitors to enjoy overnight stays within PCL. There are an estimated 1,182 huts on PCL spanning the length of the country. According to DOC, the total book value is \$67.1 million after depreciation. If we do not account for depreciation, the value of total huts is \$209 million. Track values and other infrastructure values are not provided. DOC infrastructure not residing on DOC land (such as visitor centres in settlements) has not been included.

4.3.4 Standing timber

Much of PCL is forested. An estimated 55 percent of the total PCL is indigenous forestry, which accounts for 75 percent of New Zealand’s total indigenous forests. If any of this forestry were to be harvested, there would be a significant amount of value in the wood products.

Though we estimate a value associated with standing timber, we do not suggest that the timber will be harvested. We use the Stats NZ SEEA data to estimate the total value of standing timber within PCL. This provides the total stock of standing timber by forest type for the year ended December 2017, focusing on natural and cultivated timber.

The definition of natural timber differs from indigenous forestry as it contains tall indigenous forests, self-sown exotic trees, mānuka and kānuka and other shrubland. Cultivated timber includes radiata pine (*Pinus radiata*), Douglas fir (*Pseudotsuga menziesii*), eucalypts (*Eucalyptus* spp.) or other planted species and exotic forest species that were planted on land that was natural forest.

According to the Stats NZ SEEA, each hectare of natural forestry contains 508 cubic metres (m^3) of wood available. Each hectare of cultivated forestry contains 283 m^3 of wood available. These figures are calculated by converting the total standing timber in New Zealand in 2017 to a per hectare basis to be applied to PCL. This is applied to broadleaf indigenous hardwoods, deciduous hardwoods, indigenous forest and exotic forest.

To monetise the stock of standing timber, we use the 2017 value of cultivated forestry of \$48.88 per m^3 or \$24,830 per hectare for natural forestry and \$13,828 per hectare for cultivated forestry (Stats NZ 2019). We do not inflate the price per m^3 to 2024 levels due to lower certainty around the composition and value of natural forests. We then apply this across the total hectares of natural and cultivated timber on PCL, giving a total estimated value of timber stocks on PCL of $124 billion. This is a similar approach to how the Treasury has valued PCL using proxy values of neighbouring land on an indexation basis.

This approach is not without its caveats. These figures are estimated at a national level and then applied to the relevant ecosystems in the LCDB we believe to be appropriate. This also utilises a single forestry price across a diverse range of species and represents a lower bound estimate as we have not inflated the value of timber to 2024 levels.

4.3.5 Carbon retention

Embedded carbon in forests poses risks to New Zealand with the increasing frequency and scale of wildfires in a warmer and drier climate. To meet New Zealand's Paris Agreement commitments for 2030, the Climate Change Commission estimates that we will have to purchase international credits, and wildfires may add to the required costs (Ministry for the Environment 2023).

Using the average per hectare carbon stock, we estimate that each hectare of natural timber forest contains 326 tonnes of carbon, and cultivated timber forests contain 292 tonnes of carbon. Applying these factors across the total hectares of natural forests on PCL, we estimate a total retained carbon stock of 1,635,251 kt. It is important to note that carbon is classified as physical stock, not monetary stock or asset.

SEEA guidelines state that, although there are values associated with carbon retention and carbon sequestration, only the value of carbon sequestration should be accounted for as part of assessment (NCAVES and MAIA 2022). This is because the carbon retained in timber stocks on PCL is not likely to be released and should not be considered an asset. Therefore, the price is set to $0. Carbon retention is only to be valued in ecosystems where stocks are declining due to timber harvesting or land use changes.

One way of considering the value of this carbon is through the potential costs incurred if the carbon is released using 'shadow emissions' prices. Shadow emissions prices are based on estimates of future costs of emissions reductions required to reach New Zealand's domestic emissions targets (The Treasury 2023). Using the Treasury's central shadow emissions price path to 2030, the potential future cost of abatement is estimated at a value of $296 billion.

4.3.6 Energy

The stock value of renewable energy is the total amount of renewable energy generated on PCL. Renewable energy stocks are measured by Stats NZ as the net present value of anticipated resource rent. The SEEA Central Framework recognises renewable sources of energy as:

- solar
- hydro
- wind
- wave and tidal
- geothermal
- other electricity and heat.

Across PCL, several different forms of energy generation exist. However, there is little information on the generation of renewable electricity on PCL or resources flowing from PCL. As a result, we only focus on hydroelectricity.

PCL accounts for 99 percent of snow and ice in New Zealand, which feeds into our rivers. Research estimates that 3 percent of annual river flows in the South Island are based on ice melt (Kerr 2014).

The majority of hydroelectricity generated in New Zealand occurs in the South Island (Electricity Authority 2022):

- Waitaki River feeds hydro dams such as Benmore and Aviemore.
- Clutha River runs through the Clyde and Roxburgh dams.
- Waiau River flows through the Manapōuri Power Station.

According to Stats NZ SEEA accounts, the total asset value of energy generated from hydroelectricity was $13.1 billion in 2022. Applying 3 percent to the total value of renewable hydroelectricity, we estimate an annual water value of $393 million of hydroelectricity generated from PCL.

We acknowledge that PCL will generate water for hydroelectricity from a number of different sources, including ice melt, precipitation and groundwater. We only have information on the proportion that comes from snowmelt. Therefore, this is a very conservative metric limited by data availability.

4.3.7 Minerals

The value of minerals is the expected market value of unextracted minerals on PCL. At a third of New Zealand's land area, PCL will contain many valuable minerals. There are several key minerals that New Zealand extracts, which can be broadly defined as metallic and non-metallic minerals.

New Zealand's key metallic minerals are gold, silver and ironsand. The majority of value associated with metallic minerals is from gold produced predominantly from Macraes Mine and Waihi (New Zealand Petroleum and Minerals 2024).

New Zealand's key non-metallic minerals produced include coal and rock, sand and gravel for building and roading. The majority of coal produced in New Zealand is from open-cast mines on the West Coast (New Zealand Petroleum and Minerals 2024).

Although the extent of PCL is large, there is limited available information to estimate the value of the resources it holds. For all mineral types, a large amount of prospecting would be required to estimate the value of minerals on PCL, and this would not include the cost or likelihood of being able to extract them.

4.3.8 Soil

Soil values are associated with high-quality, healthy soils. Soil health is fundamentally important to the economic and environmental outcomes. The degradation of soil could impair the capacity and capability of the land to support our wellbeing due to actual or potential losses of productivity or wellbeing (Samarasinghe, Greenhalgh, and Vesely 2013).

We have found little research that monetises the base value of soils in New Zealand. There are a number of challenges to using economic valuation to value changes in ecosystem services and the role of soils in providing these services. Studies often focus on the replacement value or productivity changes as a result of a change in specific catchments (Samarasinghe and Greenhalgh 2013).

National-level quantitative data is available when examining some bio-physical elements of soils. There are estimates of the quality of soils focusing on acidity, anaerobically mineralisable nitrogen, bulk density, microporosity, Olsen phosphorus, total carbon and total nitrogen (Ministry for the Environment and Stats NZ 2021).

4.3.9 Water stocks

Water stocks are the market and non-market value of water located on PCL. It is difficult to assess this value as there is little information available about volume or prices. As a result, we do not quantify or monetise the value of water stocks on PCL.

Stats NZ provides estimates of the total inflows and outflows of water in New Zealand by water source and by region, but this is difficult to attribute to PCL. There is an estimated stock of water stored in ice that can be estimated to be on PCL based on land use data.

Estimates based on retail prices for bottled water place an estimated value of $1,000 per m^3 of water (BERL 2020). The UN Food and Agricultural Organization estimates New Zealand's annual available freshwater to be 42,810 billion m^3 (BERL 2019). By using these figures, a value can be determined, but it doesn't reflect the reality of the difference in water quality.

4.4 Ecosystem service values

Patterson and Cole (2013) provide a comprehensive list of values for various provisioning, supporting and regulating ecosystem services in New Zealand. Where possible, we draw on publicly available datasets and academic literature to update the values with more recent estimates. Where more recent estimates are not available, we use the values within Patterson and Cole (2013) and inflate these to 2024 prices.

The subheadings in this section align with the ecosystem services set out in Table 7. Each section describes the ecosystem service, the source, the estimated value and any assumptions utilised. These are sorted by the respective ecosystem service categorisations – provisioning, regulating, supporting and cultural.

Table 7 Ecosystem services monetised

Ecosystem service	Measure	Source
Concessions	Revenue from concessions	Department of Conservation
Energy flows	Percent of energy value associated with PCL	Stats NZ SEEA accounts
Food production	No values	No values
Raw materials	Value received by the Crown	Provided by the Ministry of Business, Innovation and Employment
Genetic resources	No values	No values
Water provisioning	$/hectare	Patterson and Cole 2013

Ecosystem service	Measure	Source
Climate regulation	Annual carbon sequestered and the shadow price of carbon	Stats NZ SEEA accounts
Disturbance regulation	$/hectare	Patterson and Cole 2013
Water storage and retention	$/hectare	Patterson and Cole 2013
Biological control	$/hectare	Patterson and Cole 2013
Waste treatment	$/hectare	Patterson and Cole 2013
Erosion control and sediment retention	$/hectare	Patterson and Cole 2013
Soil formation	$/hectare	Patterson and Cole 2013
Nutrient cycling	$/hectare	Patterson and Cole 2013
Pollination	$/hectare	Patterson and Cole 2013
Refugia	$/hectare	Patterson and Cole 2013
Cultural values	No values	No values
Recreation	Revenue and non-market estimates	Department of Conservation

Source: As per source column

4.5 Provisioning services

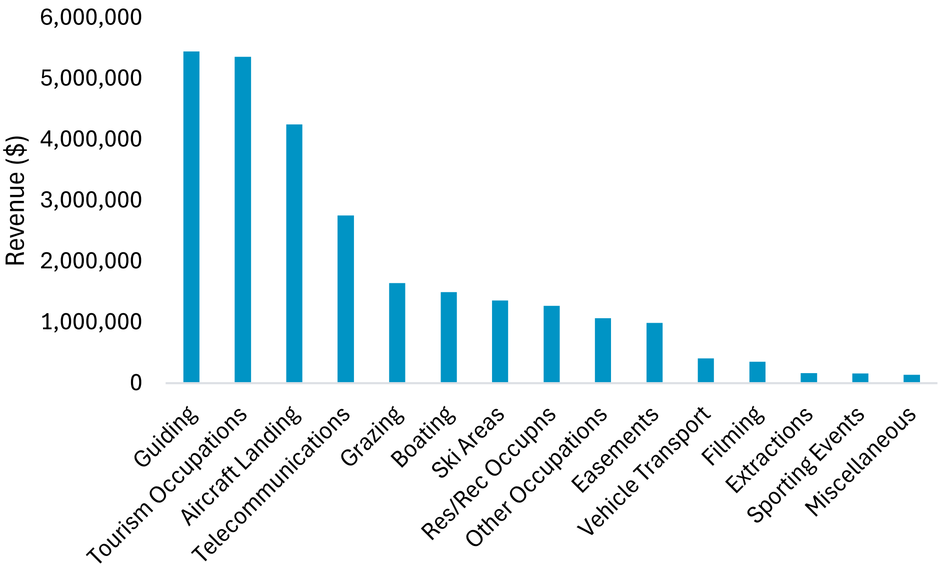
Provisioning services are those where people have direct interactions with environments to generate and acquire goods and services. For PCL, we assess that the provisioning services include concessions for commercial activities, energy flows, food and raw materials extracted, genetic materials and water provisioning.

4.5.1 Concessions

Concessions are a permit, lease, licence or easement that enables commercial activity, organised non-profit activities, occupation of land and building of structures, and research (Department of Conservation, n.d.). Concessions are important to valuing PCL as they help identify different high-value activities that occur on PCL. Data on PCL concessions was provided to us by DOC.

Concession revenue is categorised into several key categories, including guiding, tourism activities, aircraft landing, telecommunications and grazing. Concessions are paid as a proportion of revenue that the business earns, and others are based on flat fees (per person in some instances for guiding). Figure 8 shows the value paid to the Crown across concession types. The revenue from concessions paid to DOC is $26.9 million in 2024.

Figure 8 Concession revenue by category, June 2024 financial year



Source: NZIER, DOC

However, this likely underestimates the total value associated with the activity as operators capture greater revenues from sales to customers. Examples of this would include the total revenue associated with ski fields or the total value of extracted resources from forestry or mining operations with granted concessions.

4.5.2 Energy production

Energy flows are the values associated with electricity generation that stem from PCL resources. In New Zealand, renewable electricity is generated from several different sources, including hydro, geothermal, wind, wood, biogas and solar energy.

As stated in section 4.3.6, we focus only on hydroelectricity. Hydroelectricity is, in part, generated from ice melt, which occurs on PCL.

According to Stats NZ SEEA accounts, the total resource rent value of energy generated from hydroelectricity was $655 million in 2022. Applying 3 percent to the total value of renewable hydroelectricity, we estimate an annual resource rent water value of $20 million of hydroelectricity generated from PCL.

This is likely a lower bound estimate and reflects the flows of all rivers in the South Island. This figure would likely be higher in the South Island's major rivers due to more mountains and hydroelectric dams. Other estimates suggest that snowmelt contributes to 20–70 percent of spring and summer water inflows (Electricity Authority 2022).

It is difficult to disentangle the contribution of snow melt to hydroelectricity generation. Rivers and lakes contribute to hydroelectricity as part of water provisioning ecosystem service which is feed from other sources such as rain and groundwater. However, this creates a material risk of double counting, and more information is required to understand the linkages between them.

4.5.3 Food production

Food production is the value of food captured on PCL. This includes both commercial and non-commercial activities such as grazing, some fishing, cultural harvest activities and hunting.

We have not been able to quantify the food production that occurs on PCL due to the lack of available data and estimates around non-commercial food gathering in New Zealand.

4.5.4 Raw materials

Raw materials are the value of resources extracted from PCL. This includes minerals and forestry extraction.

Though there are some forestry operations concessions and known mining on PCL, we have not been able to identify the value of the resources extracted. There is little available public information on companies that operate on PCL. Concession data is not tied to total value production for sites on which it has been granted.

For forestry, we do not have a clear indication of the flow of value extracted on PCL.

For minerals, it is estimated that little is extracted from DOC land. For 2022, the total value of non-metals extracted in New Zealand was $642 million; metals were valued at $614 million and the value of coal produced was not disclosed (New Zealand Petroleum and Minerals 2024). Metals were predominantly gold from Macraes Mine in Otago, and non-metals were mainly from quarries for construction. We do not have clear information on the value of coal extracted annually on DOC land, which is predominantly from the West Coast.

Data provided by the Ministry of Business, Innovation and Employment shows that the royalties received for mining in 2023 were $1 million from Minerals permits on PCL. In total, 267 out of 868 currently active minerals permits were found to have an overlap of at least 5% with PCL. This was primarily for coal and alluvial mining on the West Coast. The royalties do not fully capture the total value extracted from PCL and are an underestimate.

4.5.5 Genetic resources

Genetic resources are the “genetic material of plants, animals or microorganisms of value as a resource for future generations of humanity” (United Nations 1997, 36). This is the supply of sources of unique biological materials and products. There is no information available on the annual value of genetic resources extracted.

4.5.6 Water provisioning

Water provisioning is the regulation of hydrological flows and the provisioning of water for agricultural and industrial processes. This includes the provision of water for hydroelectricity generation, irrigation particularly in the South Island, industrial use, commercial use, and for use by households. The value of water is vast and has many implications, which makes it difficult to assign values within the literature to PCL.

One study focusing on Te Papanui Conservation Park found that the 22,000 hectares delivered an estimated $136 million in value to Dunedin and the area from drinking water, hydroelectricity and irrigation. This value alone estimates the return per hectare of over $6,000 in value (Department of Conservation 2006b).

To estimate this value, we utilise Patterson and Cole (2013) and inflate the value from 2012 to 2024 values and apply these on a per hectare basis to relevant ecosystems. The estimated value per hectare per ecosystem can be found in Table 16.

4.6 Regulating services

Regulating services include the regulation of biophysical and ecological processes that make life possible. These include climate regulation through carbon sequestration and biological controls, water storage and retention, and waste treatment.

4.6.1 Climate regulation

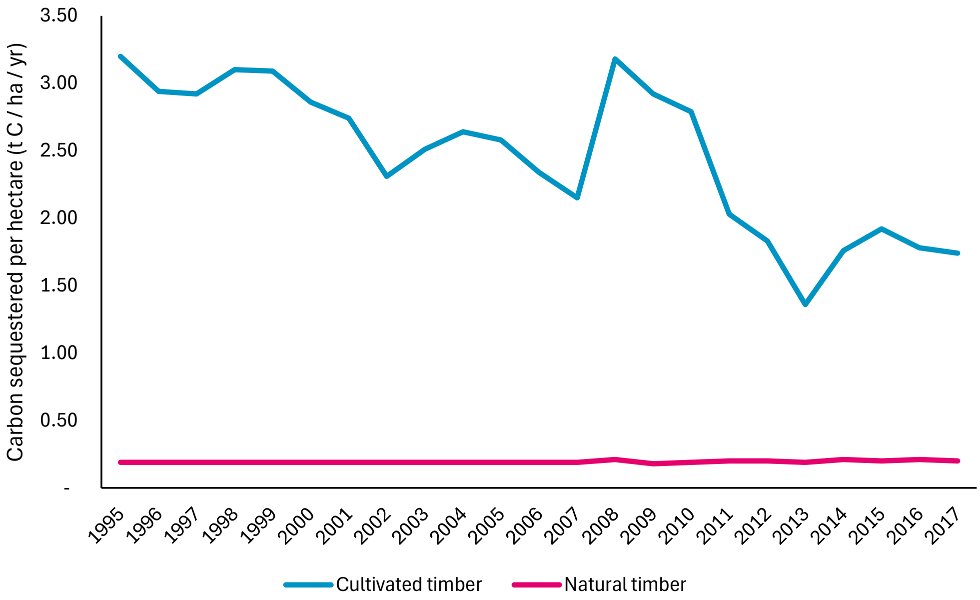
Vegetation cover provides important climate regulation benefits that contribute to the stability of environmental conditions that underpin other economic, social, cultural and environmental benefits from the environment (Scholes 2016; De Carvalho and Szlafsztein 2019).

We have combined gas and climate regulation into one ecosystem service. Climate regulation regulates global temperature, precipitation and other biologically mediated climatic processes (Patterson and Cole 2013).

The quantity and value of carbon sequestration on PCL are used as a standard proxy for the size and value of climate regulation services. Climate regulation is categorised as a regulating service using the ecosystem services framework approach.

Carbon sequestration data is provided by Stats NZ's SEEA datasets, and it includes breakdowns of carbon in soil and biomass for both natural and cultivated forests. Data on forest carbon is from the LUCAS; it is consistent with the input data used to determine emissions from the Land Use, Land Use Change and Forestry (LULUCF) sector in the New Zealand Greenhouse Gas Inventory (Stats NZ 2019). Though this series was discontinued in 2017, we can utilise the average annual sequestration for forestry. Across the data, this remains consistent with natural timber (see Figure 9).

Figure 9 Carbon sequestration per hectare by forestry type



Source: Stats NZ

Stats NZ estimates that the average sequestration of carbon in natural timber is 0.20 kt of carbon per hectare per year for the year ended December 2017. This data also captures carbon sequestration for cultivated timber and the annual sequestration associated with this. Stats NZ estimates the average sequestration for cultivated timber is 1.74 kt of carbon per hectare per year. These figures may be underestimated as PCL does not mirror the same composition of land use as New Zealand.

Mature ecosystems tend to be at a steady state ecologically, meaning new growth is offset by other parts of the forest being damaged or dying. While a large amount of carbon is stored in native forests, little additional carbon is being sequestered as these forests have reached a steady state. In contrast, cultivated timber sequesters a large amount of carbon each year.

To value the annual carbon sequestration flows, we utilise the shadow emissions value using the central price path to 2030 taken from CBAx of $181 dollars per tonne of carbon emissions equivalent (The Treasury 2023). This value represents the anticipated future emissions reduction costs required to reach New Zealand’s domestic emissions targets. These figures create an estimated value of $192 million of annual carbon sequestration across PCL.

4.6.2 Disturbance regulation

Disturbance regulation is an ecosystem’s ability to withstand environmental variation. Examples of this include storm protection, flood control and drought recovery. These services are provided by the vegetation structure and help environmental resilience.

We could not identify the value of disturbance regulation in New Zealand. To estimate this value, we utilise Patterson and Cole (2013) and inflate the value from 2012 to 2024 values. The estimated value per hectare per ecosystem can be found in Table 16.

4.6.3 Water storage and retention

Water storage and retention is the storage of water in reservoirs and aquifers. This is important as it helps retain water during wet periods and makes water more abundant for ecosystems, agriculture and forestry during drought periods. This also benefits the surrounding ecosystems and habitats. This is increasingly important for resilience and countering the impacts of climate change (Global Water Partnership 2015).

We did not find New Zealand-specific information on the value of water retention. To estimate this value, we utilise Patterson and Cole (2013) and inflate the value from 2012 to 2024 values. The estimated value per hectare per ecosystem can be found in Table 16.

4.6.4 Biological control

Biosecurity threats are significant for New Zealand and its ecosystems due to their inherent uncertainty and potential for irreversible damage. Initiatives for reducing biosecurity risk provide biosecurity protection benefits for all of New Zealand, including primary industries, tourism businesses, local communities and members of the public in their everyday activities.

Assets that are potentially protected by biosecurity initiatives encompass goods and services that have market values (such as forestry and agricultural products) and non-market values (such as air and water quality and cultural values). Public perception of these risks significantly influences non-market valuation.

Yao and Wallace (2024) undertook a meta-analysis of studies completed between 2000 and 2020 that examined biosecurity protection values across different ecosystems. Several different ecosystem services were found to be valued using a collection of methods, with studies emphasising different types of biosecurity interventions aimed at preventing the spread or entry of invasive animal species, plant species, aquatic species and pathogens.

It is difficult to utilise the summarised values due to the differing methodologies combined with studies measuring a change in the state of biosecurity as opposed to the current state (De Groot et al. 2012). To approximate a lower bound estimate, in section 4.3.1, we utilise DOC's spend on predator control based on a defence expenditure approach as one measure of intervention to protect biodiversity.

Ecosystems also provide trophic-dynamic regulation to food chains. Using Patterson and Cole (2013), we find that the estimated biological control value of PCL is $224 million.

4.6.5 Waste treatment

Waste treatment is the detoxification of excess nutrients and compounds in the environment. To estimate this value, we utilise Patterson and Cole (2013) and inflate the value from 2012 to 2024 values. The estimated value per hectare per ecosystem can be found in Table 16.

4.7 Supporting services

Supporting services refer to the processes that support the provisioning and regulating of ecosystems. This includes erosion control and sediment retention, soil formation, nutrient cycling, pollination and refugia.

4.7.1 Erosion control and sediment retention

Soil erosion leads to a loss of topsoil that is valuable for productive purposes and affects soil ecosystem health, which has several negative consequences. It leads to a reduction in productivity and results in sediment build-up in rivers, streams, lakes and the coastal environment. New Zealand also faces high levels of soil erosion due to steep terrain and high rainfall.

Stats NZ (2024) provides data measuring long-term soil erosion using the New Zealand Empirical Erosion Model. Though this model quantifies the losses, it is difficult to value them. As a result, we utilise Patterson and Cole (2013) and inflate the value from 2012 to 2024 values. The estimated value per hectare per ecosystem can be found in Table 16.

4.7.2 Soil formation

Soil formation processes are essential to maintain and regulate soil to ensure that New Zealand's growing conditions remain healthy. Erosion affects productivity by removing topsoil. Soil cover requires careful management and is important to maintain (Ministry for Primary Industries 2020). Excess sediment from soil erosion has a large impact on New Zealand rivers (Stats NZ 2020a).

We don't have a value associated with this at a national level and utilise Patterson and Cole (2013) and inflate the value from 2012 to 2024 values. The estimated value per hectare per ecosystem can be found in Table 16.

4.7.3 Nutrient cycling

Nutrient cycling refers to how nutrients move through an ecosystem, influencing productivity, consumption and food web resilience (Deemy et al. 2022). Examples of this include the regulation of nitrates and phosphorus in the environment. Excess nitrogen and phosphorus can result in significant impacts on the environment at excess levels and can damage our drinking water (Fertiliser Association 2018). To estimate this value, we utilise Patterson and Cole (2013) and inflate the value from 2012 to 2024 values. The estimated value per hectare per ecosystem can be found in Table 16.

4.7.4 Pollination

Pollination is essential to maintain New Zealand's agricultural system. The Ministry for Primary Industries (2014) estimates that insect pollination of crops is worth at least $2 billion annually to the New Zealand economy based on pollination in the primary sector. We do not utilise this number as it is not specific to PCL.

Though there is honey production on PCL, this does not capture the full non-market value that pollination provides. To estimate this value, we utilise Patterson and Cole (2013) and inflate the value from 2012 to 2024 values. The estimated value per hectare per ecosystem can be found in Table 16.

4.7.5 Refugia

Refugia is the value of habitats for animal populations. To estimate this value, we utilise Patterson and Cole (2013) and inflate the value from 2012 to 2024 values. This is likely an underestimate, as New Zealand has unique ecosystems with an abundance of different species. The estimated value per hectare per ecosystem can be found in Table 16.

4.8 Cultural services

Cultural services refer to how ecosystems contribute to the maintenance of human health and wellbeing.

4.8.1 Cultural and heritage benefits

It is well established that there is a paucity of environmental economics literature that investigates the environment from the perspective of indigenous peoples. Major gaps in addressing the challenge of environmental valuation in te ao Māori are persistent.

Addressing these challenges is important in the context of Aotearoa New Zealand. Nevertheless, addressing these challenges for the valuation of PCL is out of scope. It is a fundamental issue that needs its own research funding and the appropriate research team.

PCL is valuable for Māori and non-Māori alike. The conceptualisation of the value and unit values placed on resources varies across cultures. Indigenous peoples often take a more holistic view of environmental and community resources (NZIER 2018).

Within the literature base, there appears to be some hesitancy in applying a total economic value framework and non-market valuation approaches to matters of importance to Māori. However, some researchers have attempted to do this. Miller, Tait, and Saunders (2015) describe the application of choice modelling to estimate the cultural values of freshwater with reference to water quality for the customary gathering of food. The results suggested that Māori had a higher willingness to pay for enhanced cultural attributes of freshwater food gathering.

Where Māori represent a significant percentage of the population, having an appropriate value for how they stand to be affected by resource use decisions could be important for an effective outcome (NZIER 2018).

Patterson and Cole (2013) estimated a value that includes aesthetic, artistic, educational, spiritual and/or scientific values of ecosystems. This builds on Costanza et al. (1997) using literature estimates to derive direct value. We do not believe it to be appropriate to apply in the New Zealand context, given the differences across global cultures.

This is also difficult as there is no singular voice to represent the varying values across different iwi. Due to these difficulties and lack of available data, we do not capture cultural values.

4.8.2 Recreation on conservation land

Recreational activities within PCL can be broken down into market and non-market values.

Market values include the price paid to undertake that activity, such as booking a DOC hut or paying for a fishing charter.

Non-market values include the indirect benefits people receive, such as:

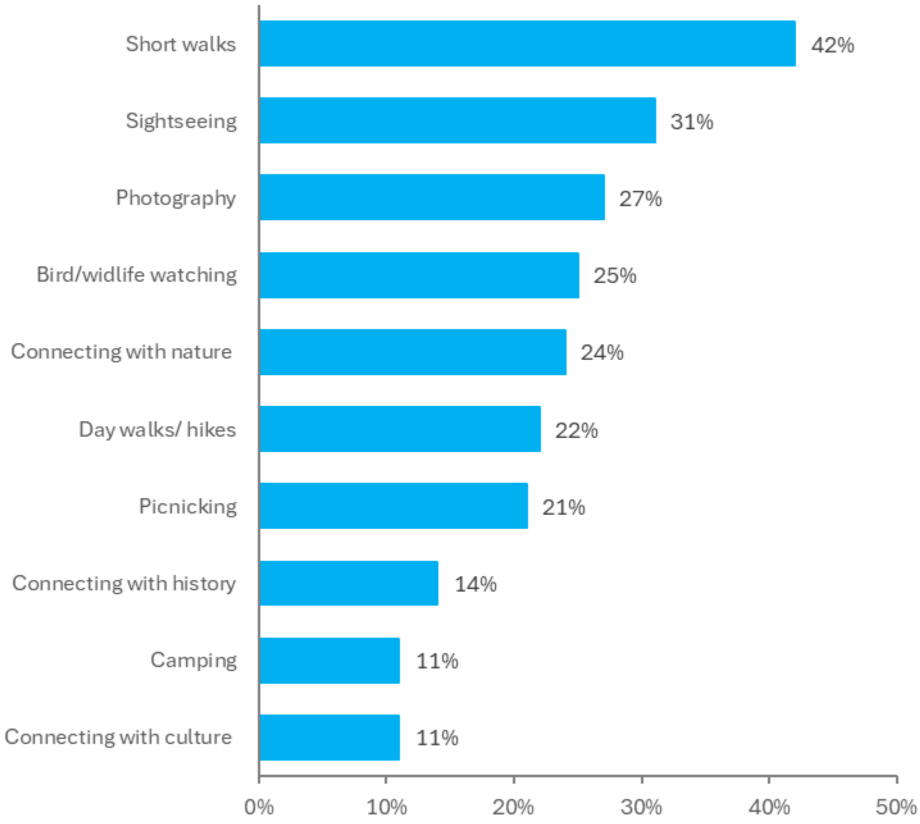
- physical and mental health benefits associated with recreational activities
- quality of life impacts such as enjoying wildlife and aesthetics
- education and research benefits
- socialisation benefits.

The total revenue from recreational activities that DOC receives is $25.4 million, and the non-market value for New Zealanders is $448 million.

It is typical to expect that the non-market value of the recreational use of public spaces is materially larger than the market value for bookable facilities. In the context of how people use PCL, it is clear that short walks (under 3 hours), sightseeing and wildlife observation are much more common than overnight stays linked to costs/revenue.

Recreational activities on PCL are mixed, but all have some connection to nature. Figure 10 shows the top 10 recreational activities on PCL identified for New Zealanders (Department of Conservation 2023).

Figure 10 Recreational activities on PCL



Source: Department of Conservation (2023)

Domestic and international visitors also spend a total of 175,000 bed nights taking part in the Great Walks each year (see Table 8). We used the 2019/20 year to avoid the impacts of COVID-19. While only a subset of recreational activity within PCL, it shows the relative importance of PCL for recreation across New Zealand.

DOC also manages close to 300 campsites, with 149 of them needing to be booked. Around 245,800 people used bookable campsites over 2022/23 (Department of Conservation 2023).

Table 8 Bed nights by Great Walk

Based on a 2019/20 year.

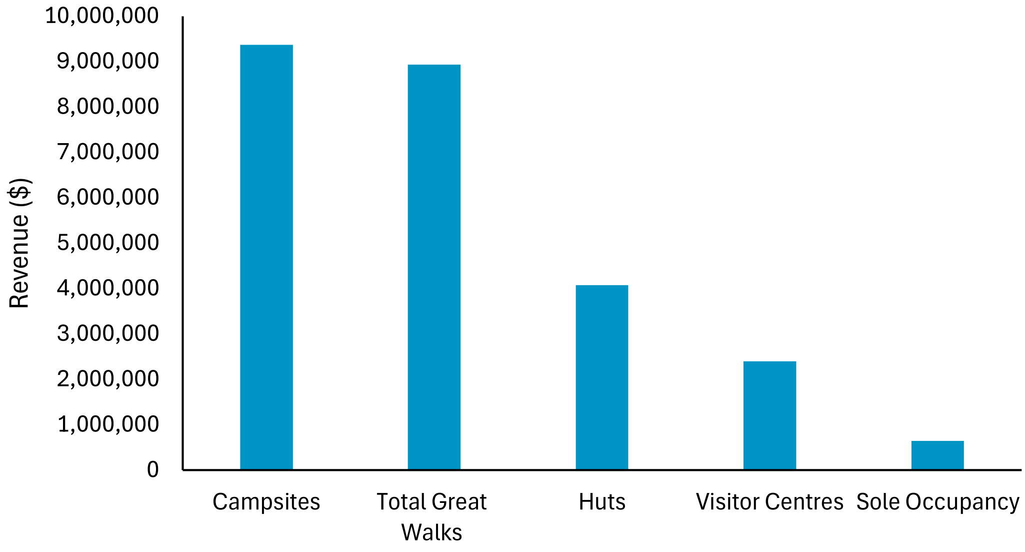
Great Walk	Domestic	International	Total
Abel Tasman Track Great Walk	33,919	28,153	62,072
Heaphy Track Great Walk	13,413	6,278	19,691
Kepler Track Great Walk	9,564	13,884	23,448
Milford Track Great Walk	5,861	5,976	11,837
Paparoa Track Great Walk	2,349	476	2,825
Rakiura Track Great Walk	6,749	4,754	11,503
Routeburn Track Great Walk	6,495	8,348	14,843
Tongariro Track Great Walk	5,303	8,432	13,735
Whanganui Track Great Walk	8,967	6,508	15,475
Total	92,620	82,809	175,429

Source: Department of Conservation

We use data provided by DOC for the financial year ended June 2024 on tourism revenue received by DOC for hiking and camping activities.

Figure 11 highlights the relative expenditure in each revenue area. Tourism expenditure is grouped into several key categories, including revenue from Great Walks, retail sales, revenue from huts and campsites, venue income and annual pass revenue from campgrounds and huts.

Figure 11 Tourism value associated with PCL



Source: NZIER, DOC

Recreational activity also generates non-market benefits that people receive from participation in recreational activities on PCL. A survey of 1,000 people aged 15 or over found that, from July 2022 to June 2023, the proportion of New Zealanders visiting protected natural areas each month was nearly 50 percent (Dodd 2023), while 61 percent of international visitors did a walk/tramp (Department of Conservation 2023). However, this survey asks respondents about their use of Protected Natural Areas, which covers all national and local reserves, including local parks and playgrounds. This means the results are more akin to the use of green space and not an unambiguous measure of the use of conservation land.

The most useful data for estimating the level and frequency of recreational use of PCL is found in two annual surveys with recreational use data from 2011 to 2014 (Nielsen 2013; 2014). The average adult uses PCL recreationally 2.6 times per year at an average of 5 hours each visit.

Table 9 shows the estimated non-market value of recreation on PCL was $448 million in 2023 (in 2024 values) based on activity rates, adult population estimates, and the estimated non-market value of outdoor land-based recreation adjusted for inflation.

Table 9 Estimated non-market value of recreation on PCL in 2024

Input description	Value
Adult population	4,260,800
PCL visits per adult per year	2.6
Proportion of a day per trip	42%
Value per day	$96
Non-market value of recreational use of PCL among New Zealanders	$448 million

Source: NZIER analysis based on inputs referenced above

Kaval and Yao (2007) found the average consumer surplus value for outdoor recreation was $72 per person per day (2007 prices). This central estimate is often used. It covers land and water-based recreational activities. Their average value for land-based activities only was $63 per person per day. The inflation adjustment factor between 2007 and 2024 is 1.53.

The valuation does not distinguish between types of land-based activity. It is worth noting that while the average value of a day in the outdoors completing land-based activities in New Zealand was estimated at $96 (in 2024 values), the value of backpacking/tramping was equivalent to $372 per day (Kaval and Yao 2007). This demonstrates the need for investment in detailed data gathering.

4.9 Non-use values

Bequest and existence values capture the value associated with the ability to pass on the land to the next generation and the knowledge that the resources exist to be enjoyed.

Patterson and Cole (2013) also estimate the non-use values based on literature for national parks. Non-use values refer to the values not related to the actual use of ecosystems. This can be split into two parts of:

- existence value
- bequest value.

These estimates face issues as many of these values are specific to culture, time and place and are estimated based on overseas studies. These also do not reflect the variation New Zealand has within our national parks and, more broadly, PCL.

Although Patterson and Cole (2013) estimate non-use values, they note that due to data limitations, studies summarised often only estimate existence values. As a result, we treat the estimated non-use values as existence values.

Patterson and Cole (2013) estimate the non-use value per working-age person in 2012 to be $169 per national park. To estimate the new total passive values for all national parks, we inflate the passive value per person to March 2024 levels (quarter 1) and multiply it by the working-age population and the total number of national parks (13). This results in the national estimate for the passive value of national parks to be $12.6 billion.

Another study by Omwenga (1995) estimates the separable components of the total economic value. This suggests that, in proportion to total economic value, use value accounts for 5 percent, option value for 20 percent, bequest value for 51 percent and existence value for 24 percent.

This has some similarities to a study of values on the database prepared at Waikato University that reviewed non-market valuation in New Zealand from 1974 to 2005 (R. Yao and Kaval 2007).

However, there is no consensus on how large non-use values might be, and some papers question the “conventional wisdom” that such values are a significant component of total economic value (Cummings and Harrison 1995). Most literature does not attempt to attribute value to specific components of non-use value.

4.10 Final summary results

This section summarises the results identified above at different levels. This includes:

- the value of PCL
- the value of national parks.

It contains caveats about the risks of interpreting data at this level and its shortcomings.

4.10.1 The value of PCL

The overall estimated value of the gross flow of ecosystem services is estimated to be $16.42 billion annually and the net flow of ecosystem services to be $10.90 billion. The value of the stocks of environmental and economic assets linked to PCL is estimated to be $134 billion.

These figures are limited to available data and don’t capture the full market value of resources extracted or activities that occur on PCL due to a lack of available information. Cultural and heritage benefits are also not included in the quantification.

Critically, these estimates of stocks and flows of the ecosystems of PCL do not fully reflect the value of biodiversity, which is quintessential to its value and contribution to society.

The ecosystem services classifications provide the following values:

- Provisioning services – $2,528 million
- Regulating services – $7,897 million

- Supporting services – $5,526 million
- Cultural services – $473 million.

Table 10 highlights the total value from each ecosystem service where identified. Option values of PCL can be seen in Table 11.

Table 10 Total annual ecosystem services

Ecosystem service		Annual value
Climate regulation	Regulating services	$192M
Disturbance regulation	Regulating services	$1,722M
Water provisioning	Provisioning services	$2,480M
Water storage and retention	Regulating services	$2,717M
Erosion control and sediment retention	Supporting services	$2,936M
Soil formation	Supporting services	$257M
Nutrient cycling	Supporting services	$2,073M
Waste treatment	Regulating services	$3,042M
Pollination	Supporting services	$151M
Biological control	Regulating services	$224M
Refugia	Supporting services	$109M
Raw Materials	Provisioning services	$1M
Recreation	Cultural services	$25M
Domestic non-market value recreation	Cultural services	$448M
Concessions	Provisioning services	$27M
Energy flows	Provisioning services	$20M
Total		$16,425M

Source: NZIER

Table 11 Total option value

Stock and flow	Value
Hut assets	$67.1M
Land values	$9,054M
Standing tree stocks	$124,422M
Energy	$393M

Source: NZIER

4.10.2 The value of national parks

National parks serve as highlights on PCL. To capture their value, we have modelled them based on land use data provided by DOC. The estimated existence value of national parks is $12.6 billion.

Some ecosystem services are identified at the PCL level but cannot be applied at a national park level. Ecosystem services that are specific at a national park level are shown in Table 12, and the total annual value of ecosystem services for each national park is shown in Table 13. Table 13 does not incorporate the existence value of national parks.

Table 12 Measurable data for national parks

What is included	What isn't included
Climate regulation	Food production
Disturbance regulation	Raw materials
Water provisioning	Cultural
Water storage and retention	Concessions
Erosion control and sediment retention	Energy flows
Soil formation	Non-market recreation
Nutrient cycling	
Waste treatment	
Biological control	
Pollination	
Recreation (market value)	
Refugia	

Source: NZIER

Table 13 Value of national parks

National park	Provisioning and cultural	Regulating	Supporting	Total
Abel Tasman	$2M	$12M	$17M	$31M
Aoraki/Mount Cook	$43M	$28M	$11M	$82M
Arthur's Pass	$3M	$37M	$65M	$105M
Egmont	$0M	$21M	$24M	$45M
Fiordland	$1,582M	$1,412M	$761M	$3,754M
Kahurangi	$30M	$225M	$364M	$619M
Mount Aspiring	$51M	$134M	$170M	$355M
Nelson Lakes	$69M	$65M	$51M	$186M
Paparoa	$1M	$22M	$32M	$54M
Rakiura	$8M	$205M	$102M	$314M
Tongariro	$4M	$60M	$41M	$106M
Westland/Tai Poutini	$40M	$139M	$74M	$254M
Whanganui	$3M	$28M	$55M	$85M
Total	**$1,836M**	**$2,388M**	**$1,766M**	**$5,990M**

Source: DOC, NZIER

Though this modelling exercise has resulted in a zero value for Egmont for provisioning and cultural services, it is not without its value.

The value of recreation captured in cultural services in Table 13 only captures the value associated with Great Walks. Given Egmont doesn't have a Great Walk and doesn't act as a water source, its value is zero. Egmont is of high spiritual value for both Māori and non-Māori and is central to the identity and whakapapa for many people of the region,[4] but we cannot monetise this value due to lack of data.

The value received by national parks from Great Walks is from the year that ended in June 2024.

[4] https://taranakimounga.nz/

5 Discussion and limitations

This section focuses on studies previously undertaken by DOC, what alternative measurement systems could have been utilised and what data limitations we face.

5.1 Previous DOC studies

DOC has completed several studies over time that focus on identifying the value of PCL, both quantitative and monetary. Some studies of note:

- The value of conservation: what does conservation contribute to the economy? (Department of Conservation 2006b)
- Regional economic impacts of Abel Tasman National Park and Queen Charlotte Track (Department of Conservation 2005)
- Regional economic impacts of Fiordland National Park (Department of Conservation 2006a)
- Regional economic impacts of West Coast conservation land (Department of Conservation 2004).

These studies focus on economic impact analysis, placing particular emphasis on economic multipliers based on certain activities. Economic impact analysis estimates how much extra money is added to the economy, the number of new jobs created and the contribution to a region's household income by activity undertaken on conservation land. This works by focusing on the flow-on effects of conversation land impacts. There is also a large emphasis on site-specific analysis. These yield benefits for understanding site-specific challenges but are difficult to apply to the whole PCL (Department of Conservation 2005, 2006a, 2006b).

5.2 Net present value

We have chosen to represent the value of PCL at a single point in time, but several alternative approaches can be taken. One is calculating the net present value, which values the asset as the net present value of future benefits accruing from holding or using the asset. The logic of the net present value approach requires estimating the stream of resource rents that are expected to be earned in the future and then discounting these back to the present accounting period. This provides an estimate of the value of the asset at that point in time. The asset value represents the discounted future income stream and, therefore, the benefits to accrue to current and future generations.

We have chosen not to use this approach as we are estimating the static value of PCL rather than potential revenues that may occur in future under different investment activities.

5.3 Data limitations

This study has been limited to secondary research and the aggregation of available data. Though there is a large literature base, estimates of non-market values are often site-specific and are difficult to extend to the whole PCL, or they focus on a marginal shift in ecosystem quality.

6 Conclusion and recommendation for future research

Our analysis showcases the economic contributions of PCL

Overall, PCL generates a net annual value of $10.9 billion from the benefits ecosystem services that contribute to the economy and society. This is a likely underestimate of the total economic value of PCL because only a portion of the full benefits can be quantified currently.

Indigenous forestry and the services it provides, including erosion control, waste treatment and nutrient cycling, are the most important drivers of ecosystem value from PCL.

In regard to option values, the majority of value is held in sequestered carbon in indigenous forestry.

National parks contribute a large amount of value within PCL, most notably Fiordland National Park, as it is the largest.

More robust information is required to help refine the estimates in this report

Where possible, we have tailored estimates to focus on PCL. However, much of the publicly available data is not designed for New Zealand-specific ecosystems. This study consists of secondary research and highlights gaps in the literature and available data. To capture a robust understanding of the value of PCL, it is essential to measure the unmeasurable.

To better refine the research and estimates provided in this report, we recommend:

- developing robust estimates of the extraction of resources from PCL, including food production and mining
- creating a better understanding of the cultural values that ecosystem services provide
- developing a wider set of measures to determine the welfare contribution of PCL, such as existence and bequest values.

This is fundamental to developing a strong knowledge base and understanding the trade-offs in investment in PCL.

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Appendix A Land use definitions and mapping

Table 14 Land use descriptions and mapping

Title (LCDB)	Definition (Manaaki Whenua – Landcare Research 2020)	Mapping	Definition (Patterson and Cole 2013)
Built-up Area (settlement)	Commercial, industrial or residential buildings, including associated infrastructure and amenities, not resolvable as other classes. Low density 'lifestyle' residential areas are included where hard surfaces, landscaping and gardens dominate other land covers.	NA	NA
Urban Parkland/ Open Space	Open, mainly grassed or sparsely-treed, amenity, utility and recreation areas. The class includes parks and playing fields, public gardens, cemeteries, golf courses, berms and other vegetated areas, usually within or associated with built-up areas.	NA	NA
Transport Infrastructure	Artificial surfaces associated with transport, such as arterial roads, rail-yards and airport runways. Skid sites and landings associated with forest logging are sometimes also included.	NA	NA
Surface Mine or Dump	Bare surfaces arising from open-cast and other surface mining activities, quarries, gravel-pits and areas of solid waste disposal such as refuse dumps, clean-fill dumps and active reclamation sites.	NA	NA
Sand or Gravel	Bare surfaces dominated by unconsolidated materials generally finer than coarse gravel (60mm). Typically mapped along sandy seashores and the margins of lagoons and estuaries, lakes and rivers and some areas subject to surficial erosion, soil toxicity and extreme exposure.	NA	NA
Landslide	Bare surfaces arising from mass-movement erosion generally in mountain-lands and steep hill-country.	NA	NA
Permanent Snow and Ice	Areas where ice and snow persist through late summer. Typically occurring above 1800m but also at lower elevations as glaciers.	NA	NA
Gravel or Rock	Bare surfaces dominated by unconsolidated or consolidated materials generally coarser than coarse gravel (60mm). Typically mapped along rocky seashores and rivers, sub-alpine and alpine areas, scree slopes and erosion pavements.	NA	NA
Alpine Grass/ Herbfield	Typically sparse communities above the actual or theoretical treeline dominated by herbaceous cushion, mat, turf, and rosette plants and lichens. Grasses are a minor or infrequent component, whereas stones, boulders and bare rock are usually conspicuous.	NA	NA

Title (LCDB)	Definition (Manaaki Whenua – Landcare Research 2020)	Mapping	Definition (Patterson and Cole 2013)
Lake or Pond	Essentially-permanent, open, freshwater without emerging vegetation, including artificial features such as oxidation ponds, amenity, farm and fire ponds and reservoirs, as well as natural lakes, ponds and tarns.	Lake	Lakes are large natural bodies of standing freshwater. They normally consist of distinct zones that provide a variety of habitats and ecological niches. Along with larger, better recognised lakes like Taupo and Rotorua in the North Island and Wakatipu and Te Anau in the South Island, there are also a variety of smaller water bodies. These smaller water bodies include what are commonly called water holes on farm properties, as well as smaller, less well-known lakes.
River	Flowing open freshwater generally more than 30m wide and without emerging vegetation. It includes artificial features such as canals and channels as well as natural rivers and streams.	Rivers	Rivers refer to a natural flow of freshwater along a definite course, usually into the sea. The different biophysical conditions in a river ecosystem provide a wide variety of habitats from the headwaters to the river mouth.
Estuarine Open Water	Standing or flowing saline water without emerging vegetation including estuaries, lagoons, and occasionally lakes occurring in saline situations such as inter-dune hollows and coastal depressions.	Estuaries	Knox (1980) defines an estuary in the New Zealand context as ‘a semi enclosed coastal body of water with free circulation to the sea; it is thus strongly affected by tidal action and within it sea water is mixed with freshwater from land drainage’. The marginal area of an estuary may include tidal salt marshes, mangrove swamps, upper wetlands and high marshes flooded by spring tides.
Short-rotation Cropland	Land regularly cultivated for the production of cereal, root, and seed crops, hops, vegetables, strawberries and field nurseries, often including intervening grassland, fallow land, and other covers not delineated separately.	Horticulture and cropping	There are about 175,000 to 200,000 hectares of arable crops, mainly in the Canterbury Region, apart from some maize-growing in the North Island. It is estimated that 64,000 hectares are used for fruit growing, with the largest areas cropped for apples, kiwifruit and grapes mainly for wine production. The remainder of the land in this category is for vegetable crops (50,000 ha).
Orchard, Vineyard or Other Perennial Crop	Land managed for the production of grapes, pip, citrus and stone fruit, nuts, olives, berries, kiwifruit, and other perennial crops. Cultivation for crop renewal is infrequent and irregular but is sometimes practised for weed control.	Horticulture and cropping	There are about 175,000 to 200,000 hectares of arable crops, mainly in the Canterbury Region, apart from some maize-growing in the North Island. It is estimated that 64,000 hectares are used for fruit growing, with the largest areas cropped for apples, kiwifruit and grapes mainly for wine production. The remainder of the land in this category is for vegetable crops (50,000 ha).
High Producing Exotic Grassland	Exotic sward grassland of good pastoral quality and vigour reflecting relatively high soil fertility and intensive grazing management. Clover species, ryegrass and cocksfoot dominate with lucerne and plantain locally important, but also include lower-producing grasses exhibiting vigour in areas of good soil moisture and fertility.	Agriculture	The ‘agriculture ecosystems’ category consists of land used primarily for pastoral farming. For the most part, this agriculture is based on exotic grass species that have replaced the indigenous vegetation present before Māori and European settlement.

Title (LCDB)	Definition (Manaaki Whenua – Landcare Research 2020)	Mapping	Definition (Patterson and Cole 2013)
Low Producing Grassland	Exotic sward grassland and indigenous short tussock grassland of poor pastoral quality reflecting lower soil fertility and extensive grazing management or non-agricultural use. Browntop, sweet vernal, danthonia, fescue and Yorkshire fog dominate, with indigenous short tussocks (hard tussock, blue tussock and silver tussock) common in the eastern South Island and locally elsewhere.	Agriculture	
Tall Tussock Grassland	Indigenous snow tussocks in mainly alpine mountain-lands and red tussock in the central North Island and locally in poorly-drained valley floors, terraces and basins of both islands.	Agriculture-scrub	This category covers land that is more marginal for pastoral farming than the land comprising the 'agriculture' ecosystem type. intermediate agriculture–scrub category there is a significant coverage of scrub and fern vegetation mixed with tracts of exotic grasses.
Depleted Grassland	Areas, of mainly former short tussock grassland in the drier eastern South Island high country, degraded by over-grazing, fire, rabbits and weed invasion among which *Hieracium* species are conspicuous. Short tussocks usually occur, as do exotic grasses, but bare ground is more prominent.	Agriculture-scrub	
Herbaceous Freshwater Vegetation	Herbaceous wetland communities occurring in freshwater habitats where the water table is above or just below the substrate surface for most of the year. The class includes rush, sedge, restiad, and sphagnum communities and other wetland species, but not flax nor willows which are mapped as Flaxland and Deciduous Hardwoods respectively.	Wetland	Wetlands cover 0.61% of the land area of New Zealand, but they have been reduced by conversion to farmland and other changes over the last century, from about 700,000 hectares to 166,000 hectares
Herbaceous Saline Vegetation	Herbaceous wetland communities occurring in saline habitats subject to tidal inundation or saltwater intrusion. Commonly includes club rush, wire rush and glasswort, but not mangrove which is mapped separately.	Estuaries	Knox (1980) defines an estuary in the New Zealand context as 'a semi enclosed coastal body of water with free circulation to the sea; it is thus strongly affected by tidal action and within it sea water is mixed with freshwater from land drainage'. The marginal area of an estuary may include tidal salt marshes, mangrove swamps, upper wetlands and high marshes flooded by spring tides.
Flaxland	Areas dominated by New Zealand flax usually swamp flax (harakeke) in damp sites but occasionally mountain flax (wharariki) on cliffs and mountain slopes.	Scrub	This category entirely consists of native scrub vegetation, and … is not used for commercial agriculture, horticulture or cropping. This ecosystem category consists of scrub communities made up of mixed broadleaved shrubs, mānuka, kānuka, bracken, ferns, subalpine scrub and gorse.
Fernland	Bracken fern, umbrella fern, or ring fern, commonly on sites with low fertility and a history of burning. Manuka, gorse, and/or other shrubs are often a component of these communities and will succeed Fernland if left undisturbed.	Scrub	
Gorse and/or Broom	Scrub communities dominated by gorse or Scotch broom generally occurring on sites of low fertility, often with a history of fire and insufficient grazing pressure to control spread. Left undisturbed, this class can be	Scrub	

Title (LCDB)	Definition (Manaaki Whenua – Landcare Research 2020)	Mapping	Definition (Patterson and Cole 2013)
	transitional to Broadleaved Indigenous Hardwoods.		
Manuka and/or Kanuka	Scrub dominated by mānuka and/or kānuka, typically as a successional community in a reversion toward forest. Mānuka has a wider ecological tolerance and distribution than kānuka with the latter somewhat concentrated in the north with particular prominence on the volcanic soils of the central volcanic plateau.	Scrub	
Broadleaved Indigenous Hardwoods	Lowland scrub communities dominated by indigenous mixed broadleaved shrubs such as wineberry, mahoe, five-finger, *Pittosporum* spp, fuchsia, tutu, titoki and tree ferns. This class is usually indicative of advanced succession toward indigenous forest.	Forest-Scrub	The forest-scrub ecosystem is a mosaic of mature forests and regenerating scrub. Much of this land is marginal in terms of its suitability for farming.
Sub Alpine Shrubland	Highland scrub dominated by indigenous low-growing shrubs, including species of *Hebe*, *Dracophyllum*, *Olearia*, and *Cassinia*. Predominantly occurring above the actual or theoretical treeline, this class is also recorded where temperature inversions have created cooler micro-climates at lower elevations, e.g. the 'frost flats' of the central North Island.	Scrub	This category entirely consists of native scrub vegetation, and … is not used for commercial agriculture, horticulture or cropping. This ecosystem category consists of scrub communities made up of mixed broadleaved shrubs, mānuka, kānuka, bracken, ferns, subalpine scrub and gorse.
Mixed Exotic Shrubland	Communities of introduced shrubs and climbers such as boxthorn, hawthorn, elderberry, blackberry, sweet brier, buddleja, and old man's beard.	Scrub	
Matagouri or Grey Scrub	Scrub and shrubland comprising small-leaved, often divaricating shrubs such as matagouri, *Coprosma* spp, *Muehlenbeckia* spp., *Casinnia* spp., and *Parsonsia* spp. These, from a distance, often have a grey appearance.	Scrub	
Peat Shrubland (Chatham Is)	Low-growing shrubland communities usually dominated by *Dracophyllum* spp. in association with *Cyathodes* spp. and ground ferns. Mapped only on the Chatham Islands.	NA	NA
Dune Shrubland (Chatham Is)	Low-growing shrubland communities dominated by *Leucopogon* spp., *Pimelia arenaria* and *Coprosma* spp., in association with sedges and scattered herbs and grasses. Mapped only on the Chatham Islands.	NA	NA
Mangrove	Shrubs or small trees of the New Zealand mangrove (*Avicennia marina* subspecies australascia) growing in harbours, estuaries, tidal creeks and rivers north of Kawhia on the west coast and Ohiwa on the east coast.	Mangrove	New Zealand only has one species of mangrove (Avicennia marina var. resinifera). It grows in the northernmost harbours, including the Waitemata, Manukau, Tauranga, Whangamata, Whangarei, Kaipara, Hokianga, Rangaunu, and the Firth of Thames. It reaches as far south as Opotiki on the east coast and Kawhia on the west.

Title (LCDB)	Definition (Manaaki Whenua – Landcare Research 2020)	Mapping	Definition (Patterson and Cole 2013)
Forest - Harvested	Predominantly bare ground arising from the harvesting of exotic forest or, less commonly, the clearing of indigenous forest. Replanting of exotic forest (or conversion to a new land use) is not evident and nor is the future use of land cleared of indigenous forest.	Forest	This consists of mature indigenous forest (podocarp, broadleaved, beech) with a significant amount of exotic commercial forests. Much of these indigenous forests are in protected areas such as national parks and forest parks.
Deciduous Hardwoods	Exotic deciduous woodlands, predominantly of willows or poplars but also of oak, elm, ash or other species. Commonly alongside inland water (or as part of wetlands), or as erosion-control, shelter and amenity plantings.	Forest	This consists of mature indigenous forest (podocarp, broadleaved, beech) with a significant amount of exotic commercial forests. Much of these indigenous forests are in protected areas such as national parks and forest parks.
Indigenous Forest	Tall forest dominated by indigenous conifer, broadleaved or beech species.	Forest	This consists of mature indigenous forest (podocarp, broadleaved, beech) with a significant amount of exotic commercial forests. Much of these indigenous forests are in protected areas such as national parks and forest parks.
Exotic Forest	Planted or naturalised forest predominantly of radiata pine but including other pine species, Douglas fir, cypress, larch, acacia and eucalypts. Production forestry is the main land use in this class with minor areas devoted to mass-movement erosion-control and other areas of naturalised (wildling) establishment.	Forest	This consists of mature indigenous forest (podocarp, broadleaved, beech) with a significant amount of exotic commercial forests. Much of these indigenous forests are in protected areas such as national parks and forest parks.

Table 15 Land use by national park (hectares)

	Abel Tasman	Aoraki/Mount Cook	Arthur's Pass	Egmont	Fiordland	Kahurangi	Mount Aspiring	Nelson Lakes	Paparoa	Rakiura	Tongariro	Westland/ Tai Poutini	Whanganui
Alpine Grass/Herbfield		2,447	3,584	1	43,543	2,129	25,002	3,079			4,114	4,536	
Broadleaved Indigenous Hardwoods	1,562		1,217	3,917	10,986	5,183	1,404	13	902	11,963	712	1,902	2,599
Built-up Area (settlement)		40	2		17	0	2	3	0		4	2	0
Deciduous Hardwoods		4	1			0	2		3				17
Depleted Grassland			17								2,395		
Estuarine Open Water	2				29	7				5		184	
Exotic Forest	55			3	2	210		0	13		22		14
Fernland	151		10		155	622	205	18	278	52	16	87	17
Flaxland						6	22		23	8	698	108	
Forest - Harvested	2			0	2	4	0		4		10	0	8
Gorse and/or Broom	41		114		4	474	63		11		40	98	5
Gravel or Rock	20	33,060	17,312	1,384	34,523	4,671	43,898	17,868	86	892	13,615	14,397	22
Herbaceous Freshwater Vegetation	58		5	159	3,386	476	210	22	99	2,600	627	1,408	
Herbaceous Saline Vegetation	13				1	0				29		344	
High Producing Exotic Grassland	95	9	31	36	80	248	1,301	45	47		48	199	206

	Abel Tasman	Aoraki/Mount Cook	Arthur's Pass	Egmont	Fiordland	Kahurangi	Mount Aspiring	Nelson Lakes	Paparoa	Rakiura	Tongariro	Westland/ Tai Poutini	Whanganui
Indigenous Forest	17,435	78	53,857	27,799	813,272	437,427	133,352	51,196	39,866	63,052	26,521	68,445	69,326
Lake or Pond	1	1,854	75	1	79,042	574	1,240	3,495		321	177	1,560	
Landslide	2		145		4,028	1,466	584	87	26	62	1	68	10
Low Producing Grassland	39	3,846	1,840	5	2,970	1,601	2,392	346	10	299	97	393	140
Manuka and/or Kanuka	3,954	30	556	0	3,307	13,282	409	456	644	21,962	5,583	600	1,903
Matagouri or Grey Scrub		123	144		279	0	65						
Mixed Exotic Shrubland					1	2	0				141		
Permanent Snow and Ice		18,683	672		4,147		27,020	3			477	16,697	
River	2	365	77		1,508	709	1,294	47	7	40	2	492	116
Sand or Gravel	10				593	127			3	1,410		65	0
Sub Alpine Shrubland		4,286	10,982	38	37,515	7,878	32,632	3,749	857	31,512	9,461	8,697	
Surface Mine or Dump				0	3	1			11			1	
Tall Tussock Grassland		7,325	27,882	734	239,060	39,641	88,342	20,765	407	5,864	14,050	11,387	
Transport Infrastructure	0				41	28			7		12	2	
Urban Parkland/Open Space	32		0		20	0	2	3			24	6	
Total	23,502	72,148	118,522	34,078	1,278,977	516,841	359,441	101,196	43,306	140,356	78,847	131,710	74,383

Source: DOC

Table 16 Paterson and Cole (2013) ecosystem values

$ per hectare, scaled to 2024.

	Agri forest	Agriculture	Agriculture-scrub	Estuaries	Forest	Forest-scrub	Horticulture and cropping	Lake	Mangrove	Rivers	Scrub	Wetland
Pollination	-	90	90	-	-	-	49	-	-	-	-	-
Biological control	15	82	82	266	14	12	-	-	-	-	13	-
Refugia	-	-	-	452	-	-	-	-	560	-	-	1,562
Disturbance regulation	-	-	-	2,022	-	-	-	-	6,650	-	-	25,975
Water provisioning	-	11	11	-	-	-	9	19,536	-	19,601	-	112
Water storage & retention	-	-	-	-	-	-	-	7,591	-	7,619	-	27,265
Erosion control and sediment retention	438	879	104	-	440	438	53	-	-	-	35	-
Soil formation	33	4	36	-	36	35	-	-	-	-	439	-
Nutrient cycling	260	-	259	13,194	259	259	-	-	-	-	259	-
Waste treatment	311	312	312	1,875	312	310	-	2,380	-	2,388	311	5,953

Source: NZIER