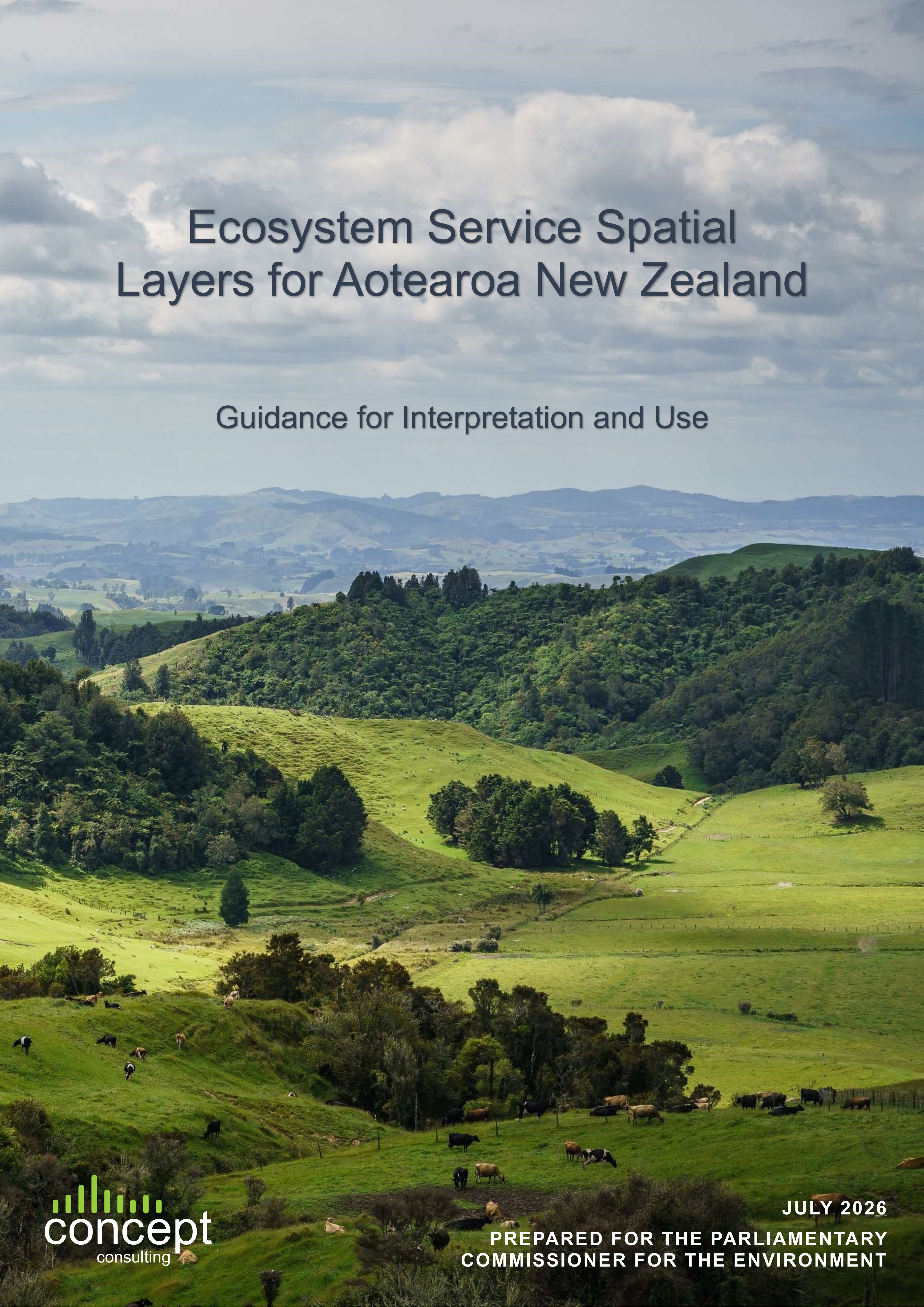
Ecosystem Service Spatial Layers for Aotearoa New Zealand

Guidance for Interpretation and Use



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Executive Summary

Purpose

Ecosystem services are the benefits that people derive from ecosystems. They include provisioning services (e.g., food and water), regulating services (e.g., flood mitigation and carbon sequestration), and cultural services (e.g., recreation and amenity). These benefits are often omitted or underrepresented in economic analysis because they lack readily observable prices and monetary measures may not fully capture their value to society.

To support more consistent consideration of non-market benefits and costs in decision-making, the Parliamentary Commissioner for the Environment commissioned the development of a nationally consistent set of ecosystem service spatial layers and associated monetary indicators for Aotearoa New Zealand. The layers combine environmental, socio-economic, and valuation information to estimate the location and relative size of ecosystem service flows across the country.

This document provides guidance on the interpretation and application of those ecosystem service spatial layers. It explains what the values represent, how they should and should not be used, and the limitations and uncertainties that users should consider when applying them. A separate technical companion document provides detailed information on data sources, modelling approaches, valuation methods, and layer construction.

Intended audience

This guidance is intended for policy analysts, economists, planners, environmental practitioners, consultants, researchers, and decision-makers involved in environmental management, infrastructure planning, regulatory analysis, public investment appraisal, and natural capital assessment. It is written for users who need to apply ecosystem service information in practical decision-making contexts, including economic impact assessment, cost-benefit analysis, strategic planning, spatial prioritisation, and policy assessment.

Assessment framework

The assessment adopts a modern ecosystem services framework that distinguishes between ecosystem service supply, realised benefit flows, demand, and beneficiaries. Ecosystem services are classified using the Common International Classification of Ecosystem Services (CICES) and aligned where possible with the System of Environmental-Economic Accounting (SEEA) Ecosystem Accounting framework.

The values are grounded in welfare economics and intended to support policy appraisal and economic analysis. In welfare economics, value is interpreted as the contribution of an outcome to human wellbeing, reflecting the preferences, values, and aspirations of society, which may differ between countries and cultures. The focus is on estimating the contribution of ecosystem services to human wellbeing under current conditions and how those benefits may change under alternative policy or management scenarios. To minimise the risk of double counting, only final ecosystem services have been monetised.

Ecosystem service value estimates

The spatial layers include a range of provisioning, regulating, and cultural ecosystem services represented through both biophysical and monetised indicators.

These values are indicative annual flows of ecosystem service benefits under current conditions. They are most relevant for assessing marginal changes in ecosystem service provision associated with land-use change, restoration or degradation of ecosystems, or changes in access. They do not represent the value of New Zealand's environment or its natural capital as a whole. Nor can they be added to GDP.

Guidance for interpretation and use

The layers are intended primarily to support policy analysis, economic analysis, strategic planning, spatial prioritisation, and scenario assessment. They can help compare alternative options, and improve the visibility of non-market benefits and costs within decision-making processes.

The layers are based on nationally consistent datasets and are designed primarily for broad-scale assessment. They are generally most appropriate for initial screening, comparing locations, and estimating the potential magnitude of impacts. They should not be used as the sole basis for site-specific policy decisions, resource consent processes, detailed engineering, or ecological assessments.

This guidance report highlights some common misuse risks, including interpreting annual ecosystem service flows as total natural capital values, assuming monetary values capture all aspects of environmental importance, over-interpreting fine-scale spatial outputs, applying values without a defined counterfactual, substituting national-scale indicators for local assessment, and treating ecosystem service values as directly additive to GDP.

Users should recognise that ecosystem service assessments necessarily involve uncertainty arising from ecological complexity, data limitations, modelling assumptions, and valuation evidence. The layers need to be used alongside local information, ecological expertise, mātauranga Māori, stakeholder engagement, and other relevant evidence.

Illustrative case studies

The report includes three case studies that illustrate how the ecosystem service layers could be applied in practice. These examples show how ecosystem service values can be incorporated into policy appraisal, used to compare options, and applied to assess the potential impacts of environmental restoration or land-use change. The case studies are intended to show practical application of the layers rather than being definitive assessments of specific projects.

Priorities for future improvement

This project builds on earlier ecosystem service assessment and valuation work undertaken in New Zealand and internationally. The report also identifies priorities for improving future iterations of the ecosystem service layers and supporting guidance. These priorities include:

- improving the spatial coupling of services involving water,
- incorporating council and local datasets,
- improving representation of ecosystem condition,
- expanding coverage where ecosystem services are currently omitted or only partially represented,
- strengthening uncertainty analysis, and updating valuation evidence as new studies become available,
- incorporating dynamic scenario modelling to assess the effects of climate change and other drivers on ecosystem service values over time.

Conclusion

The ecosystem service layers provide a practical tool for incorporating environmental considerations into policy and investment decisions. Their purpose is not to place a definitive price on nature, but to improve the visibility of ecosystem benefits and support more informed and transparent decision-making. When used appropriately and alongside other sources of evidence, they can help ensure that the contributions ecosystems make to human wellbeing are more consistently recognised within public and private decision-making processes.

Table of Contents

List of Figures

List of Tables

1. Introduction

1.1. Why this work was undertaken

Ecosystem services are the benefits that people derive from ecosystems, including provisioning services such as food and water, regulating services such as flood mitigation and carbon sequestration, and cultural services such as recreation and amenity. Over the past two decades, ecosystem services have increasingly been used as a framework for environmental policy, spatial planning, and economic appraisal because they provide a structured way to connect ecological condition with human wellbeing and economic outcomes (DEFRA, 2026). Internationally, ecosystem service assessment has evolved from largely conceptual work toward increasingly spatially explicit, policy-oriented approaches that integrate ecological modelling, socio-economic analysis, and valuation methodologies (Burkhard & Maes, 2017).

In New Zealand, the ecosystem services framework has been applied across a wide range of contexts, including indigenous biodiversity, freshwater management, urban ecosystems, recreation, and agricultural systems research. Related work by the Treasury has considered natural capital within the Living Standards Framework, including discussion of how New Zealand's natural capital contributes to wellbeing and how natural capital and ecosystem services can be measured (NZIER, 2022; Van Zyl & Au, 2018).

Previous national-scale work, including Patterson and Cole (2013), provided an important foundation for ecosystem service valuation in New Zealand, but advances in ecosystem service classification systems, spatial modelling, environmental accounting, and valuation techniques now enable a more robust and transparent assessment framework. National ecosystem service mapping and modelling has also been undertaken in New Zealand, including non-monetary spatial assessments of multiple ecosystem services, trade-offs between services, and the potential impacts of climate change on ecosystem service provision (Ausseil et al., 2013, 2019; Dymond et al., 2012).

Parliamentary Commissioner for the Environment (PCE) commissioned this work to support more consistent and transparent incorporation of ecosystem service information into policy analysis, cost-benefit analysis (CBA), environmental assessment, and broader public-sector decision-making in Aotearoa New Zealand. The project responds to the increasing need for robust environmental valuation information within government appraisal frameworks, including Treasury CBA processes, where the absence of environmental values can result in ecosystem benefits being omitted or implicitly assigned a value of zero.

1.2. Purpose and scope

This document provides guidance for interpreting and applying the ecosystem service spatial layers developed for the Parliamentary Commissioner for the Environment (PCE). It introduces the conceptual frameworks, interpretation of values, appropriate and inappropriate uses, key caveats, and treatment of uncertainty. It also includes three brief case studies to illustrate how the values might be used in practical policy and appraisal contexts.

The ecosystem service layers and values presented here should be viewed as an evolving and experimental framework designed to support more consistent incorporation of ecosystem services into decision-making. The methods draw on the best available environmental, spatial, and economic information available at the time of development.

The values should be interpreted as indicative rather than precise. They are intended to help users understand the likely scale and direction of ecosystem service impacts and to support more consistent decision-making. To help users apply the values appropriately, the methods, assumptions, data sources, and key limitations have been documented as transparently as possible. Users are encouraged to review both this guidance and the accompanying technical documentation before applying the values. The framework is also intended to evolve over time as new data, improved methods, and additional valuation evidence become available. Future development priorities are discussed later in this report.

The focus of this document is on the practical interpretation and application of the ecosystem service layers rather than providing a review of the ecosystem services literature in New Zealand. The literature relevant to ecosystem services in New Zealand is substantial and spans national, regional, urban, freshwater, agricultural, and biodiversity applications. Readers seeking a broad of ecosystem service assessment in the New Zealand may wish to consult Dymond et al. (2013) on the condition and trends of ecosystem services in New Zealand or the earlier Patterson and Cole (2013) national-scale ecosystem service valuation.

A separate technical companion document to this report explains how the layers were derived, including data sources, modelling assumptions and sources, valuation methods, processing steps, and layer-specific limitations.

1.3. Intended audience

The intended audience for this document includes policy analysts, economists, planners, environmental practitioners, consultants, researchers, and decision-makers involved in environmental management, infrastructure planning, regulatory analysis, or public investment appraisal. The guidance is particularly relevant for users applying ecosystem service information within cost-benefit analysis, strategic planning, spatial prioritisation, or natural capital assessment frameworks.

While this document aims to make the layers accessible to non-specialist users, the companion technical documentation provides the detailed methodological information needed for more technical applications. The technical document is also intended to support future refinement and updating of the layers as new data, methods, or funding become available.

2. Assessment Framework

2.1. Ecosystem services, natural capital, and welfare economics

Ecosystem services are defined here as the contributions ecosystems make to human wellbeing (CICES v5.2), interpreted through contemporary ecosystem accounting, spatial modelling, and nature's contributions to people frameworks.

All services are classified using the Common International Classification of Ecosystem Services (CICES) to ensure terminological clarity, comparability, and policy credibility. The SEEA EA includes an adopted reference list of ecosystem services (rather than a full classification), which is deliberately aligned with CICES through cross-walks[1]. The CICES has been used in Europe and embedded within a spatial framework aligned with the Mapping and Assessment of Ecosystems and their Services (MAES) initiative from the EU and is designed to operate at MAES Tier 2. This tier involves spatially explicit quantification of ecosystem condition and service supply using regionally or nationally consistent datasets, moving beyond simple land cover proxies while remaining feasible with available data (Burkhard & Maes, 2017; Maes et al., 2016).

The economic interpretation of ecosystem services is based on welfare economics. The relevant value for policy appraisal is the change in human wellbeing associated with a change in ecosystem service provision, assessed relative to a defined baseline or counterfactual. This means the focus is on marginal changes in services, not on estimating the total value of nature (TEEB, 2009). This report primarily draws on recent ecosystem accounting, classification, and Nature's Contributions to People frameworks (Díaz et al., 2018; Haines-Young & Potschin, 2018; United Nations, 2021).

While CICES provides a practical and internationally recognised framework for ecosystem service assessment, it does not capture all ways of understanding relationships between people and nature(IPBES, 2022). This is particularly important in Aotearoa New Zealand, where Māori values are often expressed through concepts such as whakapapa, mauri, mana, kaitiakitanga, and relationships with te taiao. These values extend beyond the ecosystem service categories used in this report and are not always appropriate for monetary valuation. The framework should therefore be viewed as one perspective for informing decision-making rather than a comprehensive representation of all environmental values.

The practical implication is that ecosystem service valuation should be treated as one input into decision-making rather than a complete measure of environmental importance. In this report, cultural ecosystem services are interpreted in the CICES sense and primarily relate to recreation, amenity, aesthetic, educational, and biodiversity-related non-use values. They should not be interpreted as representing the full range of cultural, spiritual, customary, relational, or Māori values associated with ecosystems.

2.2. Supply, flow, demand, and beneficiaries

A key feature of the approach adopted in this project is the distinction between ecosystem service supply, realised flow of services, demand for services, and the beneficiaries of services, as is usually represented in the literature (Schwantes et al., 2024; Vallecillo et al., 2019).

- Ecosystem service supply refers to the capacity of an ecosystem to provide a service under current ecological conditions.

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[1] https://seea.un.org/sites/seea.un.org/files/documents/EA/seea_ea_online_supplement_ecosystem_services_reference_list_crosswalk.xlsx

- Realised flow refers to the portion of that service that is actually delivered to or used by people. Demand refers to the need, preference, or exposure that makes the service relevant.
- Beneficiaries are the people, communities, assets, sectors, or places that receive the benefit.

This distinction follows spatial ecosystem service modelling literature, which emphasises that both supply and demand are spatially explicit and may differ geographically, creating spatial mismatches between where services are generated and where they are needed or used (Tian et al., 2025; Wei et al., 2017).

The extent to which individual indicators represent realised benefits varies between services. Some indicators, such as recreation, air quality regulation, local climate regulation, and flood mitigation, explicitly incorporate information on beneficiaries, exposure, accessibility, or demand and therefore more closely represent realised ecosystem service flows. Other indicators, particularly some water-quality and nutrient-regulation services, primarily represent ecosystem capacity to reduce environmental pressures. In these cases, values reflect the assumption that contaminant reduction generates social value through improved environmental outcomes or reduced future mitigation requirements, even where specific beneficiaries are not explicitly identified.

Following the same principle as the SEEA-EA (United Nations, 2022), the assessment primarily reflects benefits received by people, communities, and their economic activities within New Zealand. These benefits include market and non-market values accruing to New Zealand residents, infrastructure, and industries. International and global beneficiaries are generally excluded (United Nations, 2022) unless explicitly represented in the valuation method, such as global climate regulation values based on internationally relevant carbon prices. Tourism-related benefits should be assessed separately through tourism expenditure and economic impact analysis rather than non-market ecosystem service valuation.

2.3. Final and intermediate services

The framework distinguishes between final ecosystem services and intermediate ecological processes to avoid double counting. Final ecosystem services are the contributions ecosystems make to human wellbeing that are directly used, experienced, or valued by people. Intermediate processes are ecological functions that support final services but are not usually valued separately. This distinction follows contemporary ecosystem service classification and accounting guidance, which separates ecosystem contributions from the goods and benefits people subsequently derive from them (Haines-Young & Potschin, 2018).

For this project, only final ecosystem services have been monetised. Supporting services and intermediate ecological processes, such as soil formation, nutrient cycling, primary production, and general habitat provision, have not been monetised separately where their contribution is already reflected through final services.

Biodiversity has been included as a supporting ecological function in earlier frameworks because it helps underpin many other ecosystem services. Consistent with the final ecosystem service approach used in this report, biodiversity is not valued separately in this supporting role. However, people also value knowing that species, habitats, and ecosystems exist and are being conserved. These biodiversity existence values are therefore included as a cultural ecosystem service.

The scope of each indicator has been defined carefully to minimise overlap and potential double-counting. Each layer represents a distinct ecosystem service pathway, beneficiary group, or valuation construct, even where services are ecologically related. For example, nutrient regulation, water purification, and wetland treatment are separate indicators with distinct scopes explained further in the technical documentation. Nutrient regulation and water purification represent the capacity of landscapes and ecosystems to prevent contaminants from reaching waterways, whereas wetland treatment represents the additional treatment provided by wetlands to contaminants that have already entered waterways. In another example, water regulation and water yield are closely related services. However, water regulation is valued based on the avoided cost of providing equivalent storage capacity, whereas water yield is valued based on the contribution of water to economic production.

While these distinctions reduce the risk of overlap and support aggregation across indicators, ecosystem processes are inherently interconnected. Defining distinct services and assigning monetary estimates inevitably involves simplification and uncertainty, which may result in underestimation or overestimation.

2.4. CICES and SEEA alignment

The ecosystem services in this report are classified using the Common International Classification of Ecosystem Services, version 5.2. CICES provides a consistent terminology for provisioning, regulating and maintenance, and cultural services. Its use helps ensure that each layer has a clear conceptual definition and can be compared with other ecosystem service assessments, in New Zealand and elsewhere. Overall, 32 ecosystem services have been assessed (13 regulating, 11 cultural, and 8 provisioning).

This project has generally excluded abiotic services such as minerals, aggregates, and other geological resources. These are important natural resources, but their extraction and use are not usually dependent on current ecosystem functioning in the same way as biotic services.

Water yield is included as an indicator because it is strongly influenced by ecosystem condition, vegetation cover, soils, hydrology, and land management. Although water itself is an abiotic resource, the quantity, timing, and reliability of water flows are shaped by ecosystem processes. It is therefore included in this assessment.

Although this framework is not a formal SEEA EA account, it is aligned with relevant SEEA EA concepts relating to ecosystem extent, condition, and ecosystem services. This alignment is intentional and useful because it connects the spatial layers with international practice in natural capital accounting and environmental-economic reporting.

Several indicator layers are more disaggregated than the corresponding CICES categories where this was useful for modelling or interpretation. This reflects practical differences in data sources, ecological mechanisms, beneficiary pathways, or valuation methods. These disaggregated layers can be aggregated back to broader CICES categories if needed so offers flexibility.

2.5. Spatial approach

Spatial context is critical in ecosystem service assessment because the location of ecosystem service supply does not necessarily coincide with the location of demand or benefit. Many ecosystem services only generate realised benefits when there is a spatial connection between ecosystems and present beneficiaries. For example, flood mitigation benefits depend on downstream exposure to flooding, erosion control depends on connectivity to waterways or assets, recreation depends on accessibility to people, and urban cooling depends on the presence of nearby populations and infrastructure.

As a result, estimating realised ecosystem service flows often requires linking ecosystem service supply areas to beneficiaries using spatial relationships such as hydrological connectivity, accessibility, proximity, routing, or distance-decay functions. Without this spatial context, mapped layers may represent only theoretical ecosystem capacity rather than the benefits actually received by people.

The ecosystem service layers in this project were developed using bottom-up spatial modelling as much as possible. This means that values were estimated from spatial data on ecosystem characteristics, land use, environmental conditions, infrastructure, and beneficiaries, rather than assigned only at broad regional or ecosystem-type levels. This helps ensure that values reflect local conditions and are more closely aligned with the marginal changes relevant to policy decisions.

Working at a fine spatial scale allows different datasets to be aligned consistently and enables spatial relationships, such as upstream-downstream connections or proximity to beneficiaries, to be modelled in a coherent way. The approach combines nationally consistent datasets on land cover, soils, topography, hydrology, climate, population distribution, infrastructure, and protected areas. This helps ensure that the resulting layers are comparable across regions and suitable for strategic policy analysis at national and regional scales.

The outputs are produced on a 100-metre grid, with each indicator estimated for each grid cell. This resolution aligns with key input layers such as the soils and landcover data, and allows values to be interpreted on a per-hectare basis. It also allows results to be aggregated flexibly to the spatial scale most relevant to the decision context, such as catchments, districts, regions, or policy assessment areas.

However, the grid resolution should not be interpreted as implying high precision at the individual-cell level. Many input datasets are coarser than 100 metres and are averaged over a wider area. As a result, uncertainty is high for any single grid cell. The layers are therefore intended primarily for aggregation and comparison across larger areas, not for fine-scale site assessment.

This assessment was developed primarily using nationally consistent datasets in order to support comparable ecosystem service estimates across New Zealand. Due to project scope and time constraints, the modelling did not incorporate finer-scale local datasets held by regional and local authorities. In many cases, councils and other agencies hold higher-resolution information on local ecosystems, hydrology, biodiversity, hazards, recreation use, and infrastructure that could improve the accuracy and local relevance of individual layers. Incorporating these datasets is an important opportunity for future refinement.

2.6. Valuation approach

The valuation approach is grounded in welfare economics and is intended to support economic analysis and related policy appraisal. Consistent with the SEEA Ecosystem Accounting valuation framework, the focus is on estimating the current annual value of ecosystem service flows under present ecological, economic, and social conditions, rather than estimating the total value of ecosystem assets or nature as a whole.

The values are current marginal values. In this context, “marginal” means the approximate value of an incremental change in ecosystem service flow around the current baseline, meaning the ecosystem service provision expected under present-day conditions in the absence of the change being assessed. It does not mean the total value of the ecosystem, the full value of the underlying asset, or a fixed value that applies equally to all quantities and locations. The relevant decision margin will vary by application, such as land-use change, restoration, degradation, or avoided loss. The values are best interpreted as indicative estimates for policy-relevant changes near current conditions.

2.6.1. Valuation methods

In welfare economics, ecosystem services generate benefits by contributing to consumer surplus, producer surplus, avoided costs (e.g. the cost to build a flood bank), or avoided damages (e.g. the cost to repair flooded houses). Different valuation approaches were applied depending on the characteristics of the service, the available evidence, and the feasibility of estimating values directly. Market prices were used where ecosystem services contribute to traded outputs, such as timber or fisheries production. Simplified factor-share approaches were used in some cases to attribute part of production value to ecosystem service inputs, with the proportion attributed reflecting the estimated contribution of the ecosystem service to production. Details of the factor shares applied are provided in the technical documentation.

For non-market services, preference-based valuation evidence was used where robust studies were available, particularly for recreation, amenity, and biodiversity-related services. Avoided damage and avoided mitigation cost approaches were used where ecosystem services reduce identifiable costs or damages, such as flood impacts, water treatment requirements, or nutrient mitigation costs. Replacement cost or least-cost alternative approaches were used where ecosystem services substitute for a defined engineered or management alternative, such as water storage or managed pollination services.

Avoided damage, avoided mitigation cost, replacement cost, and least-cost alternative approaches provide a welfare-consistent estimate only where the avoided cost or substitute represents a real cost that would otherwise be incurred and delivers an equivalent service. These values should therefore be interpreted as indicative estimates of economic significance rather than precise measures of welfare change.

Where direct New Zealand evidence was unavailable, values or biophysical parameters were transferred from international studies using benefit transfer methods. Benefit transfer introduces another source of uncertainty because values or ecological relationships estimated elsewhere may not fully reflect local ecological, social, or cultural conditions in New Zealand. Users should interpret transferred values as indicative estimates and consult the technical documentation for a discussion of assumptions and limitations.

2.6.2. Non-use values

Some ecosystem services also generate non-use values. These are benefits that people derive from knowing that species, habitats, and ecosystems exist and are being conserved, even if they never directly use or visit them. Biodiversity values in this assessment are primarily of this type. The values are estimated from the perspective of New Zealand residents and therefore represent benefits accruing to New Zealanders rather than global existence values. As with other benefit-transfer estimates, they should be interpreted as indicative estimates of the welfare significance of biodiversity outcomes rather than precise measures of value.

The valuation methods used in this project are therefore pragmatic and tailored rather than a single unified valuation method applied to all services. This reflects both the diversity of ecosystem services and the limitations of available data and valuation evidence. The resulting layers should be interpreted as indicative current marginal values intended to support comparison, prioritisation, and scenario analysis, rather than precise estimates of total welfare value or national-accounting exchange value.

Care has been taken to minimise double counting, and users should refer to the technical documentation for detail on the scope of each layer and the treatment of potential overlaps. In some cases, the scope of values is determined by the source studies themselves, such as recreation studies that distinguish between specific activities or destination types. Landscape aesthetic values are treated separately and estimated primarily based on where people live and travel, rather than where they recreate. This reduces the risk of counting the same scenic or amenity value both within recreation values and as a separate aesthetic benefit.

2.7. Uncertainty

To support decision-making under uncertainty, monetised indicators are reported as low, central, and high estimates. These ranges are derived from layer-specific source-study confidence intervals, published parameter ranges, sensitivity assumptions, or plausible bounds where formal uncertainty estimates are unavailable.

The low and high estimates are implemented as scaling factors applied to a key valuation parameter or modelling assumption, which are then propagated across the entire layer. The scaling factors used for each indicator are reported in Table 4 and explained in more detail in the technical documentation. Separate low and high raster layers are not published because they would largely duplicate the central layers while substantially increasing data storage requirements.

The low and high estimates should be interpreted as plausible ranges rather than comprehensive confidence intervals. In most cases, they primarily reflect uncertainty in monetary valuation parameters rather than uncertainty in the underlying biophysical relationships or spatial datasets. They therefore provide an indication of the robustness of results to alternative valuation assumptions, but do not capture all sources of uncertainty in the modelling chain.

Users should recognise that uncertainty is generally greater for site-scale applications than for larger-area assessments because local variation and data limitations become increasingly important at finer spatial scales. However, there is insufficient evidence to quantify this effect or recommend a specific minimum mapping unit.

3. How to access the layers and data

3.1. Excel

An Excel file is published as a data supplement to this report. It includes indicator values aggregated by region and land cover class. Reported metrics include the sum for the central, low, and high sensitivity estimates, as well as the mean, median, count of non-zero cells, minimum, maximum, and 5th and 95th percentiles.

3.2. Raster layers

The spatial layers for realised flow values are published on the MfE data service[2]. The layers are published in three groups:

- Cultural: https://data.mfe.govt.nz/set/7517.
- Provisioning: https://data.mfe.govt.nz/set/7518.
- Regulating: https://data.mfe.govt.nz/set/7519.

To find a specific layer within the group, select the Contents tab. To inspect a specific indicator, open the layer and select Map +. Click a location on the map to display the raster value in that 1-hectare cell.

To download a layer for use in GIS software:

- click the three dots to the right of the layer title,
- for the Coordinate Reference System drop-down select "NZGD2000 / New Zealand Transverse Mercator 2000 (EPSG:2193)",
- and click the Export button.

Users should be aware that selecting a different coordinate reference system may introduce small transformation differences, resulting in raster totals that differ slightly from those reported in the published tables.

3.3. Source code and configuration files.

Many layers were generated using Python code for spatial processing and analysis. This code is available in a GitHub repository[3]. The code is published under the MIT License for transparency and reproducibility purposes. It is provided "as is", without warranty of any kind, and no obligation is accepted to provide technical support, maintenance, or updates.

For the layers that used InVEST models, the configuration files are also provided in this repository. The InVEST models themselves are not included, but may be downloaded from the Natural Capital Alliance website[4].

The repository also holds a number of raster files for potential supply, demand, biophysical units, and intermediate layers. Source data are not included but may be downloaded from sources listed in the technical documentation.

[2] The MfE Data Service is hosted by the Ministry for Cities, Environment, Regions and Transport (MCERT)

[3] https://github.com/ConceptConsultingNZ/Ecosystem_Services_PCE_2026

[4] https://naturalcapitalalliance.stanford.edu/invest/downloads

4. Overview of the ecosystem service layers

The following sections provide summary tables describing the ecosystem service layers developed for this project. These tables:

- identify each monetised ecosystem service, its definition, and the spatial layer used to represent service supply;
- summarise the valuation source, valuation method, and derivation of the low, central and high estimates; and
- present aggregated values by region and land cover class.

Guidance on interpreting these values, including the treatment of uncertainty, aggregation, scale, and appropriate applications, is provided later in this document.

4.1. Definitions

Table 1: Summary of provisioning service indicators and definitions

Indicator name	SEEA subtype	CICES v5	Layer name	Service	Supplied by
Aquaculture	1.4	1.1.4.1	Provisioning_aquaculture_value	Environmental conditions that support aquaculture production.	Coastal habitats suitable for aquaculture species
Biochemicals	1.5	1.1.5.2	Provisioning_biochemical_value	Provision of mānuka-derived compounds used in medicinal, cosmetic, and related products.	Mānuka-dominated vegetation cover
Crops	1.1	1.1.1.1	Provisioning_crop_value	Environmental conditions that support the growth of cultivated plants for human consumption.	Landscape yield potential
Firewood	1.5	1.1.1.3	Provisioning_firewood_value	Woody biomass for household energy use.	Woody biomass in non-conservation areas
Fodder	1.1	1.1.1.1	Provisioning_fodder_value	Environmental conditions that support pasture growth for grazing livestock.	Pasture productivity
Wild seafood	1.6	1.1.6.1	Provisioning_wild_seafood_value	Provision of wild-caught fish, shellfish, and aquatic plants for commercial harvest.	Commercial species presence and abundance by habitat
Timber	1.5	1.1.1.2	Provisioning_timber_value	Provision of wood for construction, processing, and industrial use.	Forest growth potential, represented by pine 300-index
Freshwater	1.9	4.2.1	Provisioning_water_value	Provision of freshwater for drinking, domestic, industrial, and agriculture.	Catchment water yield adjusted for land cover

Table 2: Summary of regulating service indicators and definitions

Indicator name	SEEA subtype	CICES v5	Layer name	Service	Supplied by:
Air quality regulation	2.4	2.2.6.1	Regulating_air_quality_value	Capturing/filtering of dust, chemicals and gases from air.	Tree canopy cover
Global climate regulation - blue carbon	2.1	2.2.6.1	Regulating_global_climate_blue_carbon_value	Capturing and storing of carbon by coastal ecosystems.	Seagrass, coastal wetlands, and mangroves.
Coastal storm surge regulation	2.13	2.2.1.2	Regulating_coastal_storm_surge_value	Reducing flooding and erosion from waves	Coastal wetlands and mangroves.
Erosion regulation	2.6	2.2.1.1	Regulating_erosion_regulation_value	Soil retention and the ability to prevent and mitigated soil erosion and landslides.	Vegetation cover on erosion-prone land and flowpaths.
Global climate regulation – forest carbon	2.1	2.2.6.1	Regulating_global_climate_forest_value	Capturing and storing of carbon by terrestrial ecosystems.	Woody vegetation.
Local climate regulation	2.3	2.2.6.2	Regulating_local_climate_value	Mitigating urban heat and reducing summer cooling demand.	Tree canopy cover.
Fluvial and pluvial flood regulation	2.12	2.2.1.3	Regulating_flood_regulation_value	Mitigation of damage from river and surface flooding.	Landscape capacity to retain water in catchments with exposed assets.
Nutrient regulation	2.9	2.2.5.1	Regulating_nutrient_regulation_value	Reducing nutrient losses to waterways through uptake, retention, and filtering	Nutrient retention capacity of the landscape.
Pollination	2.17	2.2.2.1	Regulating_pollination_value	Wild insects contributing to pollen transfer and reproduction of plants.	Potential habitats for wild pollinators.
Regulation of waste	2.5	2.2.4.2	Regulating_waste_assimilation_value	Ecosystem ability to filter and decompose organic material in soils.	Soil capacity to decompose organic wastes, proxied by soil drainage and moisture conditions.
Water flow regulation	2.11	2.2.1.3	Regulating_water_regulation_value	Slowing, storing and releasing water for later use.	Landscape capacity to retain water in catchments with irrigation demand.
Water purification	1.9	2.2.5.1	Regulating_water_purification_value	Sediment capture before it reaches waterways.	Vegetation, soils, wetlands, and riparian areas that slow runoff and trap sediment.
Water treatment in wetlands	1.9	2.2.5.1	Regulating_wetland_treatment_value	In-situ removal of nutrients, pathogens and sediment by wetlands.	Wetlands that intercept stream flows.

Table 3: Summary of cultural service indicators and definitions

Indicator name	SEEA subtype	CICES v5	Layer name	Service	Supplied by
Recreation - hunting	3.1	3.1.1.1	Cultural_hunting_value	Opportunities for recreational hunting and associated outdoor experiences.	Land cover and habitats supporting hunted species
Recreation - coastal	3.1	3.1.1.1	Cultural_recreation_coastal_value	Opportunities for coastal recreation including swimming, walking, and beach use.	Accessible coastline adjacent to sandy beaches, urban areas, or parkland
Recreation - freshwater fishing	3.1	3.1.1.1	Cultural_recreation_freshwater_fishing_value	Opportunities for recreational freshwater fishing.	Lakes, rivers, and streams supporting fish populations
Recreation - freshwater other	3.1	3.1.1.1	Cultural_recreation_freshwater_other_value	Opportunities for freshwater recreation including swimming and general water-based activities.	Rivers and lakes with high swimmability and water clarity
Recreation - marine boating	3.1	3.1.1.1	Cultural_recreation_marine_boating_value	Opportunities for recreational boating and marine water-based activities.	Accessible near-shore marine environments
Recreation - mountain biking	3.1	1.1.6.1	Cultural_recreation_mountain_biking_value	Opportunities for recreational mountain biking and associated outdoor experiences.	Forest and reserve land suitable for mountain biking access and trails
Recreation – short walk	3.1	1.1.6.1	Cultural_recreation_short_walk_value	Opportunities for casual nature-based recreation near urban populations.	Urban parks, forests, and reserve land near population centres
Recreation - tramping	3.1	1.1.6.1	Cultural_recreation_tramping_value	Opportunities for tramping and extended backcountry recreation.	Natural and protected landscapes accessible for tramping
Landscape aesthetics & inspiration	3.1	3.1.1.1	Cultural_aesthetic_value	Visual amenity, inspiration, and sense of beauty derived from landscapes and ecosystems.	Natural land cover, terrain diversity, and the presence of water features
Terrestrial biodiversity	3.4	3.2.2.1	Cultural_terrestrial_biodiversity_value	Existence and bequest values associated with terrestrial biodiversity and ecosystems.	Indigenous terrestrial ecosystems and species diversity
Marine biodiversity	3.4	3.2.2.1	Cultural_marine_biodiversity_value	Existence and bequest values associated with marine biodiversity and ecosystems.	Marine ecosystems and species diversity

4.2. Valuation sources

Table 4 summarises the valuation methods, unit values, and principal source studies and datasets used to develop the ecosystem service layers. Some values shown are weighted averages of more disaggregated estimates, such as values by species, activity, or location. The technical report should be consulted where more detailed values, assumptions, or disaggregated estimates are required.

Table 4: Ecosystem service valuation methods, unit values, and principal source studies and datasets used in the development of the ecosystem service layers

Ecosystem service	Approach	Key sources	Central	Low	High	Unit	Derivation of uncertainty range
Global climate regulation – forest Carbon	Shadow price	NZ Treasury (2025)	106	76	135	$/tCO_2e$	From source
Local climate regulation	Avoided energy cost	Ravazdezh & Rivers (2025), NZ variable electricity price	0.3	0.24	0.46	$/kWh	Scaled by Ravadezh effectiveness range
Air quality regulation	Avoided health cost	Ministry of Transport (2023)	639	250	999	$/kg PM10 urban	Scaled by range Hirabayashi 2022
			49	19	76	$/kg PM10 rural	
Water regulation	Least-cost alternative	Irrigation NZ	0.57	0.3	1.12	$/m^3/year	From source
Water purification	Avoided mitigation cost	Fernandez and Daigneault (2017) Matthews, Craggs, Tanner and Holland (2024, 2026)	40	33	110	$/t sediment	From typology ranges in Matthews et al. 2024
Nutrient regulation	Avoided mitigation cost	Abatement curves from Matthews, Craggs, Tanner and Holland (2024, 2026)	N/A	21	226	$/kg N or P	From typology ranges in Matthews et al. 2024
Erosion regulation	Avoided productivity loss	Soliman (2005)	0.12-5.04	0.07-4.20	1.45-8.91	$/t soil for sheep and beef	Cost for adjacent farm type
Fluvial and pluvial flood regulation	Avoided damage cost	OECD (2020)	20%	10%	30%	of residual risk	From source
Coastal storm surge regulation	Avoided damage cost	Narayan et al. 2017, Barbier et al. 2013, Fairchild et al. 2021	5%	10%	20%	Damage reduction	Range from Fairchild studies
Pollination	Replacement cost	Goodwin 2012; MPI Apiculture Monitoring	200	150	300	$/hive/year	From Apiculture Monitor

Regulation of waste	Avoided treatment cost	Council trade-waste charges	0.8	0.5	1.2	$/kg manure BOD	From source
Global climate regulation - blue carbon	Shadow price	NZ Treasury CBAx carbon price, NZ Treasury (2025)	106	76	135	$/tCO$_2$e	From source
Water treatment in wetlands	Avoided mitigation cost	Daigneault et al. 2017	27	14	54	$/kg N	From source
	Avoided mitigation cost	Daigneault et al. 2017	136	68	272	$/kg P	From source
	Avoided mitigation cost	Daigneault et al. 2017	4.1	2.0	8.2	$/t sediment	From source
	WTP for pathogen reductions	Tait 2016	69	58	80	$/ha for band A	From source
Crops	Simple factor share	Fresh Facts 2025, MPI Vineyard monitoring, AIMI 2025	0.31	0.13	0.50	Average contribution proportion	From JRC 2024
Fodder	Simple factor share	DairyNZ 2025	0.39	0.2	0.5	$/kg DM	Plausible range
	Production value	Beef + Lamb 2025	100%	58%	145%	of operating profit	5-year profit variability
Timber	Market price	Manley 2021	40.17	27.67	61.75	$/unit 300-index	From source
Firewood	Replacement cost	Cost of alternative heating by heat pump ($0.30/KWh, COP = 3)	28	15	39	$/GJ	Derived from variation in COP
Wild seafood	Market price	Fisheries catch, Fishserve port prices	100%	69%	125%	of port price/kg	Derived from marine account
Aquaculture	Simple factor share	MPI Aquaculture Performance (2024), Fishserve	60%	40%	80%	of production value	Plausible range
Freshwater	Productivity proxy	Irrigation NZ, BRANZ 2018	0.02 -1.00	0.019-0.5	0.021- 1.5	$/m3	Plausible range
Biochemical	Proxy market value	MPI Apiculture Monitoring	330	264	402.6	$ million (total)	Derived from market variablility
Recreation - hunting	Stated and revealed preference	Kerr & Woods 2010, Kerr and Abell 2014, Kerr 2019, Gren & Kerr 2022	$259	$187	$328	Weighted avg/trip	From sources
Recreation – short walk	Composite	NZTA 2013	5.14	4.11	7.41	$/trip	From source
Recreation - tramping	Revealed preference	Kaval and Yao (2010) day tramp	198.49	23.82	373.17	$/trip	From source
Recreation - tramping	Revealed preference	Kaval and Yao (2010) overnight	793.97	95.28	1492.67	$/trip	From source

Recreation - mountain biking	Revealed preference	Dhakal et al. (2012)	67.00	51.00	106.00	$/trip	From source
Recreation - coastal	Stated and revealed preference	Matthews et al. (2018)	47.21	21.21	131.35	$/trip	From source
Recreation - freshwater other	Stated and revealed preference	Kaval and Yao (2007)	115.73	55.42	154.85	$/trip	From source
Recreation - freshwater fishing	Stated and revealed preference	Kerr (2003)	120.00	78.00	605.00	$/trip	Cross-study range
Recreation - marine boating	Stated and revealed preference	Kerr and Latham (2011)	270.00	202.50	339.00	$/trip	From source
Aesthetic	Stated and revealed preference	Brander & Koetse, (2011)	1.37	0.99	11.68	$/exposure hour	From source
Terrestrial biodiversity	Stated preference	Subroy et al. (2019) - international meta-analysis	46	4	85	$/household/year	From source
Marine biodiversity	Stated preference	Chhun et al. (2013), Rojas-Nazar (2022)	22	7	54	$/household/year	Cross-study range

4.3. Aggregated value tables

The following tables summarise the ecosystem service layers by service category, land cover class, and region. More detailed results are provided in the Excel supplement, which includes summary values for each indicator, region, and land cover class. Users requiring a different spatial aggregation, such as territorial authority, catchment, or project area, will need to aggregate the underlying raster layers to the relevant boundary.

Table 5: Total ecosystem service values under the central, low, and high scenarios (NZ$ million/year), with mean and maximum central scenario values by subcategory (NZ$/ha/year), 2026 prices

Category	Subcategory	Central ($m/year)	Low ($m/year)	High ($m/year)	Mean ($/ha/year)*	Max ($/ha/year)
Cultural	Aesthetic	5,291.00	3,823.42	45,108.65	973.63	110,062.52
	Recreation - hunting	606.52	475.40	734.70	110.34	1,030.71
	Marine biodiversity	39.17	12.46	96.15	0.16	0.18

* The mean excludes cells with a no-data or zero value for the indicator.

	Recreation - coastal	18,240.32	8,195.45	50,748.58	20988.49	18,187,988.00
	Recreation - freshwater fishing	191.53	124.49	965.63	214.03	13,719.75
	Recreation - freshwater other	640.64	306.78	857.19	4700.99	317,108.66
	Recreation - marine boating	2,095.21	1,571.41	2,630.66	288.75	26,208.58
	Recreation - mountain biking	234.29	178.34	370.66	5456.61	27,454.90
	Recreation - short walk	1,065.14	852.12	1,533.81	440.29	94,148.44
	Recreation - tramping	224.61	26.95	422.27	163.31	4,513.24
	Terrestrial biodiversity	15,523.24	1,349.85	28,684.24	2520.05	5,628.00
Provisioning	Aquaculture	104.43	69.62	139.24	70.29	17,778.11
	Biochemical	329.99	263.99	402.59	360.19	13,242.00
	Crop	2,663.43	1,151.96	4,174.90	2324.10	96,000.00
	Firewood	144.98	77.67	201.94	9.55	126.00
	Fodder	10,056.13	5,807.73	14,395.03	931.53	4,983.42
	Timber	2,097.58	1,466.48	3,130.75	456.17	1,915.69
	Freshwater	3,151.22	1,890.73	5,640.69	100.34	7,296.00
	Wild seafood	734.57	506.85	918.21	10.37	68.07
Regulating	Air quality	10,835.99	4,239.43	16,940.77	453.17	29,053.29
	Coastal storm surge regulation	0.15	0.04	0.58	13.15	715.81
	Erosion regulation	87.64	17.49	154.76	11.52	2,238.32
	Fluvial and pluvial flood regulation	2,910.16	1,455.08	4,365.24	466.88	26,261.18
	Global climate regulation - blue carbon	5.64	4.04	7.18	170.01	229.31
	Global climate regulation - forest carbon	1,760.73	1,262.41	2,242.43	401.89	2,860.59
	Local climate	4.59	3.67	7.04	15.04	11,204.60
	Nutrient regulation	5,115.30	4,133.88	6,058.75	215.95	2,306.00
	Pollination	90.06	67.55	135.09	123.59	429.00
	Regulation of waste	819.97	512.48	1,229.95	73.56	275.41
	Water purification	1,151.40	949.90	3,166.35	70.44	90,035.12
	Water regulation	10,842.29	5,706.47	21,304.15	389.81	7,856.84
	Water treatment in wetlands	261.77	130.89	523.54	5236.22	2,113,251.00
Total of all services ($m or $/ha)		97,319.70	46,635.05	217,291.75	1394.75	18,187,988.00

Table 6: Values for high-level categories by land cover class in NZD (2026 prices) per hectare, including aggregate low and high sensitivity estimates.

Landcover class (LCDBv6)	Cultural ($/ha/year)	Provisioning ($/ha/year)	Regulating ($/ha/year)	Central Total ($/ha/year)	Low Total ($/ha/year)	High Total ($/ha/year)
Alpine Grass/Herbfield	42.44	566.87	677.79	1,287.11	732.79	2,392.15
Broadleaved Indigenous Hardwoods	5,099.16	438.92	1,590.61	7,128.69	2,768.48	16,725.54
Built-up Area (settlement)	14,102.80	262.35	1,363.93	15,729.08	10,728.66	112,886.08
Deciduous Hardwoods	1,939.79	743.54	1,719.66	4,402.99	2,365.08	9,811.61
Depleted Grassland	20.47	235.25	474.30	730.02	455.07	1,266.62
Estuarine Open Water	2,823.39	35.37	1,526.27	4,385.02	2,406.71	12,793.70
Exotic Forest	284.25	981.36	1,998.19	3,263.81	1,960.42	5,862.72
Fernland	316.03	365.48	1,302.80	1,984.31	1,033.99	3,560.64
Flaxland	2,660.58	244.11	3,552.87	6,457.56	2,486.28	12,127.70
Forest - Harvested	160.33	1,044.05	2,096.08	3,300.47	1,993.72	5,617.93
Gorse and/or Broom	526.98	447.30	1,525.17	2,499.45	1,449.17	5,861.91
Gravel and Rock	112.39	653.41	644.93	1,410.72	809.51	2,705.45
Herbaceous Freshwater Vegetation	3,119.11	278.29	3,281.33	6,678.73	2,485.19	12,124.75
Herbaceous Saline Vegetation	3,496.21	216.53	1,575.82	5,288.56	1,814.76	11,825.08
High Producing Exotic Grassland	397.46	1,122.66	1,124.71	2,644.83	1,557.59	5,248.86
Indigenous Forest	2,308.31	163.35	1,500.74	3,972.40	1,217.33	7,649.94
Lake or Pond	736.10	36.14	922.56	1,694.81	941.02	3,952.38
Landslide	46.60	256.88	1,304.44	1,607.92	962.09	3,102.83
Low Producing Grassland	129.31	358.68	782.56	1,270.54	747.83	2,339.80
Mangrove	3,914.09	104.60	331.56	4,350.26	1,329.86	14,103.54
Manuka and/or Kanuka	3,804.72	687.60	1,640.40	6,132.73	2,344.42	12,614.76
Matagouri or Grey Scrub	111.01	252.92	947.91	1,311.84	757.56	2,346.61
Mixed Exotic Shrubland	539.63	352.11	912.80	1,804.54	1,082.55	4,289.86
Orchard, Vineyard or Other Perennial	1,251.43	12,719.36	1,438.73	15,409.52	7,179.18	29,454.17
Permanent Snow and Ice	0.66	1,550.60	1,405.96	2,957.23	1,671.02	5,539.29
River	2,064.25	284.12	404.57	2,752.94	1,504.91	8,045.16
Sand and Gravel	89,474.30	128.80	451.78	90,054.88	40,581.67	250,843.50

Short-rotation Cropland	231.99	994.88	1,405.44	2,632.31	1,530.38	5,410.42
Sub Alpine Shrubland	64.97	237.04	1,435.40	1,737.41	977.86	3,257.43
Surface Mine or Dump	492.35	310.58	980.72	1,783.65	1,046.41	5,506.53
Tall Tussock Grassland	50.77	331.45	758.85	1,141.06	637.23	2,089.74
Transport Infrastructure	4,760.04	573.74	1,183.66	6,517.44	4,383.12	38,032.39
Urban Parkland/Open Space	151,768.47	189.14	1,106.49	153,064.09	73,273.00	463,189.11
Unclassified (ocean)	130.09	17.19	0.69	147.96	108.98	187.22

Table 7: Indicator totals for high-level categories by region NZD million (2026 prices), including aggregate low and high sensitivity estimates.

Region	Cultural ($m/year)	Provisioning ($m/year)	Regulating ($m/year)	Central Total ($m/year)	Low Total ($m/year)	High Total ($m/year)
Northland Region	2,594.72	1,370.13	1,991.39	5,956.24	2,913.17	12,870.16
Auckland Region	14,634.03	450.53	828.62	15,913.18	7,855.78	49,519.08
Waikato Region	4,061.55	3,716.46	3,962.59	11,740.60	5,984.40	24,479.07
Bay of Plenty Region	2,482.57	1,553.60	1,449.11	5,485.28	2,512.06	12,440.66
Gisborne Region	673.36	939.92	1,294.01	2,907.28	1,456.15	5,482.55
Hawke's Bay Region	1,373.72	1,059.09	1,887.91	4,320.72	2,030.98	8,533.17
Taranaki Region	882.01	955.60	860.71	2,698.31	1,307.87	5,433.44
Manawatu-Whanganui Region	1,831.32	1,706.75	2,515.42	6,053.49	2,959.44	11,713.15
Wellington Region	2,523.44	511.48	1,229.98	4,264.90	2,162.13	12,486.61
West Coast Region	2,945.58	207.99	3,193.62	6,347.19	2,102.84	11,727.89
Canterbury Region	2,916.66	2,155.08	5,669.99	10,741.72	5,803.66	22,593.73
Otago Region	1,470.06	1,561.95	2,989.82	6,021.83	3,298.61	12,513.23
Southland Region	2,735.70	1,429.43	3,954.00	8,119.13	3,342.92	14,277.30
Tasman Region	1,409.61	369.98	1,155.77	2,935.36	1,074.93	5,724.66
Nelson Region	207.47	16.88	66.87	291.23	151.40	1,033.94
Marlborough Region	1,371.78	684.45	835.88	2,892.10	1,257.36	5,629.24
Area Outside Region	38.11	593.03	0.00	631.14	421.33	833.87
Total	44,151.68	19,282.34	33,885.68	97,319.70	46,635.05	217,291.75

5. Guidance for interpretation and use

5.1. How to interpret the values

The monetised indicator layers sum to approximately NZ$97 billion per year in 2026 prices, with a sensitivity range of NZ$47 billion to NZ$216 billion. This should be interpreted as an indicative estimate of the current annual flow of monetisable ecosystem services captured by this assessment.

5.1.1. The values are flows, not stocks

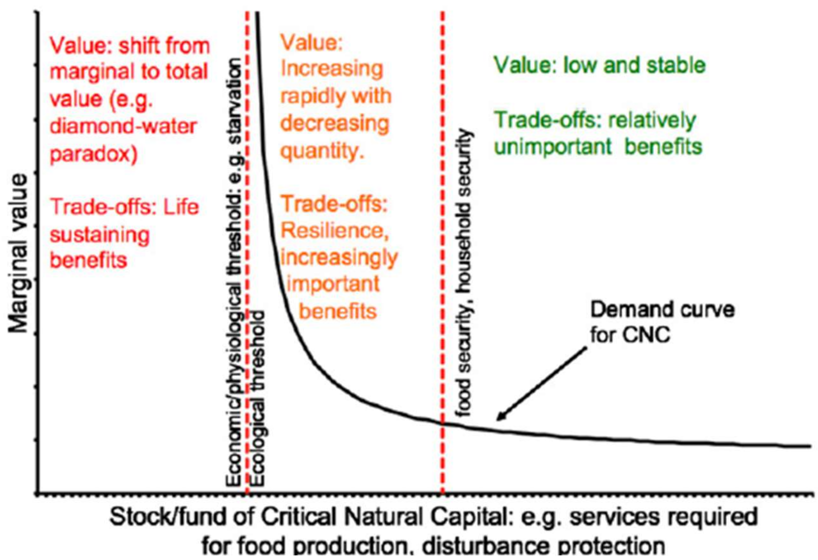
The $97 billion is not an estimate of the Total Economic Value (TEV) of New Zealand's ecosystems or natural capital, and any interpretation of the total in this way would be incorrect. The estimate excludes many values that are difficult or inappropriate to monetise, does not represent the value of ecosystem assets, and is based on current ecosystem service flows under present conditions. It should therefore be interpreted as an ecosystem-service accounting measure of annual welfare flows rather than a measure of the overall value of nature.

These annual values may change with prices, demand, population exposure, substitutes, ecosystem condition, land use, and methodological assumptions. Estimating the underlying stock value of natural capital would require ecosystem asset accounting, including expected future service flows, asset condition, degradation, restoration, and discounting. That is outside the scope of this analysis.

5.1.2. Marginality matters

Figure 1 illustrates that the stability of marginal values in response to a change depends on the scarcity of the ecosystem service and the availability of substitutes. A static value, which these layers provide, is most appropriate for assessing a relatively small change in ecosystem extent or condition. It is less appropriate in situations of critical scarcity, represented by the steep section of the curve below.

Figure 1: The demand curve for critical natural capital (Farley, 2012)



5.1.3. There is some overlap with GDP

The indicator values should also not be interpreted as either wholly additional to the economy or as a subset of GDP. Some indicators are linked to marketed production, such as food, timber, and carbon-related values, and therefore overlap conceptually with parts of measured economic activity. Others reflect non-market benefits that are not entirely captured in GDP, such as recreation, aesthetic amenity, water quality, existence values, and avoided damages. The estimates are therefore best understood as an ecosystem-service accounting view of annual welfare flows: they identify the contribution of ecosystems to human wellbeing, using both market and non-market valuation evidence, rather than measuring a separate "environmental economy" that can simply be added to GDP.

5.1.4. Aggregation and double-counting

The published indicators are intended to be additive and may be aggregated across services within the same spatial area and scenario. Users should not, however, add external valuation estimates or site-specific values that represent benefits already captured by the published indicators without first checking for overlap. Where custom analyses modify indicator definitions or introduce additional ecosystem service values, the risk of double counting should be reassessed.

5.1.5. These are not generic per-hectare values

Unlike traditional ecosystem service valuation databases, the values in this framework are not, in most cases, estimates applied uniformly to a land-cover type. They are modelled annual ecosystem service flow estimates that depend on the underlying spatial data, ecological assumptions, valuation evidence, and, where relevant, the location and characteristics of beneficiaries.

As a result, two areas with the same land cover may have very different values depending on factors such as ecosystem condition, scarcity, accessibility, population exposure, hydrological connectivity, or demand for the service.

5.2. When to consider using ecosystem service values

Ecosystem service values should be considered where environmental changes are likely to generate meaningful impacts on human wellbeing, economic activity, public infrastructure, or social outcomes. Their primary purpose is to help ensure that non-market benefits and costs are visible within decision-making processes, particularly where these effects would otherwise be omitted or implicitly treated as having zero value.

The layers are most useful where decisions involve clear trade-offs between environmental outcomes and other objectives such as development, infrastructure, land-use change, or public expenditure. In these situations, ecosystem service values can help identify the scale, direction, and distribution of environmental effects in a manner that is more consistent with standard policy appraisal and cost-benefit analysis frameworks.

Typical situations where ecosystem service values may be useful include:

- evaluating policy options that affect land use, freshwater, biodiversity, or coastal environments,
- comparing environmental and economic trade-offs in cost-benefit analysis,
- assessing infrastructure proposals with environmental impacts,
- identifying priority areas for restoration, protection, or investment,
- assessing cumulative impacts across catchments or regions,
- supporting spatial planning and strategic land-use decisions,
- screening proposals for potential environmental effects,
- informing natural capital assessments or environmental accounts,
- and communicating the scale of environmental impacts in more decision-relevant terms.

These applications should involve incremental changes in ecosystem service provision around current conditions, consistent with the marginal nature of the values.

5.3. What values to include in an assessment

Not all ecosystem service values will be relevant in every assessment. The appropriate set of values depends on the nature of the proposal, the environmental changes involved, the affected beneficiaries, and the scale of the decision being made. Attempting to include every possible ecosystem service in every analysis is neither practical nor desirable, and can create unnecessary complexity.

Instead, assessments should focus on ecosystem services that are likely to be materially affected by the proposal and relevant to the decision context. Treasury guidance (New Zealand Treasury, 2025) emphasises proportionality and fit-for-purpose analysis, with effort directed toward impacts that are likely to influence decisions.

In practice, this means selecting ecosystem services that:

- are expected to change meaningfully under the proposed scenario,
- affect identifiable beneficiaries,
- are likely to be significant relative to other impacts,
- can be assessed with reasonable confidence at the scale of the decision,
- and are relevant to the objectives of the analysis.

For example:

- a wetland restoration project may primarily involve flood mitigation, water purification, biodiversity, carbon sequestration, and recreation values,
- an urban greening project may focus on urban cooling, air quality regulation, amenity, recreation, and stormwater management,
- a forestry conversion proposal may involve carbon storage, erosion control, water yield, biodiversity, and landscape impacts,
- while an irrigation proposal may focus on provisioning services, downstream water quality, hydrological impacts, and recreational effects.

The assessment should begin by identifying the main ecological changes associated with the proposal and tracing how those changes affect people, infrastructure, economic activity, or wellbeing (A.-G. Ausseil et al., 2022). This follows the “supply-flow-benefit” logic embedded in modern ecosystem service frameworks and ecosystem accounting guidance.

In practice, identifying relevant ecosystem services does not require specialist tools or complex analysis. It can often be done through a standard intervention logic, theory of change, or impact mapping exercise that links environmental changes to their consequences for people. This initial screening helps identify which ecosystem services are likely to be affected and therefore deserve more detailed assessment.

5.4. How to use the ecosystem service values

There are five broad ways in which ecosystem service values may be estimated using the published layers and/or the methods behind them. These approaches differ in the level of spatial detail, analytical effort, and confidence they can support.

5.4.1. Use the tables of values by region and/or landcover

The simplest approach is to use the summary tables of ecosystem service values by region and land cover provided in this report and supplementary spreadsheet. This may be appropriate where the decision context is not tied to a specific site, where only a broad indication of values is required, or where the assessment is being undertaken at a regional or national scale.

The summary tables may also be useful for sensitivity analysis and for providing context around site-specific estimates. Because local ecosystem service values can vary substantially depending on ecological condition, accessibility, population exposure, and other factors, regional or land-cover averages can help users understand whether project-scale estimates are broadly representative or reflect unusually high- or low-value locations.

5.4.2. Screening and hotspot identification

A more robust approach is to aggregate the published layers over a defined study area. This can be done in GIS using methods such as zonal statistics to calculate average or total ecosystem service values for the area of interest, or for particular ecosystem or land-cover types within that area.

This approach may be useful for assessing current ecosystem service values that could be affected by a proposed change. It may also be appropriate where the intervention is expected to alter the extent or use of ecosystems, but is not expected to substantially change the underlying biophysical processes that determine ecosystem service provision.

5.4.3. Aggregate the layers to a study area

A more nuanced approach is to aggregate cell-level ecosystem service values over a defined study area, such as a sea-draining catchment, urban area, or waterways with similar water quality. This can be done in GIS software using methods such as zonal statistics. The result can be expressed as an average value per hectare, a total annual value for the study area, or separate values by ecosystem type within the study area.

This approach can support simple change assessments where the impact can be represented as a change in the area of a land use or land-cover type. For example, if a proposal would convert 10 hectares of pasture to wetland, the values associated with existing wetlands in the area could be used as a proxy for the expected ecosystem service value of the restored wetland. The estimated change would then be based on the difference between the values associated with the current and future land-cover types.

However, this approach assumes that the published cell values, or the values from comparable land-cover types nearby, remain valid under the proposed change. It is therefore less suitable where the intervention would alter the local processes that determine ecosystem service provision, such as hydrology, recreational access, exposure of nearby populations, or contaminant loads. In those cases, the scenario modelling and re-running the relevant model may be more appropriate.

5.4.4. Hybrid approach using specialised models for some services

Some users may already have access to more detailed local models for specific ecosystem services, particularly hydrological services such as flood attenuation, contaminant reduction, groundwater recharge, or flow regulation. In these situations, it may be appropriate to use the specialist models to quantify the applicable service, and use the published ecosystem service layers to fill the gaps.

Relevant models in New Zealand may include CLUES or SWAT for catchment-scale water-quality modelling; SedNetNZ for catchment erosion modelling; Overseer for farm-scale nutrient-loss estimation; NZWaM-Hydro for catchment hydrology and related water-quality applications; and HEC-RAS, TUFLOW, MIKE FLOOD or other locally applied hydraulic and hydrological models for flood-flow and inundation modelling.

The modelled biophysical outputs would need to be linked to a separate valuation step, such as avoided damage costs, treatment-cost savings, replacement-cost estimates, production impacts, or non-market valuation evidence. FARMAX, for example, is useful for estimating the farm-scale costs of mitigation measures or land-use changes, supporting least-cost or opportunity-cost valuation approaches for ecosystem services such as nutrient retention, flow regulation or erosion reduction. And RiskScape turns flood events into monetary consequences.

This hybrid approach allows local process detail to be incorporated where it is most material, without requiring all ecosystem service models to be re-run. Care is still required to ensure conceptual consistency and to avoid double counting where detailed modelled impacts overlap with ecosystem service values already represented in the published layers.

5.4.5. Scenario construction

Where local effects are expected to be significant, highly spatially variable, or materially different from the assumptions embedded in the published layers, it may be preferable to construct alternative scenarios and re-run the relevant ecosystem service models.

This involves modifying the input data used to generate the relevant ecosystem service layer, such as land use, water quality, land cover, population, accessibility, hydrology, or other model inputs, and then re-running the associated model. This approach is more data- and resource-intensive, but can provide a more defensible estimate.

For example, recreation benefits depend strongly on factors such as accessibility, environmental quality, population proximity, and the availability of substitute sites. Similarly, local climate regulation benefits are highly dependent on the spatial relationship between vegetation, built form, and exposed populations. In these cases, average values from the published layers may not adequately capture the localised effect of a proposed change.

Depending on the ecosystem services being assessed, scenario construction may involve a combination of InVEST models and project-specific source code. The source code, intermediate files, and configuration files for these workflows are available from the repository link provided in Section 3.3.

The appropriate approach will depend on the scale of the decision, the materiality of the expected impact, the availability of local data, and the level of confidence required for the appraisal. Summary tables or visual inspection may be sufficient for screening. Aggregation of the published layers may be appropriate for many area-based assessments. Model re-runs are more likely to be warranted where local ecosystem service impacts are central to the decision.

5.5. How to include the values in decision-making frameworks

The ecosystem service layers can be used at different levels of analytical intensity depending on the scale, significance, and complexity of the decision being considered. In many cases, the layers are most appropriately used as an initial screening and prioritisation tool. More detailed valuation and modelling may only be justified where environmental effects are likely to be material to the final decision.

The level of analysis should therefore be proportionate to:

- the scale of the proposal,
- the magnitude of expected environmental effects,
- the degree of uncertainty,
- and the importance of the decision.

5.5.1. Screening and prioritisation applications

At the simplest level, ecosystem service values can be used to identify whether environmental effects are likely to be important enough to warrant further investigation.

In this role, the layers are primarily used to:

- identify areas with high ecosystem service provision,
- highlight potentially sensitive locations,
- compare broad spatial patterns,
- identify possible trade-offs,
- and support early option development.

At this level, values should be interpreted comparatively and directionally rather than as precise welfare estimates. The focus is typically on questions such as:

- Which areas are likely to provide significant ecosystem services?
- Which services are most likely to be affected?
- Which options appear to create the largest environmental trade-offs?
- Is further ecological or economic assessment warranted?

For example:

- a transport corridor passing through areas with high flood mitigation and water purification values may trigger more detailed hydrological assessment,
- a land-use change proposal intersecting high recreation or urban cooling values may warrant additional urban amenity analysis,
- or a catchment with high downstream water quality benefits may justify more detailed modelling of contaminant impacts.

5.5.2. Full assessment and appraisal

Where environmental impacts are likely to be material, ecosystem service values may be incorporated into a more formal assessment framework. This typically involves comparing ecosystem service outcomes under alternative scenarios relative to a defined counterfactual.

The appropriate question is generally “How do ecosystem service outcomes change under this option compared with what would otherwise occur?” rather than: “What is the total value of the ecosystem?”

In many government contexts, this may involve cost-benefit analysis using Treasury’s CBAx framework (New Zealand Treasury, 2025) or related appraisal methods. Under these approaches:

- ecosystem service changes are treated as benefits or costs relative to the baseline,
- values are assessed over time,
- uncertainty and sensitivity analysis are undertaken,
- and ecosystem service impacts are considered alongside financial, economic, social, and distributional impacts.

However, cost-benefit analysis is not the only appropriate framework. Depending on the decision context, ecosystem service information may also support:

- multi-criteria analysis (MCA),
- real options analysis (ROA),
- adaptive planning approaches,
- natural capital accounting,
- strategic environmental assessment,
- or broader spatial planning exercises.

5.5.3. Relationship to economic impact analysis

Ecosystem service values are most compatible with welfare-based appraisal frameworks such as cost-benefit analysis (CBA), rather than economic impact analysis (EIA). Economic impact analysis typically estimates changes in economic activity, such as GDP, employment, industry output, household income, or regional expenditure flows.

In contrast, many ecosystem service values represent changes in social welfare, including non-market benefits and avoided damages that may not correspond to observable market transactions. As a result, ecosystem service values should not be added directly to GDP, employment, or regional output measures.

However, this does not mean ecosystem services are irrelevant to economic impact analysis. Many proposals may appropriately involve both a CBA assessing changes in social welfare, including ecosystem service impacts, and an EIA assessing impacts on economic activity and regional economies (NCAVES & MAIA, 2022).

For example:

- a wetland restoration project may generate ecosystem service benefits captured in CBA through flood mitigation, carbon sequestration, and recreation values,
- while also generating regional employment and expenditure impacts captured through EIA.

Similarly:

- a land-use intensification proposal may increase regional output and exports in an EIA framework,
- while simultaneously reducing water quality or recreation values captured within a CBA framework.

The two approaches therefore provide complementary but conceptually different information. CBA asks whether society is better off overall, while EIA examines how economic activity and distributional effects change across industries, regions, or groups.

Where both approaches are used, the distinction between welfare impacts, economic activity impacts, and fiscal impacts should be maintained clearly to avoid double counting or misinterpretation.

5.5.4. Use multiple lines of evidence

Regardless of the framework used, ecosystem service values and cost-benefit analysis should rarely be the sole basis for decision-making (DEFRA, 2011; NCAVES & MAIA, 2022). Good practice is to combine:

- monetised values,
- biophysical indicators,
- spatial analysis,
- ecological assessment,
- stakeholder input,
- cultural impact assessment,
- distributional analysis,
- and any other relevant qualitative evidence.

Some important ecosystem outcomes cannot be reliably monetised, while others may involve ethical, cultural, or distributional considerations that extend beyond economic efficiency alone.

As a general rule, the greater the scale, cost, controversy, or irreversibility of a decision, the greater the need for local data, site-specific assessment, and expert judgement in addition to the published ecosystem service values.

5.5.5. Future values and discounting

Ecosystem services can generate flows of benefits over long time periods. Where ecosystem service values are incorporated into formal appraisal, future benefits and costs should generally be assessed consistently with the broader appraisal framework being used, including any applicable Treasury or agency guidance on discounting and time horizons.

The ecosystem service layers represent annual flows of services or indicative annual values. Users should therefore avoid:

- summing annual values across years without discounting,
- treating annual service values as permanent,
- or assuming ecosystem service flows remain constant over time.

Future ecosystem service flows may change due to:

- land-use change,
- ecosystem degradation or restoration,
- climate change,
- population growth,
- technological change,
- or changing patterns of demand.

There is an ongoing literature in New Zealand and internationally regarding the appropriate treatment of social discount rates for long-term environmental impacts (e.g. Grimes, 2023). Lower discount rates generally increase the present value of long-lived ecosystem services such as carbon sequestration, biodiversity protection, and resilience benefits. This guidance does not prescribe alternative discounting approaches, and formal appraisal should generally remain consistent with applicable Treasury guidance. However, where long-term ecosystem impacts materially influence results, sensitivity analysis using alternative discount rates is recommended.

5.5.6. Practical workflow

A practical process for incorporating ecosystem service values into an assessment, adapted from applied ecosystem service valuation guidance and extended for use in policy appraisal, is shown below. The process emphasises early identification of stakeholders, beneficiaries, and decision-makers to help ensure that the assessment focuses on the ecosystem services and wellbeing outcomes most relevant to the decision context (A.-G. E. Ausseil et al., 2023; Schuster & Doerr, 2015).

1. Define the decision context, objectives, stakeholders, and decision-makers.
2. Define the baseline and alternative scenarios.
3. Define the relevant spatial and temporal boundaries, including the assessment time horizon.
4. Identify ecosystem services likely to change materially.
5. Determine which services can be assessed quantitatively, monetarily, or qualitatively.
6. Estimate changes in ecosystem service flows between scenarios over time.
7. Incorporate results into the chosen assessment framework, including appropriate treatment of discounting where relevant.
8. Check for overlap, double counting, and consistency.
9. Undertake sensitivity analysis where uncertainty is material, including sensitivity to key temporal assumptions where relevant.
10. Present ecosystem service results alongside other relevant evidence and constraints.

The objective is not to force all environmental effects into a single monetary metric, but to ensure that ecosystem-related benefits, costs, and trade-offs are considered systematically and transparently within the broader decision-making process.

The Nature Conservancy (Schuster & Doerr, 2015) provide a more detailed structured workflow for incorporating ecosystem service valuation into restoration projects. Defra's ENCA resources, including case studies, assessment templates, and databooks may also be useful for understanding how natural capital and ecosystem service approaches can be integrated into practical policy and project appraisal (https://www.data.gov.uk/dataset/3930b9ca-26c3-489f-900f-6b9eec2602c6/enabling-a-natural-capital-approach). While developed for the UK context, they provide illustrative examples of assessment structure, valuation integration, and proportionality in applied decision-making.

5.5.7. Sensitivity analysis

The low, central, and high estimates are provided to support sensitivity analysis and transparent interpretation of uncertainty. In most applications, the central estimate should be used as the main case, with the low and high estimates used to test whether conclusions are robust to plausible variation in ecosystem service values. For example, where ecosystem service values are material to a cost-benefit analysis, users should test whether using low or high values changes key results such as net present value, benefit-cost ratios, option rankings, or preferred policy conclusions.

The low and high estimates can also support more nuanced assessment where there is a reasonable basis to believe that a specific location differs from average conditions. For example, a site with unusually high recreation demand, strong ecological condition, limited substitutes, or high exposure of beneficiaries may justify placing greater weight on the upper end of the range. Conversely, sites with lower condition, weaker service flows, limited accessibility, or fewer beneficiaries may warrant greater weight on the lower end. Any such judgement should be clearly explained and supported by local evidence where available.

The purpose of reporting ranges is not to imply false precision, but to make uncertainty visible and allow users to test the importance of valuation assumptions. Where conclusions depend heavily on whether low, central, or high values are used, this should be reported as a material uncertainty rather than hidden in a single point estimate.

5.6. Potential pitfalls

When using the ecosystem service values, the main risk is not that the values are 'wrong', but that they are used for a purpose or at a scale they were not designed for.

5.6.1. Confusing annual flows with total natural capital value

A common pitfall with ecosystem services is treating the total as the value of natural capital. The values represent annual ecosystem service flows captured by this assessment, not ecosystem asset values, replacement values, or the total worth of nature.

5.6.2. Assuming monetised estimates capture all value

Monetised values should not be treated as comprehensive measures of environmental importance. Some values are not monetised, and some cultural, relational, spiritual, intrinsic, and intergenerational values cannot be adequately represented in monetary terms. Low monetary value should not be interpreted as low ecological, cultural, or policy importance.

5.6.3. Over-interpreting individual grid cells

The 100 metre grid is useful for modelling and aggregation, but it should not be interpreted as implying precision at the individual-cell level. Many input datasets are coarser, modelled, or based on transferred values. The layers are therefore better suited to comparison and aggregation across larger areas than to interpretation of single cells.

5.6.4. Treating values as fixed prices

The values are indicative current marginal values, not fixed prices that apply equally to all quantities, locations, or scales of change. They are most defensible for changes near current conditions and should not be applied mechanically to very large changes without considering ecological thresholds, scarcity, substitutes, and changes in demand.

5.6.5. Using values without an explicit counterfactual

The ecosystem service values are most appropriately used within a cost-benefit analysis or scenario assessment framework that clearly defines the counterfactual. They are intended to inform the welfare implications of changes relative to an alternative state, such as land-use change, restoration, degradation, or changes to accessibility. Interpreting the values without a defined counterfactual can lead to misleading conclusions about the scale or significance of ecosystem service impacts.

5.6.6. Using national layers as a substitute for local assessment

The layers are intended to support strategic analysis, screening, comparison, and scenario testing. They should not be used as a substitute for local data, ecological expertise, mātauranga Māori, stakeholder input, or site-specific assessment where decisions require finer-scale evidence.

5.6.7. Treating ecosystem service values as directly additive to GDP

The values should not be interpreted as directly additional to GDP or simply added to standard economic accounts. Some values overlap with marketed production, while others represent non-market welfare benefits or avoided costs. The values should therefore be interpreted as an ecosystem-service view of annual welfare flows, not as a separate environmental sector.

6. Case studies

This section outlines the approach for a set of case studies that illustrate the practical application of the ecosystem services (ES) framework and associated valuation methods. These case studies are not intended to represent a full analysis of costs and benefits, but rather to provide clear, policy-relevant examples of how changes in land use or environmental conditions translate into changes in ecosystem service provision and associated values.

Consistent with best practice in ecosystem service modelling, each case study focuses on spatially explicit changes in ecosystem service supply and, where feasible, service flows to beneficiaries. The analysis emphasises biophysical and monetary changes in ecosystem services under defined counterfactual scenarios.

6.1. Wetland restoration

This case study shows the use of ecosystem service layers to assess the indicative implications of restoring a former wetland system. Wetland restoration is a topical policy and investment issue because wetlands can contribute to several current priorities at once, including freshwater improvement, flood-risk management, biodiversity protection, climate regulation, and adaptation to more frequent extreme rainfall events. Restoration of former wetlands may also provide an opportunity to recover ecosystem functions in landscapes where drainage and land conversion have substantially reduced wetland extent.

Figure 2: A quiet wetland providing vital habitat for native wildlife and supporting healthy freshwater ecosystems.

6.1.1. Site selection

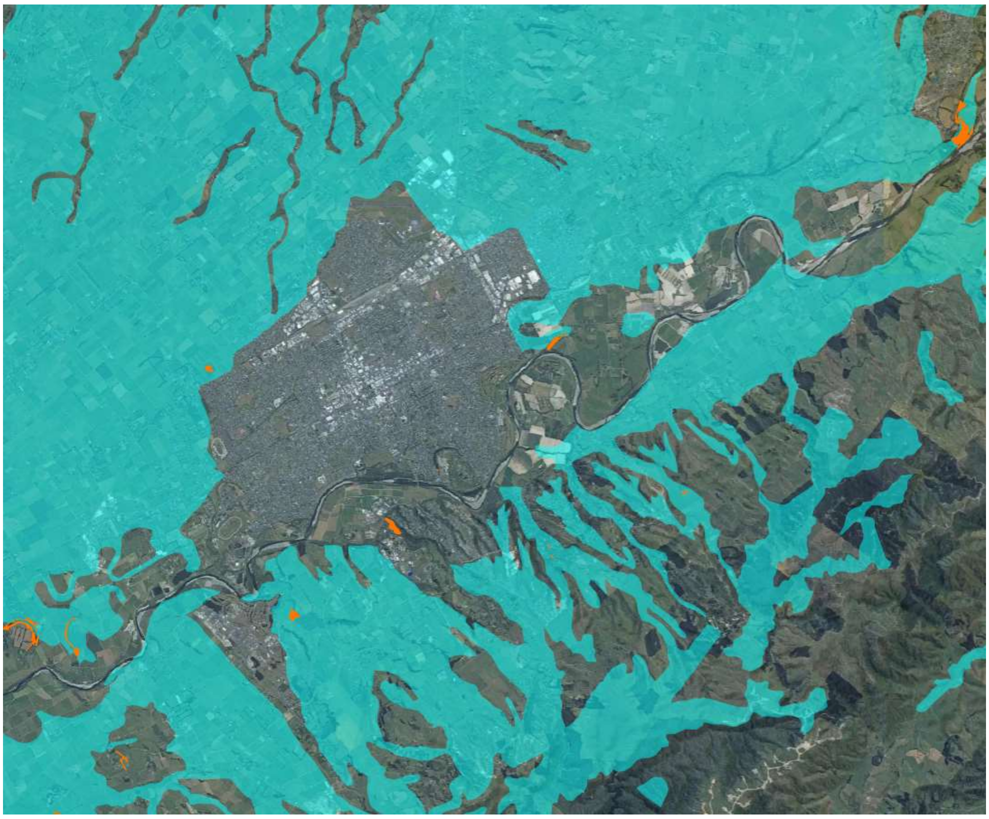
The case study area was selected to represent a catchment where wetland restoration could plausibly affect multiple ecosystem services. The selection criteria were that the catchment should:

- have experienced substantial historical loss of pre-human wetland extent;
- have documented nutrient, sediment, pathogen, or water-clarity pressures;
- include areas subject to flood risk, where flood attenuation benefits could be material.

The Manawatū sea-draining catchment was selected because it meets these criteria. It has well-documented freshwater quality pressures, including nutrients, sediment, E. coli and water clarity, alongside active restoration and catchment-management efforts. The catchment covers approximately 588,000 ha. Current wetland extent is estimated at 1,145 ha, compared with an estimated pre-human wetland extent of 145,197 ha, indicating substantial historical wetland loss.

Within the catchment, this analysis focuses on the area around Palmerston North because it brings together several intersecting ecosystem pressures and potential benefits. These include freshwater quality pressures, capital exposed to flood risk, and a nearby population that may benefit from cultural services. This makes it a useful illustrative setting for assessing how wetland restoration could affect multiple ecosystem services at once.

Figure 3: Satellite image of Palmerston North overlaid with current wetlands (orange) and pre-human predicted wetlands (blue)



Wetlands in New Zealand are commonly classified as bogs, fens, swamps, marshes and shallow-water wetlands (Clarkson, 2012). Some wetland types are also now much rarer than others due to historical drainage and land conversion, with lowland swamps and marshes particularly reduced in extent across many regions. The following table shows current wetland extent, in hectares, based on the LCDB v6 wetland attribute, categorised by wetland type from the 2013 wetland extent layer[5]. It also shows estimated pre-human wetland area by type[6], providing a basis for comparing remaining wetland extent with historical wetland distribution.

Table 8: Current and pre-human wetland by type for Manawatū sea-draining catchment

Wetland type	Current hectares	Pre-human hectares (predicted)	% Remaining
Bog	7	2696	0.3%
Fen	81	891	9.1%
Marsh	207	11285	1.8%
Seepage	16		
Swamp	618	130325	0.5%
Uncategorised	215		
Total	**1145**	**145197**	**0.8%**

6.1.2. Analytical approach

The case study demonstrates how the ecosystem service layers can be used to assess indicative trade-offs associated with wetland restoration. It does not identify preferred restoration sites or imply that any specific land parcel should be converted to wetland. Instead, it uses areas identified as pre-human wetland extent to illustrate how current land-use values can be compared with the potential ecosystem service values associated with restored wetland habitat.

The analytical approach involved:

- Calculating average ecosystem service values for existing wetlands in the Manawatū catchment
- Selecting an illustrative area within the pre-human wetland extent that is not currently classified as wetland.
- Summing current ecosystem service values for that area to represent the services associated with its present land use.
- Comparing these values with the average values of existing wetlands to highlight indicative trade-offs from restoration.

6.1.3. Current wetland values

For this assessment, the ecosystem service layers were aggregated by catchment and wetland classification. Table 9 presents the average ecosystem service values for current wetlands in the Manawatū catchment. The table excludes marine ecosystem services.

Some current wetlands have recreation values because they are located near tramping tracks, mountain biking trails, or urban areas. Cultural values are highest for biodiversity, reflecting the importance of remaining wetland habitats. Some wetlands also show provisioning values because areas classified as wetlands overlap with cropping, grazing, or plantation forestry land uses in the New Zealand Land Use Management layer[7].

Current wetlands also tend to have high flood-regulation values, reflecting the presence of downstream capital at risk within the catchment. In-wetland water treatment values are also relatively high where wetlands intersect streams with elevated concentrations of nutrients, pathogens, or sediment.

[5] https://data.mfe.govt.nz/layer/52676-current-wetland-extent-2013/

[6] https://data.mfe.govt.nz/layer/52677-prediction-of-wetlands-before-humans-arrived/

[7] https://lris.scinfo.org.nz/layer/122805-new-zealand-land-use-management-version-03-nzlum-v03/

Table 9: Average ecosystem service values for wetlands in the Manawatū catchment (2026 NZD/ha)

Category	Service	Central Mean ($/ha/year)	Sensitivity range: Low Mean ($/ha/year)	Sensitivity range: High Mean ($/ha /year)
Cultural	Aesthetic	212.96	153.89	1,815.59
	Recreation - hunting	57.64	45.18	69.82
	Terrestrial biodiversity	3,985.24	346.54	7,364.03
	Recreation freshwater fishing	3.20	2.08	3.64
	Recreation freshwater other	10.46	5.01	14.00
	Recreation mountain biking	8.76	6.67	13.86
	Recreation short walk	1,235.99	988.79	1,779.82
	Recreation tramping	1.27	0.15	2.39
Cultural Total		**5,515.52**	**1,548.31**	**11,063.15**
Provisioning	Biochemical	0.05	0.04	0.06
	Crop	135.28	58.51	212.05
	Firewood	13.36	7.16	18.61
	Fodder	629.04	363.29	900.44
	Timber	9.94	6.95	14.84
	Water	7.16	5.91	19.70
Provisioning Total		**794.83**	**441.85**	**1,165.70**
Regulating	Air quality	294.84	115.35	460.94
	Erosion regulation	0.61	0.12	1.07
	Flood regulation	1,466.74	733.37	2,200.11
	Global climate	309.35	221.80	393.98
	Local climate	0.02	0.02	0.03
	Nutrient regulation	361.41	292.07	428.07
	Pollination	9.05	6.79	13.58
	Waste assimilation	43.84	27.40	65.76
	Water purification	1.34	0.71	2.64
	Water regulation	443.89	266.33	794.56
	Wetland water treatment	3,445.40	1,722.70	6,890.80
Regulating Total		**6,376.49**	**3,386.65**	**11,251.54**
Grand Total		**12,686.83**	**5,376.82**	**23,480.39**

6.1.4. Restoration scenario

A pre-human wetland feature was selected as an illustrative restoration area. The site is currently primarily used for sheep grazing, is located near Palmerston North, and sits within a landscape similar to existing small wetlands in the catchment that have relatively high regulating service values. The selected feature has an area of 319 hectares.

The restoration scenario assumes that the restored wetland would have similar per-hectare ecosystem service values to existing wetlands in the catchment, as presented in the previous table. Some adjustments were made to reflect expected changes in land use. In particular, the restored wetland is assumed to not support cropping or production forestry, although it may retain a minor firewood provisioning value.

The estimated waste assimilation value falls because the change in land use removes the livestock manure load that previously created demand for this service by soil. This does not imply that the land has lost its biophysical capacity to process waste. Rather, the realised service flow declines because the source of waste is no longer present. This illustrates an important limitation of interpreting ecosystem service flows as equivalent to ecosystem value: a lower service value may reflect reduced demand or use, rather than reduced ecological function.

The following table compares the ecosystem services associated with the current land use, the indicative wetland restoration scenario, and the estimated difference. The restoration scenario shows substantially higher cultural, flood-regulation and water-treatment values. Global climate regulation values are also higher, reflecting increased woody biomass. Overall, the estimated net increase in ecosystem service value is $10,063 per hectare per year. Across the 319-hectare restoration area, this equates to approximately $3.2 million per year.

Table 10: Comparison of ecosystem service values under current land use and indicative wetland restoration in the selected restoration area (2026 NZD/ha)

Category	Service	Current land use ($/ha/year)	Restored wetland ($/ha/year)	Difference ($/ha/year)
Cultural	Aesthetic	106.18	212.96	106.78
	Recreation - hunting	0.00	57.64	57.64
	Terrestrial biodiversity	78.13	3,985.24	3,907.11
	Recreation - freshwater fishing	1.18	3.20	2.02
	Recreation - freshwater other	0.00	10.46	10.46
	Recreation - mountain biking	0.00	8.76	8.76
	Recreation - short walk	30.88	1,235.99	1,205.11
	Recreation - tramping	0.00	1.27	1.27
Cultural Total		**216.37**	**5,515.52**	**5,299.14**
Provisioning	Biochemical	0.16	0.00	-0.16
	Crop	0.00	0.00	0.00
	Firewood	3.23	13.36	10.13
	Fodder	663.60	0.00	-663.60
	Timber	35.38	0.00	-35.38
	Freshwater	13.75	7.16	-6.58
Provisioning Total		**716.12**	**20.57**	-695.59
Regulating	Air quality	50.58	294.84	244.26
	Erosion regulation	0.04	0.61	0.57
	Fluvial and pluvial flood regulation	98.21	1,466.74	1,368.53
	Global climate regulation – forest carbon	9.36	309.35	299.99
	Local climate regulation	0.00	0.02	0.02
	Nutrient regulation	286.98	361.41	74.42
	Pollination	0.00	9.05	9.05
	Regulation of waste	71.87	43.84	-28.03
	Water purification	0.08	1.34	1.26
	Water regulation	400.14	443.89	43.75
	Water treatment in wetlands	0.00	3,445.40	3,445.40
Regulating Total		**917.27**	**6,376.49**	**5,459.21**
Total		**1,849.76**	**11,912.52**	**10,062.76**

For a more detailed site-specific assessment of wetland restoration, users may wish to modify a landcover layer to include the new wetland and then re-run selected ecosystem service models, as described in Section 5.4.4. This would be particularly useful for services that are highly sensitive to local conditions, such as wetland water treatment, where results depend strongly on the contaminant loads delivered to the stream. For some regulating services, users could also supplement the national-scale ecosystem service layers with more detailed hydrological modelling of contaminant reduction, flood attenuation, or flow-regulation impacts.

6.1.5. Applications in assessment

The indicative changes in ecosystem service values from the wetland restoration should be incorporated into a broader assessment framework that considers capital costs, operating costs, appropriate discounting, and the choice of assessment timeframe. The assessment should also include non-monetised information where available. Cultural, ecological, site-specific values may not be adequately represented in the monetary ecosystem service estimates.

The assessment timeframe should be long enough to reflect the gradual development of wetland functions. Restored wetlands typically take time to develop vegetation structure, soil processes, hydrological function, habitat quality and water-treatment capacity. The ES changes should therefore be phased in over time, rather than assuming that the full annual value of a mature wetland is achieved from year one.

The timing of ecosystem service benefits is likely to vary between services. Services associated with woody vegetation, such as carbon sequestration, air-quality regulation, and the provision of harvestable biomass, might be phased in according to the growth curves of the woody species. In contrast, services that depend on hydrological function and herbaceous wetland vegetation, such as nutrient retention, sediment trapping, water-quality improvement, and flow regulation, may develop within just a few years if the wetland is appropriately planted. Biodiversity-related benefits may follow a different trajectory again. While some species establish quickly, the development of diverse and resilient ecological communities often occurs over much longer timeframes. The appropriate timing assumptions should be informed by available ecological evidence where possible.

Care is also needed in the treatment of opportunity costs because the ecosystem service values already includes the change in agricultural production through provisioning services. In a full cost-benefit analysis, changes in agricultural production should generally be identified separately and treated explicitly as costs or benefits.

The assessment should also account for changes in ecosystem pressures resulting from land retirement. For example, retirement of the land from production would probably reduce contaminant run-off at source. These change in environmental pressure is not conceptually part of the realised ecosystem service flow, and is therefore not captured in the estimated change in ecosystem service values.

Table 11: Relationship between this wetland case study and the section 5.5 workflow

Workflow element	Wetland restoration case study
Decision context	Assessing the ecosystem service benefits of restoring wetlands on currently modified land.
Assessment type	Screening-level scenario analysis.
Counterfactual	Current land use and ecosystem service provision.
Change assessed	Conversion of modified land to restored wetland habitat.
Values estimated	Difference between current and post-transition ecosystem service flow values.
Key assumptions	Restored wetlands provide ecosystem services similar to existing local wetlands.
Main simplifications	Does not explicitly model restoration costs, restoration success rates, time lags, local hydrology, contaminant loads, or changes in ecosystem condition through time.
Additional evidence needed for formal appraisal	Site-specific restoration design, restoration and maintenance costs, ecological response, hydrological assessment, contaminant loads, restoration success probabilities, timing of benefits, and treatment of uncertainty.

6.2. Peri-urban native forest

This case study illustrates how ecosystem service values can inform decisions about indigenous forest in an urban or peri-urban setting. The decision context could include protecting remaining native forest, expanding native forest cover through new planting, or adding recreational infrastructure to improve access to existing forest areas. It focuses on an area where native vegetation is scarce, land-use pressures are high, and local communities may benefit from improvements in habitat, amenity, shade, air quality, stormwater regulation, and access to nature. The caveats associated with each decision context are discussed further below.

The analytical approach involves:

- Selecting an urban area that has little native forest remaining.
- Calculating average ecosystem service values for native forest within the wider urban area.
- Calculating average ecosystem service values for other land cover classes within the same area.
- Comparing these values to illustrate how the ecosystem service profile of native forest differs from other urban and peri-urban land covers.
- Interpreting the results as indicative differences between land cover classes, rather than as site-specific estimates of the benefits of converting any particular location to native forest.

Figure 4: A visitor enjoying a short visit to a native forest in a peri-urban setting.

6.2.1. Site selection

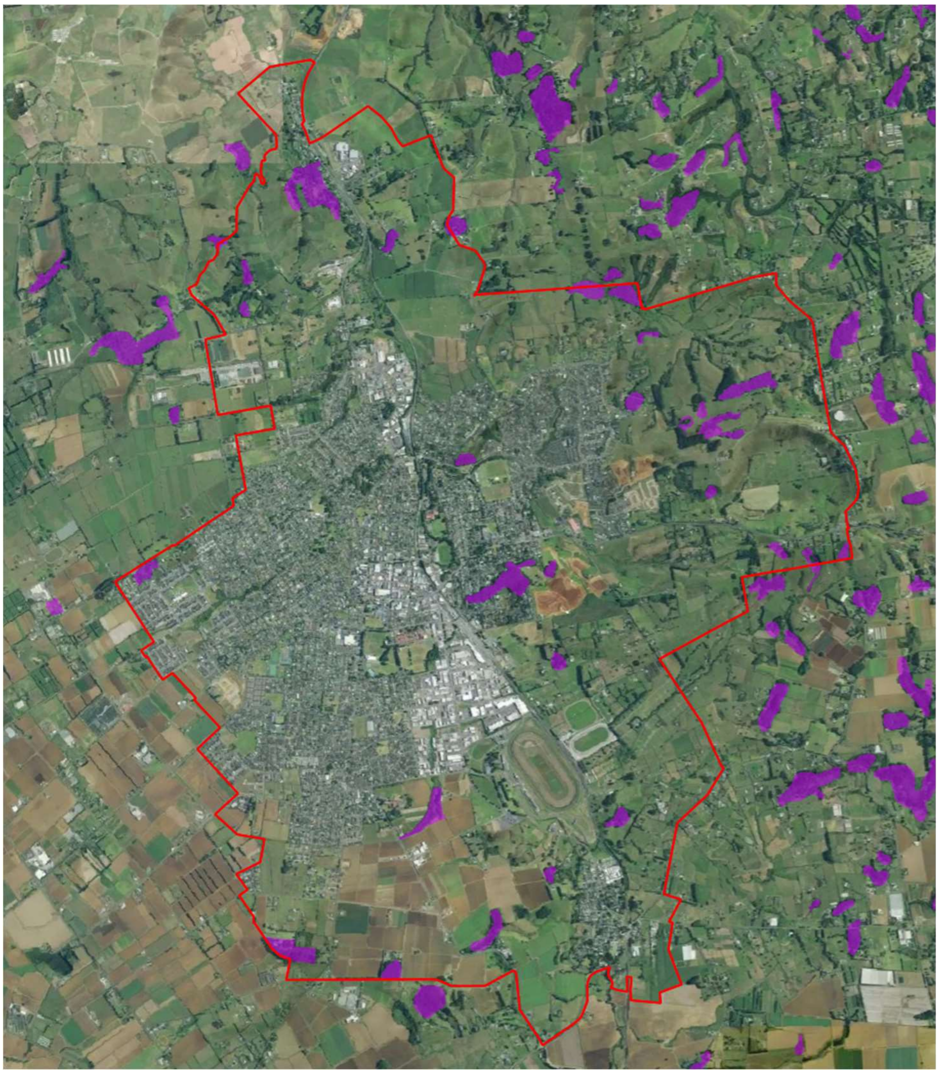
The wider Pukekohe urban area, as defined by the Stats NZ Functional Urban Area layer, was selected as the case study location. Pukekohe provides a useful example because it sits within a highly modified peri-urban landscape where little indigenous forest remains. The wider area has approximately 2 to 5 percent native vegetation cover, reflecting the long-term conversion of land for settlement and highly productive horticultural and agricultural use. Its fertile, high-class soils have supported intensive food production, but this has also contributed to the loss and fragmentation of indigenous vegetation.

For this analysis, native forest is defined using the following LCDB classes: Indigenous Forest, Broadleaved Indigenous Hardwoods, and Mānuka and/or Kānuka. These classes were used to identify remaining patches of native woody vegetation within and around the selected urban area.

The case study therefore represents a landscape where a new indigenous micro-forest would be expected to provide relatively high marginal ecosystem service benefits. In a setting with limited existing native vegetation, even small areas of restored forest can contribute to habitat connectivity, urban cooling, stormwater interception, recreation and amenity values, and local sense of place. These benefits are particularly relevant in urban and peri-urban environments, where ecosystem services are closely linked to human wellbeing and where access to green space can affect a large number of people.

The following figure shows an aerial view of the case study area, with remaining areas of native forest highlighted in purple.

Figure 5: Aerial imagery of Pukekohe urban area, with native forest areas highlighted in purple.



6.2.2. Results

The case study area covers 3,115 hectares, with total estimated annual ecosystem service values of $29.9 million, with a sensitivity range of $20.5 million to $191.3 million. The following table reports the per-hectare value of cultural, provisioning, and regulating services for each land cover class, along with total low and high sensitivity bounds. Built-up area has the highest total ecosystem service value, largely because it accounts for a substantial share of the case study area (34%). On a per-hectare basis, the highest values are associated with lakes and ponds. These values primarily reflect aesthetic benefits to nearby residents, rather than contact recreation, as the water bodies are not considered swimmable. For forest land cover classes, estimated values are dominated by cultural services, which are examined in more detail in the next table.

Table 12: Pukekohe per-hectare and total ecosystem services by landcover class

Landcover class 2023	Cultural ($/ha/year)	Provision-ing ($/ha/year)	Regulating ($/ha/year)	Central total ($/year)	Low total ($/year)	High total ($/year)
Broadleaved Indigenous Hardwoods	13,241	1,144	3,708	253,302	139,827	852,892
Built-up Area (settlement)	12,831	293	1,188	15,170,178	10,765,459	117,784,533
Exotic Forest	9,270	447	4,229	376,537	242,054	2,165,950
Forest - Harvested	559	87	2,458	12,418	6,839	34,619
Herbaceous Freshwater Vegetation	13,509	2,361	10,652	106,088	61,701	214,457
High Producing Exotic Grassland	3,365	1,197	1,642	9,498,315	6,252,906	49,191,991
Indigenous Forest	13,484	1,333	5,319	1,208,095	681,352	3,835,858
Lake or Pond	23,466	23	7,676	31,165	20,073	211,236
Manuka and/or Kanuka	9,876	17	1,828	23,440	11,763	50,861
Orchard, Vineyard	2,105	4,885	1,823	26,438	14,443	85,783
Short-rotation Cropland	3,788	1,367	1,609	1,961,369	1,324,512	10,667,082
Urban Parkland/Open Space	9,078	473	1,132	1,271,390	938,833	6,202,229
All classes	7,153	876	1,583	29,938,735	20,459,762	191,297,493

Some land-cover types usually associated with provisioning services also have relatively high cultural values. Cropland and exotic grassland contribute to landscape amenity through open views, visual variety, and patches of tree cover. This is particularly important in this peri-urban case study, where many nearby residents benefit from the attractive rural landscape. Freshwater recreation values may also occur where streams cross productive land and are also bordered by conserved vegetation. This example highlights the value of modelling the factors that drive ecosystem service provision, rather than relying solely on land-cover classes as proxies.

A breakdown of services by native forest and other land cover classes (Table 12) shows that native forest has substantially higher aesthetic value than average for the area. This partly reflects its contribution to landscape diversity, as well as its high underlying aesthetic score. Biodiversity existence values are also high, reflecting the relative scarcity of native forest in the wider area.

Table 13: Pukekohe ecosystem services per hectare for native forest versus other landcover

Category	Service	Native forest ($/ha/year)	All other classes ($/ha/year)
Cultural	Aesthetic	4,518.66	113.00

	Recreation - Hunting	0.00	0.00
	Terrestrial biodiversity	3,326.59	83.19
	Recreation – freshwater other	0.00	0.00
	Recreation - freshwater fishing	23.88	0.00
	Recreation - marine boating	0.00	0.60
	Recreation - mountain biking	0.00	0.00
	Recreation - short walk	5,474.90	136.92
	Recreation - tramping	0.00	0.00
Cultural Total		13,344.03	333.71
Provisioning	Biochemical	0.03	0.00
	Crop	426.32	10.66
	Firewood	27.62	0.69
	Fodder	589.03	14.73
	Wild seafood	0.00	0.00
	Timber	0.00	0.00
	Freshwater	220.30	5.51
Provisioning Total		1,263.29	31.59
Regulating	Air quality	2,986.00	74.67
	Erosion regulation	3.64	0.09
	Fluvial and pluvial flood regulation	11,09.81	27.75
	Global climate regulation – forest carbon	43.93	1.10
	Local climate regulation	22.63	0.57
	Nutrient regulation	265.82	6.65
	Pollination	5.45	0.14
	Regulation of waste	35.24	0.88
	Water purification	3.75	0.09
	Water regulation	453.74	11.35
	Water treatment in wetlands	0.00	0.00
Regulating Total		4,930.01	123.29
Grand Total		**19,537.33**	**488.59**

The cropping and fodder provisioning values attributed to native forest arise from minor misalignment between the LCDB v6 and NZLUM input layers, with the latter used to derive production values. These values should therefore be interpreted as artefacts of the input data rather than as services provided by native forest.

Native forest also has high air quality regulation values because of its proximity to the urban area. It provides nutrient regulation to surface flows and water retention services. The forests also provides some flood regulation benefit due to being located on or near floodplains.

The total ecosystem service value for native forest is estimated at $19,540 per hectare, with a sensitivity range of $10,960 to $62,363 per hectare. This is substantially higher than the case study area average across all classes of $489 per hectare, indicating that changes in native forest extent could have relatively large welfare implications, whether through loss of existing forest or gains from restoration.

6.2.1. Applications in assessment

As with the wetland case study, applying these values in a formal assessment framework would require a fuller specification of costs, timing, and counterfactuals. This would include capital costs, operating and maintenance costs, appropriate discounting, and the choice of assessment timeframe. It would also require consideration of values that are not fully captured by the ecosystem service layers, such as cultural, heritage, ecological, or strategic considerations, as well as any site-specific factors relevant to the decision.

The decision context is also important. If the relevant decision concerns the potential loss of the full 76 hectares of remaining native forest, the welfare change could be much larger than a simple per-hectare estimate implies. The unit values used here are most appropriate for marginal changes and may not scale linearly to the loss of all remaining native forest.

Similarly, if the decision context involves expanding native forest extent, some values may decline on a per-hectare basis as scarcity, ecosystem pressure, or substitution effects change. For example, additional forest may not generate a proportional increase in recreation value if visits are partly substituted from more distant or lower-quality sites. Conversely, new or expanded forest may increase the value of nearby ecosystems, such as streams, by improving environmental quality, habitat connectivity, or amenity.

In summary, the values presented here are best interpreted as indicative marginal estimates. They provide useful evidence on the relative ecosystem service value of native forest compared with other land cover classes, but they should not be treated as a complete cost-benefit assessment without further analysis of costs, timing, site-specific conditions, and the relevant policy counterfactual.

6.2.2. Scope limitations

In practice, the biodiversity benefits of micro-forests are likely to differ from those of larger or more remote forests. These differences may reflect greater exposure to human pressures, smaller patch size, edge effects, limited habitat connectivity, and the ecological characteristics of newly established forest rather than mature or old-growth forest. A detailed assessment of these factors is outside the scope of this rapid assessment.

Recreation substitution effects are also outside the scope of the analysis. These effects could be explored using existing literature, but would ideally be informed by a local survey to understand how residents currently use green spaces and how their behaviour might change in response to new or improved native forest areas.

These limitations highlight the importance of supplementing monetary ecosystem service estimates with non-monetary ecological, cultural, and social information.

Table 14: Relationship between this forest case study and the section 5.5 workflow

Workflow element	Wetland restoration case study
Decision context	Assessing the ecosystem service implications of retaining, losing, or expanding native forest in a peri-urban setting.
Assessment type	Screening-level scenario analysis.
Counterfactual	Current native forest extent and ecosystem service provision.
Change assessed	Potential loss or gain of native forest extent relative to current conditions.
Values estimated	Difference in annual ecosystem service flows associated with native forest and other land cover classes.
Key assumptions	Existing native forest values provide a reasonable indication of the ecosystem services associated with similar forest areas in comparable locations. Additional forest increases total nature-based recreation and is not purely substitution.
Main simplifications	Does not explicitly model ecological condition, habitat connectivity, restoration time lags, recreation substitution effects, or site-specific cultural and biodiversity values.
Additional evidence needed for formal appraisal	Site-specific ecological assessment, local recreation and access information, biodiversity and cultural assessment, opportunity or restoration costs, timing of impacts, and treatment of uncertainty.

6.3. Mining compared to conservation

This case study examines the potential interaction between mineral extraction and ecosystem services in an area with high conservation values.

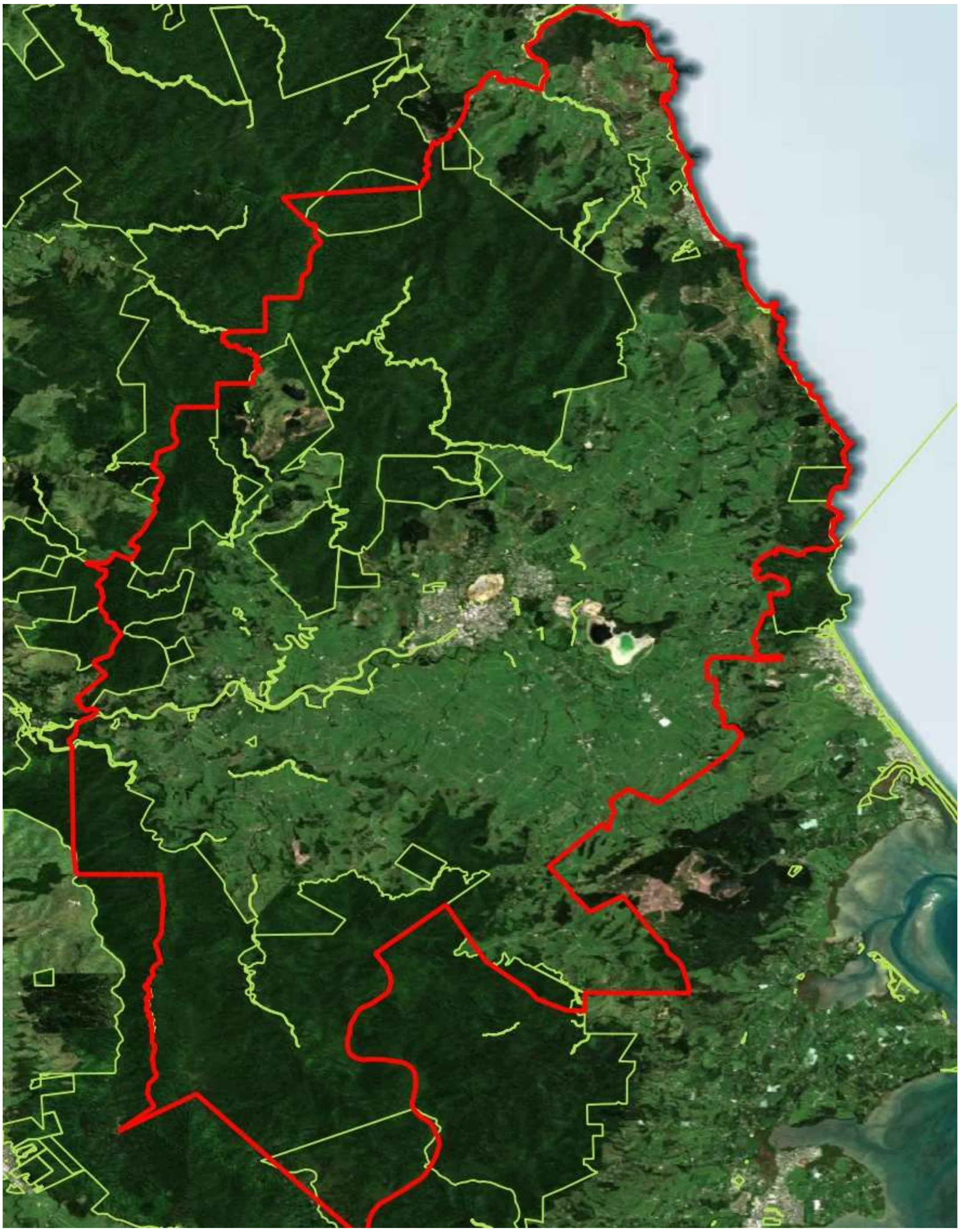
Figure 6: The Martha open pit at Waihi

6.3.1. Site selection

The Waihi gold mine was selected because it provides an example of a resource extraction proposal occurring near, and partly beneath, land with recognised conservation values. It is also a current policy-relevant example, given recent fast-track approval processes for mining and related infrastructure.

For this rapid assessment, the Waihi Statistical Area 3 (SA3) published by Stats NZ is used to define the area of interest. This provides a consistent spatial unit for summarising the ecosystem service layers, although it does not correspond exactly to the project footprint or the full ecological area of influence. Figure 7 shows that a large proportion of the Waihi SA3 is covered by protected areas. The proposed Wharekirauponga underground mine would extend beneath parts of this protected conservation land, highlighting the close spatial relationship between mining operations and conservation land.

Figure 7: Waihi SA3 case study area (red outline) and protected areas (green outline)



A comprehensive ecosystem service assessment would require detailed spatial information on the expected effects of each mining activity. Relevant impact pathways could include:

- direct surface disturbance from drill pads, shaft sites, camps, helipads, access tracks and surface infrastructure.
- potential effects on the forest park above the underground mine, particularly where groundwater, wetlands, biodiversity, cultural values and non-use values may be affected.
- downstream hydrological effects on streams, wetlands and receiving environments from groundwater drawdown, water diversion, sediment generation or discharge.
- effects on recreation, landscape amenity, noise, visual character and sense of place.

This level of information is not available for the present case study. The analysis therefore does not estimate the actual ecosystem service losses caused by mining. Instead, it presents the current modelled ecosystem service values within the selected area as an indication of the non-extractive values that may be exposed to risk from mining expansion. The results should be interpreted as a screening-level assessment of ecosystem service exposure, rather than an impact assessment.

6.3.2. Results

The following figures show regulating and cultural ecosystem service values overlaid on satellite imagery of Waihi. They illustrate substantial variation in service values, including within areas that share the same land-cover class.

Regulating services, such as erosion control and nutrient regulation, are shaped by local topography, landcover and hydrological connectivity. Cultural service values show a different spatial pattern. Some values are concentrated around urban greenspace, streams and accessible recreation areas, while values associated with conservation land are distributed across a much larger area. As a result, these values may appear lower on a per-hectare basis even though the total value of the conservation area is substantial.

Figure 8: Waihi SA3 (red outline) overlaid with regulating ecosystem service values per hectare

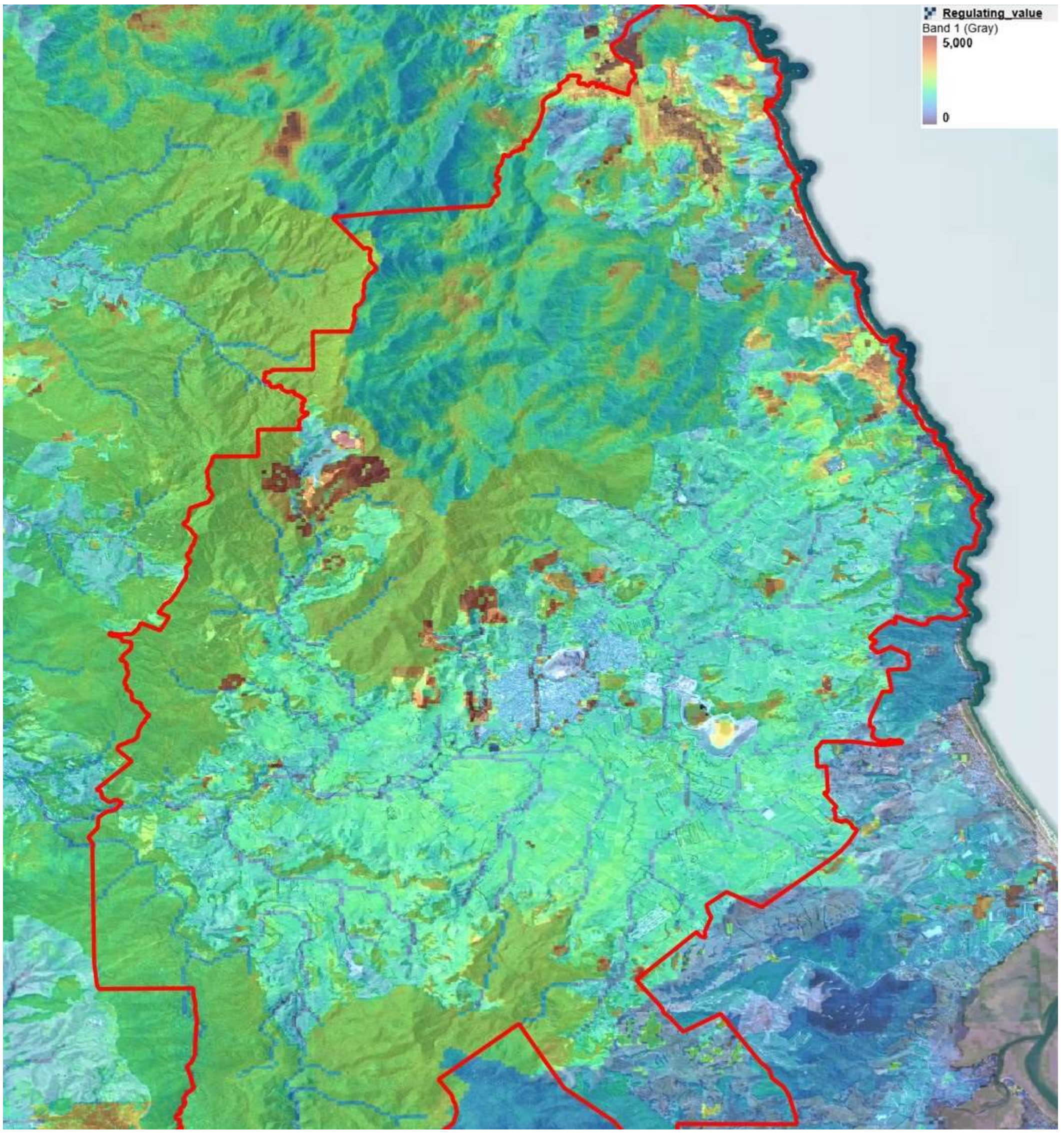
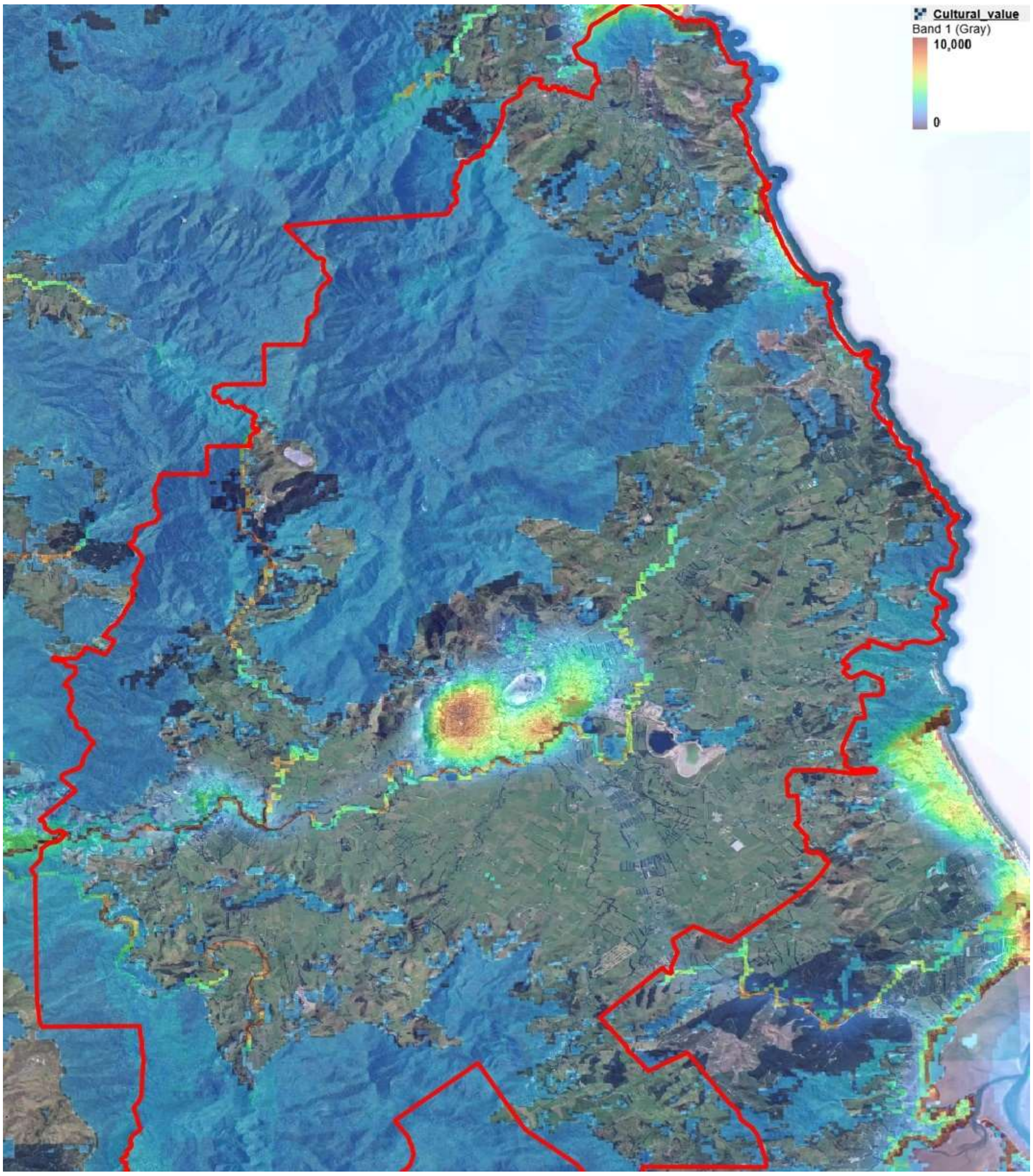


Figure 9: Waihi SA3 (red outline) overlaid with cultural ecosystem service values per hectare



Within the Waihi area, ecosystem service values are summed across all land identified as protected area by Land Information New Zealand. This protected area covers 15,506 hectares and is almost entirely conservation area (with a small area of local purpose reserve). The following table Table 15 reports total annual values for each monetised service, including central, low and high sensitivity estimates. Across all services, the estimated annual value ranges from $24 million to $134 million, with a central estimate of $72 million. Cultural services account for approximately half of this value, while regulating services account for just under half.

Table 15: Ecosystem services on conservation land in Waihi SA3 area (2026 NZD/year)

Category	Service	Central Total ($/year)	Low Total ($/year)	High Total ($/year)
Cultural	Aesthetic	1,201,862	868,499	10,246,534
	Recreation - hunting	457,376	358,498	554,037
	Terrestrial biodiversity	26,984,960	2,346,518	49,863,513
	Marine biodiversity	4	1	10
	Recreation - coastal	2,320,516	1,042,618	6,456,185

	Recreation – freshwater other	581,783	278,600	778,442
	Recreation - freshwater fishing	191,590	124,534	217,934
	Recreation - marine boating	4,220	3,165	5,299
	Recreation - mountain biking	0	0	0
	Recreation - short walk	1,490,956	1,192,765	2,146,977
	Recreation - tramping	2,668,930	320,272	5,017,589
Cultural Total		35,902,199	6,535,471	75,286,520
Provisioning	Aquaculture	0	0	0
	Biochemical	92,193	73,754	112,475
	Crops	60,000	25,951	94,049
	Firewood	533,124	285,602	742,566
	Fodder	103,477	59,761	148,123
	Wild seafood	328	226	409
	Timber	16,244	11,357	24,245
	Freshwater	66,254	54,660	182,199
Provisioning Total		871,619	511,310	1,304,067
Regulating	Air quality	15,827,277	6,192,205	24,744,053
	Global climate regulation - blue carbon	229	164	292
	Coastal storm surge	25	6	98
	Erosion regulation	105	21	185
	Fluvial and pluvial flood regulation	4,996,588	2,498,294	7,494,882
	Global climate regulation – forest carbon	292,962	210,048	373,112
	Local climate	60	48	91
	Nutrient regulation	177,980	143,833	210,806
	Pollination	333	250	500
	Waste assimilation	8,818	5,511	13,227
	Water purification	148,533	78,175	291,854
	Water regulation	13,371,906	8,023,144	23,935,712
	Water treatment in wetlands	0	0	0
Regulating Total		34,824,816	17,151,700	57,064,812
Grand Total		71,598,634	24,198,480	133,655,399

6.3.1. Applications in assessment

The ecosystem service values presented here could be used within a cost-benefit analysis as an estimate of the non-market benefits currently generated by conservation land in the area. If a mining proposal were expected to reduce the provision of ecosystem services through land disturbance, changes in hydrology, impacts on biodiversity, reduced recreational opportunities, or other pathways, the estimated change in ecosystem service values could be treated as a cost of the project. These costs could then be compared against the economic benefits of mining, such as employment, royalties, export earnings and regional economic activity. In practice, a robust assessment would require information on the spatial extent, duration and magnitude of mining impacts, together with any mitigation, rehabilitation or offset measures. The ecosystem service values presented in this case study therefore represent the potential value at risk, rather than an estimate of actual losses resulting from mining.

6.3.2. Limitations

The ecosystem service layers provide a useful starting point for identifying and valuing the services that may be affected by a mining proposal, but they should not be relied upon in isolation. The layers estimate the current supply and value of ecosystem services under existing environmental conditions and do not predict how services will change in response to specific mining activities.

The example highlights some of the uncertainty involved in applying national-scale ecosystem service layers to small areas. For example, mountain biking benefits are estimated as zero because the input data do not identify a formal mountain bike park in the area. This does not necessarily mean that mountain biking does not occur; it means that this activity is not captured by the available spatial data. The example illustrates the importance of supplementing national input layers with local information where possible, particularly for activities that are informal, seasonal, or dependent on local knowledge.

Table 16: Relationship between this forest case study and the section 5.5 workflow

Workflow element	Mining case study
Decision context	Identifying non-extractive ecosystem service values on conservation land that could be exposed to mining-related impacts.
Assessment type	Screening-level value-at-risk assessment.
Counterfactual	Current conservation land extent, condition, and ecosystem service provision.
Change assessed	No specific change in ecosystem extent or condition is modelled. The case study identifies current ecosystem service values that may be at risk if mining or associated infrastructure affects the area.
Values estimated	Current annual ecosystem service flows associated with the relevant conservation land.
Key assumptions	Current mapped ecosystem service values provide a useful indication of non-extractive values that may warrant further investigation where mining is proposed.
Main simplifications	Does not model the footprint, timing, duration, reversibility, or intensity of mining impacts. Does not estimate changes in hydrology, biodiversity, recreation, landscape amenity, cultural values, access, or mitigation and offset outcomes.
Additional evidence needed for formal appraisal	Project-specific mine footprint, infrastructure layout, disturbance duration, rehabilitation assumptions, ecological and hydrological impact assessment, recreation and access impacts, cultural assessment, mitigation and offset design, opportunity costs, timing of effects, and treatment of uncertainty.

7. Key limitations and uncertainties

The ecosystem service layers provide a nationally consistent framework for identifying, mapping and valuing ecosystem services. However, the results should be interpreted with an understanding of the limitations and uncertainties inherent in the underlying data, modelling methods and valuation approaches. The layers are intended to provide structured, indicative estimates to support policy analysis and appraisal, rather than precise measures of ecosystem service value at every location.

7.1. Data and spatial limitations

The spatial layers are derived from a range of national datasets that vary in their accuracy, completeness and resolution. As a result, some local conditions may not be accurately represented. For example, land adjacent to Auckland airport runway is classified as urban parkland within the Land Cover Database (LCDB), despite being inaccessible and unsuitable for recreation. Similar classification issues may occur elsewhere and may affect the estimated supply or value of ecosystem services in particular locations.

These limitations are particularly relevant where ecosystem service provision depends on fine-scale site characteristics, such as access, land management, vegetation condition, hydrological connectivity, or the location of nearby beneficiaries. Users should therefore exercise caution when interpreting results for specific sites or small areas.

More generally, any limitations in the underlying datasets will flow through to the ecosystem service estimates and associated values. Practitioners are encouraged to familiarise themselves with the data sources, assumptions, and limitations relevant to the ecosystem services that are material to their analysis. These limitations are documented in the accompanying technical documentation to support informed and appropriate application of the values.

7.2. Modelling and valuation assumptions

The ecosystem service estimates depend on a range of modelling assumptions regarding ecosystem processes, service flows, beneficiaries and monetary valuation. These assumptions are necessary to produce nationally consistent outputs, but may not fully reflect local environmental conditions or site-specific circumstances.

Many of the monetary values are based on value transfer methods, whereby estimates derived from one location, study or context are applied to another. While this approach is widely used in ecosystem service assessment, the transferability of values may be limited where ecological conditions, beneficiary populations, cultural preferences or economic circumstances differ from those of the original studies.

Users should refer to the technical documentation for detailed information on the datasets, modelling methods, valuation approaches and assumptions used for each ecosystem service layer.

7.3. Temporal limitations

The ES layers are static in nature. They layers represent ecosystem service provision under current or recent conditions and generally do not account for future changes in land use, climate, ecosystem condition, population distribution or beneficiary demand. As a result, the estimated values may not reflect future ecosystem service flows.

This means the layers are most appropriate for understanding current spatial patterns and indicative values. Additional analysis may be required where the policy question involves long-term change, dynamic environmental responses, climate change impacts, or future development scenarios.

7.4. Treatment of uncertainty

To reflect uncertainty in the underlying evidence base, low, central and high value estimates are provided where possible. These sensitivity ranges illustrate the potential variation in results arising from different valuation assumptions. However, they do not capture all sources of uncertainty, including uncertainty in ecological processes, spatial data quality, future environmental change or the transferability of values between locations.

Accordingly, the results should be interpreted as indicative estimates rather than precise measures of ecosystem service value. They are most useful for identifying broad patterns, comparing relative magnitudes, and testing whether conclusions are robust to plausible changes in valuation assumptions.

7.5. Missing services

The layers represent a subset of ecosystem services for which suitable data and valuation information were available. A number of potentially important services are not currently included or monetised. The omission of a service from the monetised layers does not imply that the service has no value. In many cases, it reflects limitations in available data, valuation evidence, spatial modelling methods, or the suitability of monetary valuation.

Some ecosystem services included in CICES have not been monetised in the current layers because there is no well-established market in New Zealand, or insufficient information to estimate market values reliably. Examples include crops grown for fuel, textiles or medicinal use. Other services are difficult to represent at the spatial scale used in the national layers. For example, noise attenuation is highly localised and depends on the location of noise sources, intervening vegetation, topography and nearby receptors. Wind damage attenuation faces similar issues, as benefits depend on exposure, shelter effects, land use and the assets being protected.

Pest and disease control, corresponding to CICES categories 2.2.3.1 and 2.2.3.2, is another service that has not been monetised in the current layers. This service refers to the capacity of ecosystems to regulate pests and diseases, including through genetic variation in plants and animals that can reduce disease susceptibility, and through the actions of predators and parasites that suppress pest populations. There is emerging New Zealand evidence that native plantings and semi-natural habitats may support beneficial insects relevant to agricultural pest control. However, quantified evidence linking native vegetation to avoided pest damage, reduced disease incidence, or measurable yield gains does not appear to be available.

Several cultural services are also not monetised, including traditional knowledge, religious and spiritual values, heritage values, cultural harvest and other place-based relationships with the environment. These values are often highly context-specific and may not be appropriately represented using generic national monetary values. Their omission from the monetised layers does not imply that they are unimportant, only that they require different forms of evidence and assessment.

8. Future improvements

The ecosystem service layers developed for this project represent a substantial step towards more consistent incorporation of ecosystem services into policy analysis and economic appraisal in New Zealand. Nevertheless, ecosystem service assessment remains a rapidly evolving field, and a number of opportunities exist to improve future versions of the framework. The potential improvements identified below have been ranked according to their expected contribution to policy relevance, analytical robustness, and practical usefulness.

8.1. Higher priority improvements

Improve modelling of hydrological ecosystem service flows

The highest priority area for future development is improving the representation of hydrological processes that determine how water, sediment, nutrients and other contaminants move through the landscape. In the current framework, hydrological connectivity is represented only in a limited way. The InVEST-based layers include a simplified representation of surface flow pathways, while other water-related services are generally attributed across sea-draining catchments rather than routed through explicit upstream-downstream flow networks.

Future improvements should focus not only on estimating contaminant loads or sediment yield, but on attributing the generation, retention, transformation and delivery of those flows to specific ecosystems and land uses. Existing national layers that estimate outcomes such as sediment yield do not answer the necessary question: which ecosystems reduce, intercept or exacerbate downstream impacts, and who benefits from them?

Additional development could also account for the effects of low and high flows. Low flows can reduce dilution capacity, increase contaminant concentrations, constrain water availability and affect aquatic habitat. High flows can increase erosion, sediment mobilisation, nutrient transport and flood risk, while also shaping the delivery of water retention and flood attenuation services.

Strengthening the hydrological component of the framework would improve its ability to represent realised water-related benefits rather than broad catchment-level potential.

Technical Review and Refinement

A further area for improvement would be more systematic review of the ecosystem service layers by subject matter experts. Expert input was sought during the development of a number of services, helping to inform model selection, assumptions, datasets, and interpretation of results. However, the level of review varied across services and was not intended as a formal peer-review or endorsement process. Future work could involve more structured engagement with specialists for each ecosystem service to test key assumptions, assess the suitability of datasets, identify potential omissions, and evaluate alternative modelling approaches. This would help strengthen confidence in the results and support ongoing refinement of the ecosystem service layers.

Incorporate improved data as it becomes available

The layers should be periodically updated as improved national datasets become available. The current layers reflect the best information publicly available at the time of development, but substantial improvements are expected in several areas.

Examples include the national flood hazard mapping currently being developed for the Ministry for the Environment, which could improve flood mitigation and water regulation assessments. Similarly, advances in remote sensing and spatial analysis, such as Bioeconomy Science Institute's tree canopy mapping methods, could provide more accurate and up-to-date canopy information for services that depend on urban forests and tree cover.

Improvements may also be possible through the incorporation of regional and local datasets that could not be obtained or synthesized due to the time constraints of this project. Some councils hold valuable information on recreation use, visitor counts, park utilisation, flood modelling, ecological condition and other environmental indicators that could improve regional ecosystem service estimates.

Develop quantitative uncertainty measures

The current framework incorporates uncertainty through sensitivity analysis, documentation of assumptions, and the use of low, central and high valuation estimates. Future work could strengthen this approach by developing explicit spatial uncertainty measures.

Examples include confidence scores for individual layers, data quality indicators, valuation confidence ratings, and spatial uncertainty maps. These products would provide users with a clearer understanding of the reliability of individual estimates and improve the transparency and defensibility of the results.

8.2. Medium priority improvements

Expand the New Zealand valuation evidence base

Many cultural ecosystem service values continue to rely on benefit transfer because of the limited availability of New Zealand-specific valuation studies. Expanding the domestic evidence base would improve the accuracy, credibility and policy relevance of future valuations.

An addition that would be very useful for change analysis is the development of demand functions that link measurable ecosystem attributes to cultural benefits. For example, gather evidence on how features such as naturalness, vegetation type, water clarity, biodiversity, accessibility, landscape diversity and proximity to population centres affect recreation, aesthetic appreciation and other cultural values.

Future work should also improve the treatment of visual amenity. Viewshed modelling could be combined with empirical validation to test how visible ecosystem attributes influence aesthetic values, property values, recreation choices or stated preferences. This would help move beyond broad assumptions about scenic value and towards spatially explicit estimates of where visual benefits are likely to be greatest.

Better observed data on recreation behaviour would also be valuable. Information on where people actually visit, how often they visit, how far they travel, what activities they undertake, and how site characteristics influence their choices would improve estimates of realised cultural service flows. This could draw on visitor counts, mobility data, surveys, recreation platform data, or administrative datasets where appropriate.

Improve representation of ecosystem condition

Although the framework moves beyond simple land cover proxies in many areas, ecosystem condition remains an important determinant of service provision. Future versions could incorporate indicators such as vegetation condition, river ecological health, wetland condition, habitat quality and soil condition.

However, these indicators also need to be linked to realised benefits. Future work should therefore focus on how changes in condition affect ecosystem service flows and outcomes such as recreation quality, water treatment costs, flood risk, carbon sequestration, habitat availability and cultural values. This would make the framework more sensitive to degradation, restoration and management actions.

8.3. Longer-term development opportunities

Incorporate dynamic and scenario-based modelling

The current layers primarily represent ecosystem service provision under existing conditions. Future development could build on the source code used to derive the published layers so that alternative scenarios can be tested in a more automated and repeatable way.

This could take the form of a scenario explorer, allowing users to adjust key assumptions or input layers and assess how ecosystem service values change under alternative futures. Potential applications include land-use change scenarios, afforestation and restoration programmes, urban expansion, and alternative policy interventions. Future work could also improve the representation of how climate change may alter ecosystem condition, service provision, beneficiary exposure, and the value of ecosystem services over time.

Developing this capability would make the framework more useful for cost-benefit analysis, strategic planning and policy appraisal. It would also improve transparency by allowing scenario results to be generated from a consistent modelling workflow rather than through one-off manual adjustments.

Expand cultural ecosystem service assessment

Cultural ecosystem services remain among the most challenging services to quantify and value. Future work could focus on developing spatial indicators and assessment methods that better capture cultural, spiritual, heritage, and place-based values.

Given the limitations of monetary valuation for many cultural services, future development may benefit from complementary non-monetary approaches, including participatory mapping, cultural indicators, and place-based assessment methods. Such approaches may be particularly valuable for representing Māori relationships with land, water, and ecosystems.

Further alignment with ecosystem accounting

The framework has been designed to align closely with CICES and the System of Environmental-Economic Accounting (SEEA) Ecosystem Accounting framework. Future development could strengthen this alignment through the creation of ecosystem extent, condition, service flow, and ecosystem asset accounts.

This would support greater integration between ecosystem service assessment, natural capital accounting, and official environmental-economic statistics, while increasing the usefulness of the framework for long-term policy development and environmental reporting.

9. Conclusion

This report has outlined the purpose, scope, interpretation, and appropriate use of the ecosystem service spatial layers developed for Aotearoa New Zealand. It has covered the underlying assessment framework, including ecosystem services, natural capital, welfare economics, CICES and SEEA alignment, spatial interpretation, valuation methods, uncertainty, and practical use in policy analysis and cost-benefit analysis.

The project builds on a substantial body of previous work in New Zealand and internationally. The principal contribution of this project has been to integrate these diverse sources of knowledge into nationally consistent, spatially explicit set of realised flow values. The layers are a major step forward in spatial representation of ecosystem services, going from 9 service supply maps produced in 2013 to 32 ecosystem services maps covering the full cascade from supply to value. Spatial context is a critical determinant of value, as the benefits provided by an ecosystem depend not only on ecological conditions but also on the location, characteristics, and needs of beneficiaries.

The key message of this report is that ecosystem services make important contributions to human wellbeing and that these contributions can be represented in a nationally consistent, spatially explicit framework. The values should be interpreted as indicative annual ecosystem service flows, not as the total value of nature or natural capital, and are most useful for assessing marginal changes, comparing options, identifying trade-offs, and supporting transparent appraisal.

These layers can help make non-market benefits and costs more visible in decision-making, particularly where they might otherwise be omitted or treated as having zero value. The values should be interpreted as indicative annual ecosystem service flows, not as the total value of nature or natural capital. They are best used to assess marginal changes, compare options, identify trade-offs, and support transparent appraisal.

The framework represents a practical step toward more consistent environmental valuation, while recognising the uncertainty and judgement involved in combining ecological data, spatial modelling, and monetary values. Used carefully, the layers can support better decisions by ensuring the contribution of ecosystems to human wellbeing is recognised alongside other social and economic considerations.

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