

## Natural Capital Region: Quantifying the multiple benefits of natural resource management investment

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### Key Points

- Natural resource management investment planning is an impediment to achieving investment in nature repair because it is inconsistent, time consuming and has high transaction costs.
- Natural Capital Region presents a consistent currency for creating and comparing NRM investment portfolios within and across regions.
- Our approach uses regionally specific data to represent the current condition across 20 environmental and social measures.
- Our approach can be used to collate curated libraries of on-ground actions with the cost and effectiveness of those actions quantified.
- Our approach includes the consideration of negative actions and the valuing of conservation activities.

### Abstract

Natural resource management (NRM) on-ground actions typically have multiple outcomes across water quality, biodiversity, social, First Nations, economic, land resilience and climate change. However, we could not find examples where all these outcomes are quantified to allow the stacked benefits to be considered in investment portfolio planning.

We created the Natural Capital Region application which is applied at a regional level to develop portfolios of the most cost effective on-ground actions by quantifying the combined benefits of each potential on-ground action. Natural Capital Region quantifies the outcomes of potential on-ground actions for 20 indicators. Users define the investment outcome priorities across these indicators for each portfolio scenario. We have implemented the approach across six NRM regions covering ~1Mkm<sup>2</sup> (about four times the size of Victoria)

We have learned that a NRM region scale delivery approach allows high quality local data to be used, compared to state or national delivery scales. We also found that the range of potential on-ground actions across regions is finite. We have developed ~80 alternative on-ground actions. Most actions are shared by at least three regions. The collation of the science to represent the effectiveness of actions creates a knowledge resource that can be shared between NRM regions.

The approach allows the use of regionally specific environmental condition data, and on-ground cost and effectiveness data, whilst presenting investment outcomes using consistent high level reporting indicators. This allows for the use of consistent language across regions and investment portfolios. This provides a consistent and repeatable currency for quantifying and comparing investment programs.

### Keywords

Natural capital, natural resource management, prioritisation, reporting, nature restoration

## **Introduction**

Investing in on-ground projects for environmental improvement is always fraught with the problem of working out what is the most useful way to spend what is never enough money. The answer to this problem is some form of prioritisation, which historically has been variations of an expert driven qualitative assessment which often includes maps and crayons or a digital version thereof. The process is not ideal, it is also expensive and time consuming. Subsequent funding rounds typically have different priorities, which often initiates an entirely new prioritisation adventure.

We have been endeavouring to reduce the transaction costs associated with NRM investment planning and implementation through the creation of a suite of applications (Natural Capital Suite (Truui 2024)).

In breaking down the investment prioritisation process, we have found that there are a limited number of on-ground actions that can be implemented in a region. Further, there is a mostly fixed range of outcomes that those on-ground actions have an impact on. The prioritisation activity is essentially a process of filtering a fixed set of actions to give the best return on investment for the priorities of the funding round.

The basic premise of the Natural Capital Region approach is that there is a limit to the things we care about (outcomes), and there is a limit to the things we can do in terms of on-ground actions. Natural Capital Region is essentially a regional collection of all the on-ground actions that are likely to be done, and for each action, the impact of the action on all the outcomes is quantified. From this basic relationship it is possible to conduct endless prioritisation studies by varying the relative importance of the outcomes or by filtering the potential actions.

**Natural capital** is the stock of natural assets including soil, water, land, air, and all living things from which we derive environmental, economic, social and cultural value.

## **Selecting indicators**

For NRM investment, what outcomes do we care about? To answer this question, we have looked at international reporting frameworks; Kunming-Montreal Global Diversity Framework (GBF, 2023), The Taskforce for Nature Related Financial Disclosures (TNFD) (McKenzie, 2023), global Sustainable Development Goals (SDGs) (UN, 2015) and Environmental, Social, Governance framework (UN Global Compact, 2004). These international reporting frameworks provide high level indicators to report against. To determine what the underlying sub-indicators and the supporting measures we have looked to local reporting such as NRM regional plans (e.g. SQL 2022) and state based planning and environmental reporting (e.g. DAWE 2021).

We have adopted a hierarchical reporting approach whereby the highest level indicators are measures of outcomes that are used within with global reporting frameworks. Underlying those high-level outcomes are indicators which are an aggregation of science-based measures. This top-down approach is distinct from a science-discipline based approach where, depending on which scientist you ask, ultimately everything you can possibly measure (and plenty that you cannot) matters deeply and must be reported. The top-down approach provides a basis by which to select suitable and quantifiable measures. Perhaps investors don't have it right and are not focused on the most important things. If this is true, the reporting frameworks will be refined over time. Our task here is not to review the reporting frameworks to define what outcomes are important but to make them tractable by delivering pragmatic assessments of environmental and related services that match these indicators.

We have taken a pragmatic approach to developing the outcomes, indicators, and measures (Table 1) used to quantify and report the value of on-ground actions. Firstly, we have selected measures that can be reported against in a consistent way across broad spatial scales (ultimately nationally). Secondly, we have tried to limit autocorrelation by selecting measures that are largely independent of each other. Thirdly, we have implemented a simple aggregation approach that can scale to include locally relevant measures, whilst maintaining a fixed set of high-level indicators and outcomes.

**Table 1. Reporting framework**

Outcome	Indicator	Measure (can be regionally refined)
Environment	Biodiversity	Biodiversity, Threatened species
	Water	Sediment, Nitrogen, Phosphorus
	Soil	Soil health, Erosion
	Climate	CO <sub>2</sub> , Methane
Social	Equality	Employment diversity, Pay equity
	First Nations	Participation, On-country values
	Economic	Local economic
Governance	Accountability and transparency	Accountability, Transparency
Productivity	Profitability	Land use, Yield, Soil health, Product diversity
	Resilience	Water quality, Soil stability, Chemical runoff, Dryland salinity
	Reputation	Community standing, Industry standing

### Spatial scale

Natural Capital Region is implemented on a regional basis. The underlying spatial elements (planning units) are typically hydrologically defined sub-catchments and vary in size to give 20-40 planning units per regional implementation. The size of the planning units can vary dramatically between each regional implementation. Small regions typically consider implementation areas at a smaller scale and have higher resolution of underlying condition data to work with. Large regions, consider larger spatial units and have coarser resolution data with which to assess condition. There is also the human limitation to simultaneously consider many possible locations. We have found that consideration of more than about 40 regional locations becomes an intractable communication and logistical problem.

For each of the measures described above, the current condition is captured for each planning unit. The region-based approach allows the use of the best available data that has regional coverage for that measure, as opposed to being firmly fixed on national scale data.

### Actions

To determine what actions are possible. We have used NRM plans and historical investment programs plus workshops and meetings to curate regionalised libraries of actions. The range of actions varies region by region but we generally end with a list between 30 and 100 possible actions per region. These actions are rarely unique for a region (e.g. grazing land management practices apply anywhere there is cattle), but their impact may vary depending on local biophysical conditions.

For every action, we quantify the impact of that action on each of the underlying measures. Some of those impacts are indirect. For example, many actions impact on erosion processes, the erosion processes in turn have a quantifiable and consistent impact on water quality and land productivity measures. In this erosion process example, the action impact is defined in terms of its impact on erosion processes. The erosion process changes are then modelled by Natural Capital Region in terms of impact on water quality measures.

At this point we have a representation of the current condition across all measures a library of the possible on-ground actions and their effectiveness at impacting on the measures. We have also captured an estimate of the costs to implement each action within a region. Basic prioritisation of actions for a given investment portfolio can now be conducted based on the measures of importance for the investment. However, once prioritisation commences there are questions that quickly arise:

- How long will it take to achieve an outcome (temporal response)?
- How accurate are the predictions (confidence)?

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- How likely is it that anyone will implement these actions (adoption likelihood)?
- What about the continued clearing/urban expansion (negative actions)?
- How do we account for good land stewardship as opposed to nature repair (valuing conservation)?

We address each of these second order considerations below.

### Temporal Response

There is often a temporal trade-off between actions that achieve similar outcomes. Some actions are inexpensive but take a long time to achieve an outcome (e.g. remove stock and await natural regeneration) compared to more expensive actions with similar outcomes that are achieved much faster (e.g. active replanting, close monitoring and weed management). For each of the actions we have quantified the temporal response across all measures. The basic response period is set to 15 years and one of four alternative response trajectories are nominated (Figure 1).

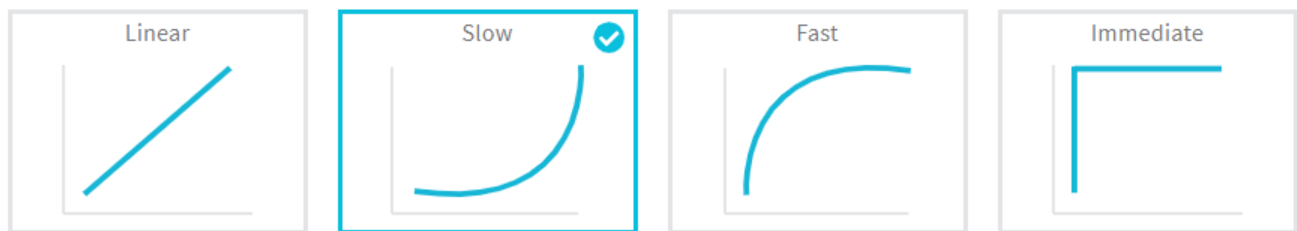


Figure 1: Response time for Actions

### Action Confidence

Some on-ground actions have been well studied, and their effectiveness can be predicted with a high confidence across some measures. However, many actions are experimental or their effectiveness against some measures have not been well quantified. Natural Capital Region uses a survey-based approach (Figure 2) to capture a confidence score that incorporates both epistemic and data error concepts. Data error is a simple concept relating to the underlying data used to estimate the effectiveness of an action on a measure. Data error quantifies the known unknowns. Data error is typically all that is considered where a numerical confidence interval is reported. However, this data error-based confidence interval approach is a disingenuous attempt at representing error because it does not consider the unknown unknowns (epistemic error). Epistemic error is the degree to which we understand the processes that we are attempting to quantify. For example, estimating the effectiveness of erosion control measures on social outcomes assumes processes of social/biophysical interaction that are mostly untested and rarely quantified. Natural Capital Region provides an overall confidence score by which action impacts are reported and can be filtered, or set as the basis for prioritisation in the creation of investment portfolios.

Calculate confidence score ★★★★★

How mature is the science

Emerging

How robust is the data

Limited quantitative data

What level of extrapolation (concepts, locations) is required

Data to support the science is limited, so there isn't much to extrapolate fr...

How directly does the data support the science

Limited - Data to support the science is limited

Figure 2: Effectiveness of action on each measure includes a confidence scoring system

### Adoption Likelihood

Most natural capital investment occurs on private land. The successful implementation of actions requires cooperation by landholders. Consequently, actions that provide a poorly compensated impost on land productivity have low adoption rates. Natural Capital Region includes the prediction of adoption likelihood, using the ADOPT approach (Kuehne et. Al. 2017), for each action.

### Negative Actions

Despite the excellent work of natural resource managers, there is expansion of degrading activities such as land clearing, weed infestation, feral animal infestation, and urban expansion that continues to degrade the natural environment. Historical modelling approaches adopt the naive assumption that the current condition will continue to be static, and only model improvement from this point. Natural Capital Region allows the inclusion of libraries of ‘negative actions’. This approach firstly allows the more realistic representation of a declining baseline condition under the ‘do nothing’ scenario (Figure 3). Secondly, it provides a basis to value actions that arrest further decline. For example, how would one predict the benefit of regulations to restrict further clearing without accounting for the decline in baseline condition that projected land clearing is likely to have?

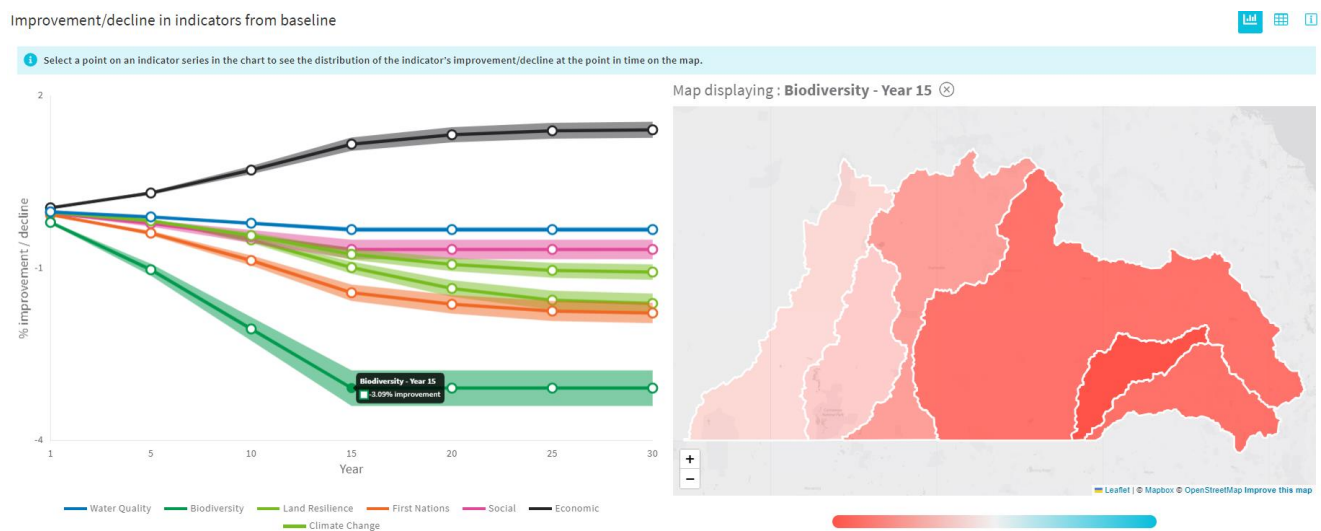


Figure 3: Negative Actions only considered

### Valuing Conservation

Most natural capital investment is focused on new work. Nature repair is the current fashionable catchall term for natural capital investment programs. The cost of repair is much higher than the cost of protection. A simple example to demonstrate this is that grazing (sheep and beef) activities generated \$27.30/ha of profit in 2022 (ABARES 2024). If you were to protect existing remnant vegetation that is being degraded through grazing by stock exclusion, then the opportunity cost is \$27.30/ha/yr. That is, if you paid graziers \$30/yr to exclude stock from areas of remnant vegetation, then the opportunity cost of this conservation activity is covered (apart from initial fencing). Under long term land stewardship arrangements, say 25 years, the opportunity cost is \$750/ha. Compare this to the nature repair activity of active restoration of previously cleared forest areas at \$8,500/ha (Mappin et.al., 2021). In this case the cost of conservation is approaching more than ten times the cost of repair. It is astounding that for the meagre investment in natural capital, the vast majority is spent trying to repair highly degraded environments while we watch the neighbouring high quality environment decline.

By including negative actions discussed above, Natural Capital Region intrinsically quantifies the value of conservation by including actions that conserve (restrict the negative actions).

## Prioritisation

Traditional prioritisation or optimisation approaches focus on a single objective function to give the best portfolio of actions for say one or two measures. They then repeat this across all the measures, and then could repeat the process again by also considering adoption and repeat it yet again to consider temporal response and repeat it again to consider confidence. The end result is a huge collection of equally good portfolios, from which investment planners must interpret and choose a desired portfolio. Natural Capital Region uses a different approach whereby the priorities for investment are set at the scenario definition stage and an objective function for the scenario is created *a priori*. The result of this approach is a single investment portfolio that matches the objectives of the investor across all the measures, adoption, confidence and temporal response requirements.

Natural Capital Region also includes scale opportunities as part of the prioritisation process. That is, it allows weighting toward planning unit areas (sub-catchments) where a lot of similar action opportunity exists thus to concentrate programs of works and take advantage of scale opportunities in program delivery.

## Output

Natural Capital Region is a web-based application developed with an instance for each region. Any number of organisations can have their own private ‘group’ for each instance. Each group has access to the curated base condition data and to the curated collection of actions and their effectiveness for the region. Groups can create their own ‘private’ action libraries. Users of a group can create and store any number of scenarios to predict the cost and effectiveness of different portfolios of investment. The outputs from Natural Capital Region are libraries of possible scenarios that can be shared amongst a group, explored through data visualisations and downloaded for further post processing (Figure 4).

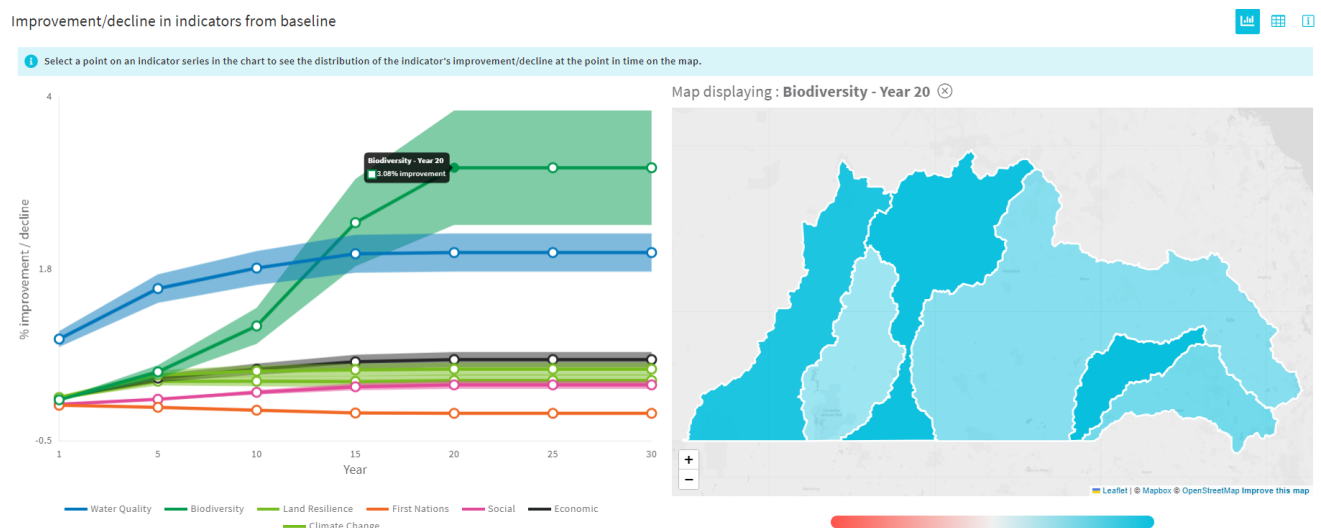


Figure 4: Interface to explore a scenario

## Implementation

We have been trialling the implementation of all the above concepts across different geographical regions. To date, Natural Capital Region has been implemented in six regions across (Figure 5) ~1Mkm<sup>2</sup> (about five times the size of Victoria). With each new region implementation we learn a little more and incorporate those findings in the platform to reinforce the collective approach.

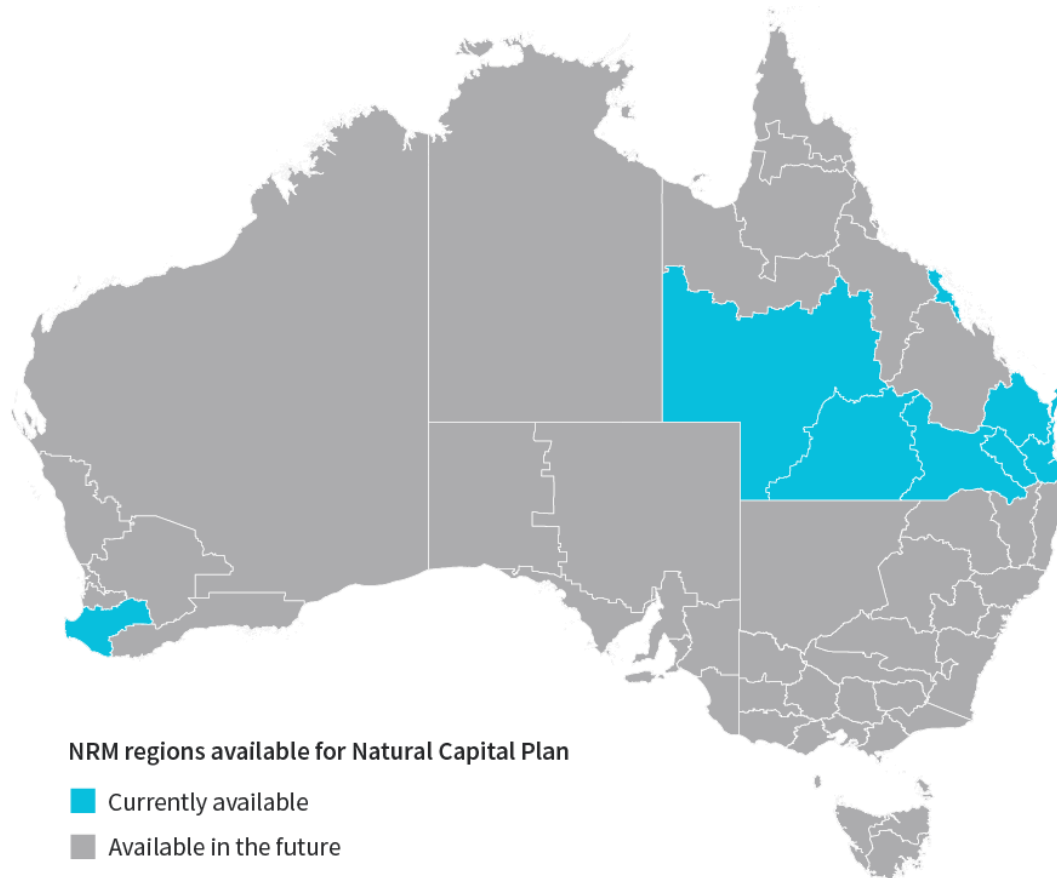


Figure 5: NRM regions where Natural Capital Region been trialled

## Conclusions

The goal of our work is to reduce the transaction costs for establishing natural capital investment programs. There are a fixed range of on-ground activities conducted for natural resource management, and there are a fixed range of outcomes that are the focus of these on-ground activities. What does change frequently is the relative importance of the outcomes. Last year water quality outcomes were the focus, this year it is carbon sequestration outcomes and next year it might be social and biodiversity outcomes. With each new priority comes a new investment prioritisation process. We have presented an approach that captures the fixed range of outcomes that we value and the fixed range of actions that we undertake to support those outcomes. Within this approach, the prioritisation can be refocused to suit the objectives of the day without re-prosecuting the entire outcomes-actions case.

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