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Smart allocation of restoration funds

Natural area managers are faced with the challenge of how to make public expenditure on restoration cost-effective, efficient and transparent. We are finding and testing new ways to improve decision making in restoration.

Over a quarter of Australia's native forest and woodlands have been cleared since European settlement, and vegetation restoration is urgently needed to avoid further loss of species and ecosystem services (such as clean air and water).

The Smart Allocation of Restoration Funds research program has developed new theory and methods to help land managers allocate restoration funds for vegetation recovery in a way that addresses aspirations to maximise return on investment. In this project, restoration ecologists and decision scientists have partnered with the Natural Area Management Unit (NAMU) from the City of Gold Coast, to make public expenditure on restoration more effective, efficient and transparent across approximately 800 conservation areas, covering over 12,000 hectares.

The work is to guide future management decisions about where to undertake restoration work in an environment where there are competing priorities and it is not possible to do everything at once. Importantly, these methods can also be scaled up and are transferable to other regions.

Points of difference

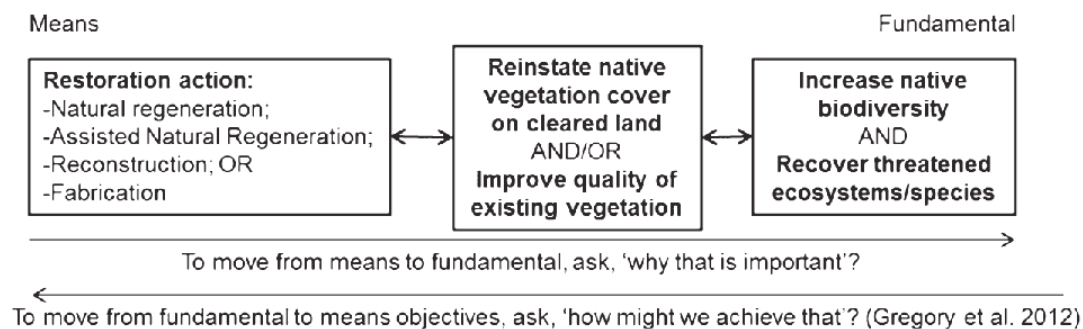
- We have developed a decision support tool that delivers a cost-effective 'roadmap' for investment in land restoration
- Forecasts outcomes of management strategies over long timeframes (well beyond usual planning timeframes)
- Addresses the question of how long it will take and how much it will cost to achieve specific restoration outcomes
- Reveals potential trade-offs in outcomes among alternative management strategies
- Accounts for changing cost of restoration projects over time and time delays between starting projects and realising on-ground outcomes

Identifying 'what matters'

A key part of the project development has been early engagement with natural area managers to scope and define the 'real world' problem and co-design the research through close dialogue between all members of the project team.

In 2015 the team successfully secured funding through ARC Linkage scheme to advance the research program with City of Gold Coast as the partner organisation and also involving Griffith University as a collaborating organisation.

A workshop, funded by the ARC Centre of Excellence for Environmental Decisions, was held in 2015. The workshop helped to create a shared understanding of the restoration problem and define a clear set of goals (fundamental objectives). These objectives were used to guide research questions and develop restoration solutions through the partnership (Guerrero et al. 2017, Figure 1).



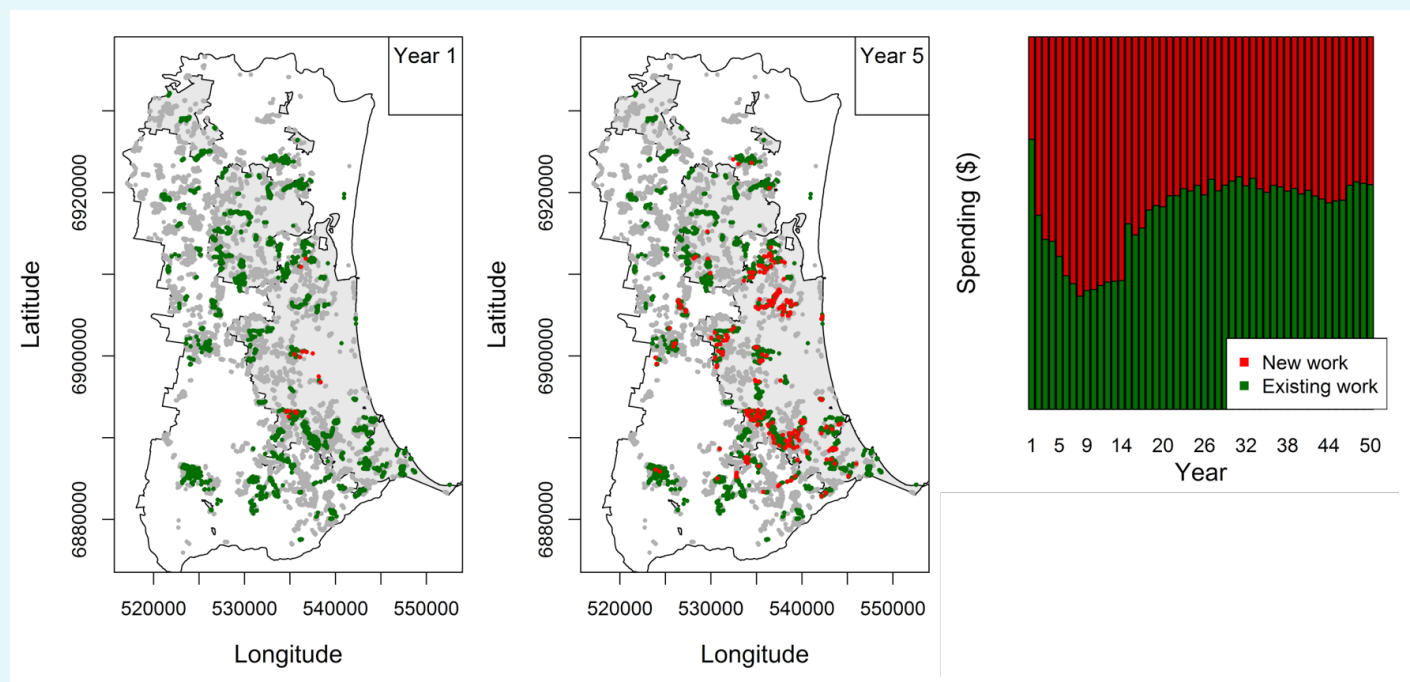
◀ **Figure 1.** Increasing native biodiversity and recovery of threatened ecosystems were identified as the most important (fundamental) objectives (reproduced from Guerrero et al. 2017).

A roadmap to get there

Our decision support tool provides a powerful platform to sift through all of the many possible combinations of restoration projects and find investment solutions that are most cost-effective for achieving goals (i.e. restoration road map).

Importantly, the purpose of the tool is to inform (not make) decisions. Goals still need

to be defined and final decisions made by natural area managers after considering additional social and ecological complexities and constraints. However, support to help find cost-effective solutions and knowledge of what can be achieved over a 20 or 50 year timeframe is a game changer and is extremely useful for improving decision-making.



▲ **Figure 2.** Restoration roadmap and spending for an example management scenario generated from the decision support tool. Left panel - map of restoration sites selected in year 1; middle panel - map of restoration sites selected in year 5 [grey circles = potential restoration sites; green circles = existing restoration work; red circles = new restoration work]. Right hand panel - Projected annual spending over a 50 year timeframe.

What is 'decision science'?

Decision science provides a framework to help people to allocate resources to solve problems in a way that is more objective and efficient.

Decision science is used in a diverse range of fields from medicine to engineering. A broad range of methods or tools can be used to solve problems. However, common among the various approaches is a disciplined protocol to problem solving that includes the following steps: specifying management objectives, listing management options, specifying variables that describe the state of the system, a conceptual model of the system being managed, specifying constraints and uncertainty, and finding solutions to the problem (Possingham et al. 2001).

The Centre of Excellence for Environmental Decisions (CEED) is a partnership between Australian and international universities and research organisations. We aim to be the world's leading research centre for solving environmental management problems and for evaluating the outcomes of actions.

For further information, see Decision Point, a free bi-monthly magazine on conservation decision science (decision-point.com.au).

Exploring 'what if' management scenarios and evaluating trade-offs

A valuable feature of the tool is that it requires goals to be clearly defined. Outcomes of 'what if' management scenarios can then be projected and explored. This allows us to answer basic questions such as how long will it take or how much will it cost to achieve specific outcomes (e.g. recovery of threatened ecosystems). We can also evaluate potential trade-offs in outcomes between management strategies.

For example, it is possible to compare the outcomes of a management strategy that prioritises increasing vegetation cover with a strategy that prioritises increasing high quality vegetation.

In our case, we show that over a 20 year timeframe, if you concentrate on increasing cover the trade-off is limited improvement in high quality vegetation. Conversely, if you concentrate on increasing high quality vegetation then the trade-off is limited improvement in cover.

Interestingly, the trade-off in outcomes between the two strategies diminishes over a longer 50 year timeframe if you first concentrate on increasing cover but persists if

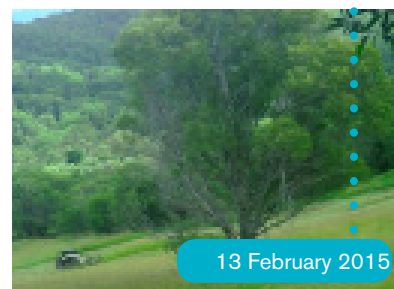
you first concentrate on increasing high quality vegetation.

Without a tool to explore these pathways it would be very difficult to understand the timeframes, total budgets required and the impact of our choices.

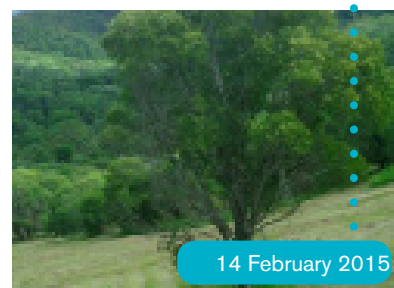
Other outcomes from the project

Steps have been completed as precursors to the restoration roadmap which are valuable in their own right. Some key examples include:

- new **planning units** defined so that they contain only a single vegetation group of a single quality level. The boundaries of planning units are fixed (stable through time) which enables investment, restoration work and outcomes to be tracked through time.
- new **baseline cost estimates for restoration** interventions for each combination of vegetation type and initial quality level that ensure our costs closely capture local operating procedures and constraints.
- developed a method to predict **deviation of actual costs from baseline costs** due to differences in spatial context and site conditions (e.g. due to longer travel times by vehicle and foot or reduction in work efficiency due to steep terrain)
- generated working estimates of **expected recovery timeframes** for each combination of vegetation type and initial quality level that allow us to project expected outcomes from investment over time. We have reduced complex forest succession to a series of time discrete and mathematically tractable steps (e.g. analysis of field data shows that many work sites can achieve minimal maintenance after 5 years with a corresponding reduction in the resources that a work site requires allowing resources to be allocated to a new site).
- automatic estimation of **investment required to honour commitments to pre-existing restoration** projects (i.e. how much and where to allocate resources).
- peer-reviewed **journal articles** (six published to date)
- **articles in industry newsletters** (e.g. Australian Association of Bush Regenerators newsletter, South-east Queensland Fire and Biodiversity Consortium newsletter, Decision Point) and ARC CEED funded research briefs (two to date). The research team has also co-presented the research with City of Gold Coast natural area managers at State and Local Government forums.



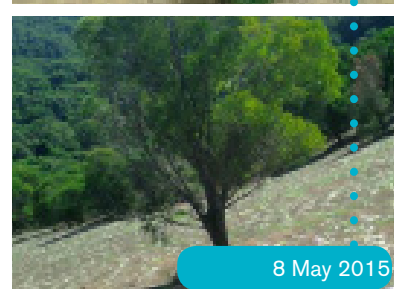
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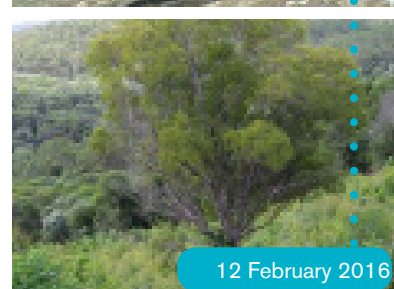
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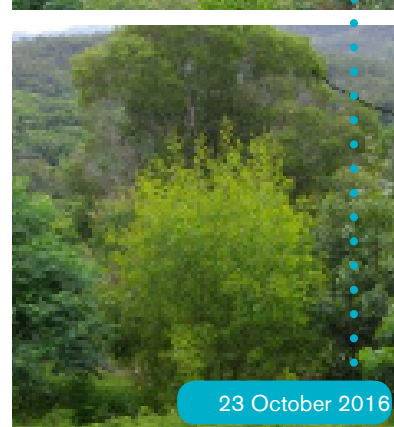
8 March 2015



8 May 2015



12 February 2016



23 October 2016

Reinstating native vegetation cover on cleared land over time, from (top to bottom) February 2015 to October 2016.



Education and training

The project has also generated important outcomes for training and communication. Some key outcomes include:

- ➔ research training for students: 3 honours, 1 masters (CoGC staff member) and 1 PhD.
- ➔ field training for NAMU outdoor teams on rapid monitoring of vegetation condition.
- ➔ in 2016 the project team showcased restoration work at Numinbah Conservation Area through the Society of Ecological Restoration Australasia becoming finalists in the Inaugural SERA Awards for Restoration Excellence (2016 SERA conference, New Zealand) (<http://www.seraustralasia.com/pages/SERAawards.html>).

Benefits of collaboration

Realistically, a complete measure of the strategic benefit of this project will take time to emerge. Importantly, we have co-developed a tool to guide future management decisions that will help to make on-ground work more effective and efficient. The next phase of implementation will reveal the extent to which achievements of restoration objectives has been increased and accelerated.

However, we can already identify some important benefits that are worth acknowledging. Examples include:

- **enhanced organisational profiles** of both CoGC and partnering universities (UQ and GU) as leaders in research-industry innovation through high profile awards, joint conference presentations and publications.
- the project has encouraged **clear articulation of objectives, creative thinking** about alternative futures and **informal transfer of knowledge** (social learning)
- provided quantitative **assessment of long-term outcomes** of alternative management strategies including satisfying key priority actions in Our Natural City Strategy.
- **explored trade-offs** between two management strategies that prioritise either cover or quality of vegetation
- the process of developing new region-specific cost estimates for restoration interventions has helped NAMU **gain efficiencies and savings** in tendering processes and procurement systems.
- we have provided strong **supportive evidence** for the ecological benefits of assisted regeneration widely used by NAMU (and bush regenerators more broadly) as a low cost approach to accelerate forest recovery (Uebel et al. 2017).
- the project has met the broader **objectives of the Australian Research Council** Linkage Projects scheme. The project has (i) supported the initiation and/or development of long-term strategic research alliances between higher education organisations and other organisations; (ii) provided opportunities for researchers to pursue internationally competitive research in collaboration with organisations outside the higher education sector; (iii) encouraged growth of a national pool of world-class researchers to meet the needs of the broader Australian innovation system. ●

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