# Biodiversity Benefits Project – Phase 3

# Mapping of Vegetation Enhancement Activities

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**A report to the Australian Government, Department of the Environment and Heritage**

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# Executive Summary

The Biodiversity Benefits Phase 3 project has mapped 216,379 hectares of on-ground vegetation enhancement activities across six case studies at 691 individual sites. Data from the project allows stakeholders to apply the Biodiversity Benefits Framework to asses the effectiveness of their on-ground activities by utilising existing landscape scale data. Mapping has occurred over a variety of landscapes from fragmented agricultural landscapes in the south-east of Australia, rainforest communities in the Wet Tropics and rangelands in Western Australia. In addition to primary data collection, the project has also resulted in the development of mapping and attribute data collection protocols and tools to enable NRM groups to map and inventory their on-ground activities.

Tools developed include the BioAudit relational database management system for managing and analysing on-ground vegetation enhancement data and the FieldAudit handheld computing system linked to a GPS which allows field mappers to rapidly collect data in the BioAudit system. The report evaluates the ease of data capture and notes that the primary challenge in collecting biodiversity benefits information is to obtain historical data regarding vegetation enhancement inputs (e.g. quantity of seed, provenance) and outputs (e.g. survival rates). Via the case studies, the project has identified issues confronting NRM groups who wish to collect biodiversity benefits data to support their planning activities. These include the following:

- Collecting data to Biodiversity Benefits minimum specifications requires a high level of skill and resources and may be best coordinated by regional bodies who routinely maintain this technical capability (approximately $25,000 for 100 enhancement polygons);
- Although the initial cost to conduct baseline mapping is high, ongoing maintenance and addition of sites to a district database is expected to be cost effective and could be done by regional groups if suitable IT systems are in place;
- Utilising private contractors was the most efficient mechanism for data acquisition for a large project such as this;
- There is a need to develop more rigorous methods and guidelines for the assessment of vegetation enhancement inputs and outputs (e.g. volume of seed, number of plantings, survival rates);
- Ensuring standard mapping protocols are enforced is critical to enable inter and intra site comparison, ongoing monitoring, and with some flexibility built into the system to allow for regional requirements (e.g. new vegetation condition scoring methods);
- To operationalise the BioAudit approach, there is a requirement for improved IT systems based on BioAudit designs which allow stakeholders to collect, manage and analyse their own data using centralised WWW-based tools and databases; and
- The current use of extant vegetation mapping does not adequately address issues of scale and accuracy and this requires urgent attention if this critical data are to be used to support monitoring and evaluation. Map producers must assess map accuracies and communicate outcomes to decision-makers to ensure that scale and accuracy assumptions are made explicit.

It is unrealistic to expect the widespread national mapping of past on-ground vegetation enhancement activities to Biodiversity Benefits specifications. We recommend that mapping tools and protocols be made available to NRM groups to enable them to conduct their own mapping utilising national standards. We also recommend the mapping of a larger number of study sites to act as long-term monitoring sites to assess the biodiversity benefits of vegetation enhancement activities. In addition to collecting data, this would also include conducting a more detailed biodiversity benefits assessment. A scaleable sample of study sites would allow for inter-study site comparisons of the effectiveness of on-ground activities. This may in-turn facilitate the adoption of adaptive management approaches to improve the biodiversity outcomes of future on-ground vegetation enhancement activities.

# Introduction

In January 2002, the NRMMC Land Water and Biodiversity Advisory Committee (now the Natural Resource Programs and Policy Committee) agreed to undertake an assessment of the biodiversity benefits of revegetation and vegetation rehabilitation and protection programs, including an analysis of the most effective program interventions to deliver biodiversity outcomes. The Committee established a Task Group to complete the assessment, and CSIRO Sustainable Ecosystems was commissioned to undertake the work. CSIRO developed a four step framework (http://www.deh.gov.au/land/vegetation/benefits/index.html Last Accessed September 21, 2006), but were unable to determine the benefits of NHT-funded vegetation enhancement activities as few on-ground projects recorded the necessary information, such as the precise location of their work. Under Phase 2 of the project, CSIRO used the four-step framework to assess the biodiversity benefits of vegetation enhancement activities and applied it to seven case studies of varying size and with various levels of data completeness (http://www.deh.gov.au/land/vegetation/benefits/index.html Last accessed September 21 2006). The framework is designed to assist in the design of new projects, or to design and implement monitoring procedures to assess the biodiversity benefits of past on-ground works. An objective of the framework was to determine whether the Commonwealth's investment in vegetation enhancement activities leads to an improvement in indicators of biodiversity, and how the Commonwealth should best invest to achieve the greatest biodiversity benefits.

A component of this framework was the use of spatial information to conduct a Biodiversity Benefits assessment at the landscape scale. The framework observed that 'It is impossible to assess the potential benefits of vegetation enhancement without a well-constructed GIS that includes mapping vegetation enhancement activities'. Step 3 of the framework recommends the use of mapped on-ground works to calculate landscape attributes of biodiversity including: increases in total woody cover, changes in vegetation patch size, changes in isolation of patches, the proportion of remnant vegetation protected by fencing and where possible, the type of vegetation. However, in order to calculate these landscape attributes effectively and to ensure results are comparable across study areas, some fundamental spatial and attribute data requirements emerged. Consequently, the following recommendations emerged from the study:

- Mapping of on-ground works should be incorporated into every natural resource management project that receives substantial (>$100,000) public investment;
- Mapping should be incorporated into a spatial database that adequately describes the purpose and inputs invested in each mapped polygon;
- Ready access to digital data layers for vegetation extent, composition, conservation status and habitat quality is needed at a finer scale; and
- The potential biodiversity value of mapped on-ground works ought to be assessed against regional targets and against the likely benefits expected from changed landscape configurations and management. Those people most closely associated with a mapped project area should conduct this assessment.

These recommendations have led to the establishment of the Biodiversity Benefits Phase 3 project titled 'Mapping of Vegetation Enhancement Activities'. The project is a collaborative research initiative between CSIRO, DEH and case study stakeholders. The project aims to develop methods and protocols for cost effectively and accurately mapping existing vegetation enhancement activities, and to operationally test the methodology for six national case studies. The protocols focus on both spatial data acquisition, and aspatial (attribute) data acquisition and management. The outcomes from this project are expected to make an important contribution to national NRM monitoring and evaluation frameworks by developing tested processes for capturing information on existing vegetation enhancement activities. This data can be used for assessing the baseline status of enhancement activities, for future planning and for ongoing monitoring of biodiversity outcomes. In this report it is stressed that an essential feature of effective reporting and evaluation systems is the use of well structured databases to enable comparison between case studies, and through time for individual study sites. Consequently one project output is a well structured GIS and attribute database which meets minimum data specifications for six national case studies. The objectives for the Biodiversity Benefits Phase 3 project include the following:

- More efficient assessment of the biodiversity benefits of investment in vegetation works, via the use of appropriate spatial information;
- Improved approaches and tools for monitoring vegetation enhancement activities, through implementation of the Biodiversity Benefits Framework;

Expected project tasks include the following:

- Develop design advice on how to select a nationally representative sample of on-ground works to be mapped. The project should examine a sample of Australian Government funded vegetation enhancement projects under Bushcare 1, Bushcare 2, Save the Bush, One Billion Trees program, and include both past and current projects. Implement the sampling design to select suitable case studies of vegetation enhancement works;
- Develop protocol and recommendations for the most cost-effective mechanisms for collecting as much data on these projects as possible within the allocated funding and timing constraints;
- Consult with States and regional bodies and promote their cooperation and collaboration in the project (possibly through previous members of the Biodiversity Benefits Task Force, ESCAVI or the Monitoring and Evaluation Coordinating Committee);
- At the conclusion of the data collection, compile the spatial data into a database, in consultation with ERIN, to enable further analysis using the Biodiversity Benefits Framework
- Undertake preliminary analysis on the data;
- Testing applicability of Biodiversity Benefits Framework minimum data specifications,
- Building capacity of regions and project managers to map their on-ground works and assess the biodiversity benefits of their projects, and to set and measure progress against vegetation targets; and
- Demonstrate that enhanced dataset on projects which will enable improved analysis of the effectiveness of past projects and provide a more objective basis for making future investment decisions in vegetation enhancement.

## Project Justification

Why map on-ground vegetation enhancement activities? As this report will highlight, accurately mapping on-ground vegetation enhancement activities to Biodiversity Benefits Framework minimum specifications is a costly exercise. For example, mapping a case study of approximately 100 vegetation enhancement sites can cost in excess of $25,000. Justifying an investment in mapping of on-ground activities by either regional or local groups can be justified for a number of reasons including the following:

- **Development of monitoring programs**: Regional natural resource management agencies can use the data to develop monitoring programs to assess the effectiveness of their activities and to report against their targets. The mapped vegetation enhancement activities allows groups to stratify their monitoring program by factors such as age of the activity, size of the activity or according to regional risk factors such as neighbouring land uses or threats (e.g. salinity);
- **Assessing progress towards regional NRM targets**. Many catchment action plans specify spatially explicit targets for the enhancement of native vegetation. A target may be a percent increase in area or representativeness by area for a particular vegetation community;
- **Support vegetation mapping programs**: Given the relatively small size of vegetation enhancement activities, assessing this change from satellite imagery is difficult and hence individually mapping activities is the only way a region can assess whether they are on a trajectory which will meet targets;
- **Support vegetation restoration principles:** In addition to the NRM targets, regional NRM bodies prescribe other targets which are fundamentally spatial in nature. For instance, the establishment of corridors for improving the connectivity between parcels of land preserved for conservation, or corridors which are designed for enhancing the abundance of a specific species (see Bennett, Kimber and Ryan 2000). Indeed many of the fundamental principles for enhancing the value of vegetation at the landscape scale described by Bennett, Kimber and Ryan (2000, p.11) and Williams (2005 p. 103) require mapping of on-ground activities. Without detailed mapping of the current vegetation it is impossible to develop effective biodiversity plans;
- **Assess vegetation representativeness:** A key concern many agencies have is the need to more effectively achieve vegetation enhancement targets which improve the representativenes of threatened ecological communities. Data such as that captured in this project allows managers to assess existing species composition relative to pre-cleared status, and allows them to adaptively assess whether they are achieving an improvement in

representativeness (e.g. use of Birds Australia bird atlas data in the Gascoyne-Murchison or contextual EVC mapping in NE Victoria);

- **Adaptive management:** From an adaptive management perspective, Biodiversity Benefits Framework data allows individual groups (e.g. Landcare groups) to assess the success of their activities relative to neighbouring communities. Cost-benefit assessments which compare fencing and revegetation activities, survival rates of specific species, improvements in understorey composition from different treatments, can all be conducted with such data;
- **Assessing risk:** Having accurate maps of vegetation enhancement activities allows managers to more effectively integrate spatially explicit threat mapping. For instance, salinity outbreak mapping or regional stream condition data can be integrated into the planning process more effectively if represented spatially;
- **Project management and compliance:** There are compelling reasons for having mapped vegetation enhancement information to support project management and compliance requirements; and
- There are also a suite of other emerging reasons for mapping the investment in vegetation enhancement activities including the management of vegetation clearing offsets, for modelling future landscape scenarios (Wilson and Lowe, 2003), for providing information to national carbon accounting systems and for the continual update of existing large scale (1:100,000) vegetation maps to name only a few examples.

## Report Structure

This report documents the methods, outcomes and key findings from the Biodiversity Benefits Phase 3 project. The report firstly examines the site selection methodology which led to the choice of the six case study projects. The selection of suitable case studies was a challenging component of the project as it required the identification and engagement of case study projects according to prescriptive project criteria, and within specified time frames. Selecting these case studies to optimise across criteria including the spatial extent of the vegetation enhancement activities, geographical representativeness, stakeholder willingness to participate and ability to meet project timelines proved to be a major project challenge.

The report introduces the methods and protocols used to map on-ground vegetation enhancement activities. A more rigorous treatment of these methods is presented in Appendices A and B owing to their length, detail and to ensure they are self-contained to allow them to be provided to other users. The appendices document the development of methods for the rapid acquisition of spatial and attribute information to support ongoing monitoring and evaluation frameworks. They describe mapping protocols, standards and recommendations for mapping on-ground words using both field based GPS techniques and desktop mapping approaches utilising remotely sensed data. It pays particular attention to the development of the BioAudit relational database management system for managing and analysing vegetation enhancement data. BioAudit formalises the minimum data specifications reported in the Phase 2 report using entity-relationship data models. An associated development is the creation of the *FieldAudit* tool which is handheld computer software linked to a GPS to enable rapid field data acquisition and synchronisation with the main BioAudit database. The *FieldAudit* suite of tools are described in detail given their potential utility to regional bodies interested in mapping their on-ground activities.

The report then introduces each of the six case studies and provides some preliminary results based on data in the BioAudit database and contextual GIS data. As the primary focus of this research was the development and implementation of mapping methods and tools, the analysis phase is not as detailed as the Phase 2 report. However the BioAudit database contains a rich array of data which could be used to conduct a more detailed analysis for any of these case studies. The primary purpose of the analysis phase is to evaluate the utility of the BioAudit data model and mapping protocols.

The concluding discussions in the report examine key issues which have emerged from this study. For example, it examines the ease of data acquisition derived from a survey of stakeholders to assess the feasibility of collecting BioAudit data. Findings from this component of the project are likely to be useful if the methodology is operationalised in the future. The discussion also examines institutional issues which have provided challenges to the project including the need for extensive stakeholder engagement at various administrative levels. The report concludes with a suite of recommendations based on the mapping of six national case studies to the Biodiversity Benefits Framework minimum mapping specifications. It provides an appraisal regarding the feasibility of operationalising the mapping methodology to support national monitoring and evaluation imperatives. The report also examines the broader issues which need to be addressed before regional bodies or local groups can effectively conduct a Biodiversity Benefits assessment using the Biodiversity Benefits specifications and protocols.

In addition to documenting the methods for spatial and attribute data acquisition, the Appendices also document two other major components of this project. The first (Appendix C) is the need to better understand and appropriately apply landscape metrics to summarise the structural change which has occurred in a landscape from on-ground vegetation enhancement activities. There are a number of commonly used metrics which summarise the structural change in vegetation including total increase in area enhanced, proportional increases in vegetation, nearest neighbour distances and distances to core areas. However, some of these metrics, such as the nearest neighbour distance are scale dependent. We examine the issues associated with the use of landscape metrics have attempted to overcome limitations by developing a method which is more robust to scale and provides a more useful summary of the structural change from on-ground vegetation enhancement activities. This method is described in Appendix C and applied it to the Nullamanna case study to highlight its utility.

Appendix D examines the issue of vegetation mapping accuracy and its impact on a Biodiversity Benefits assessment. Mapping of native vegetation is a core requirement for such analyses and there has been found to be problems with the quality of existing mapping. Using the Border Rivers case study as an example the importance of detailed extant vegetation mapping to support monitoring and evaluation is examined and the discussion highlights how inaccurate mapping can lead to misleading assessments. The discussion provides some recommendations for practitioners to address limitations associated with the use of existing and future vegetation mapping products.

# Methods

## Data Collection and Analysis

There are two components to developing a database for inventorying, monitoring and assessing on-ground vegetation enhancement activities. They consist of a spatial database (GIS) and an attribute database. The spatial database records the spatial boundary of each activity while the attribute database stores the descriptive information (funding sources, inputs, survival rates, site photographs). Although these databases can be integrated, they represent two distinct phases of data acquisition, and commonly require two distinct databases as GIS tables are generally not efficient at storing complex attribute data. The development of the spatial database requires extensive use of GIS and associated technologies (GPS and remote sensing). The attribute database is normally managed using a relational database management system (RDMS). Owing to the level of detail required to describe the methodology, rules and protocols the mapping and attribute collection methodologies are documented in detail in Appendix A and Appendix B. By including them in the appendices, these methodologies can be self-contained for use by others independent of the primary report.

The attribute data component receives particular attention as the database technologies and protocols provide a useful template for storing and managing on-ground vegetation enhancement data for other study regions in Australia. The description of the protocol has been treated in detail to enable adoption of this approach by other agencies or organisations with an interest in collecting and managing data pertaining to on-ground vegetation enhancement activities. The results section for each case study provides additional methodological descriptions when these differ from the broader protocols. The methods component of this report describes the site selection methodology, it documents the mapping protocol (Appendix A) and discusses the attribute data acquisition and management system (Appendix B).

As this report focuses on the development of methodologies, standards and protocols for collecting Biodiversity Benefits data, the case study analysis component receives only limited attention. However, for each of the case studies preliminary results are provided to highlight what can be reported with such information. For a more detailed treatment of Biodiversity Benefits analyses options readers should refer to Freudenberger and Harvey (2003) and Freudenberger et al. (2004). The analysis techniques adopted in this study can be summarised as follows:

1. **Database Query and Reporting** – the BioAudit database is used to generate summary statistics and graphs reporting on various aspects of the study region's on-ground activities. This can include showing the temporal change in activities graphed by area of activity, enhancement activities shown by area, survival rates plotted as histograms or patch size histograms;
2. **Landscape Metrics** – creation of summary statistics which assess the spatial arrangement or pattern of vegetation enhancement activities in the landscape. These are generally presented pre and post the vegetation enhancement activity and can include measures of clustering,

connectivity and arrangement. Appendix D provides a more detailed treatment of the use of landscape metrics and also documents the development of new methods for summarising the spatial change in a landscape from on-ground vegetation enhancement activities; and

3. **Contextual Analysis** – analyses (primarily spatial) which includes the use of additional GIS data to examine the change which has occurred in a landscape. This may include incorporating additional vegetation mapping (e.g. EVC data in Victoria) to examine the complementarity of vegetation communities; creation of digital elevation models to examine how vegetation enhancement activities are distributed in the landscape; inclusion of land use data to examine the distribution of activities from the perspective of risk to ecological communities; and utilising other landscape-scale indicator data such as Birds Australia Bird Atlas data, or rangelands monitoring sites.

The appropriateness of each approach will vary from study region depending on the availability and quality of the data. Analysis techniques (1) and (2) can always be implemented if Biodiversity Benefits minimum data specifications have been met. The feasibility of conducting a contextual analysis will depend on the availability of supporting data. As the database query and reporting component is conceptually straightforward, Appendix C examines the use of landscape metrics in greater detail. The discussion examines a number of landscape metrics, discusses their limitations and presents a new approach which provides a technique for summarising structural change in landscapes from on-ground vegetation activities. Options for contextual analysis are discussed within the methods section of each case study as they vary depending on the availability of contextual data for each study area.

## Site Selection Methodology

The study site selection and stratification was conducted in collaboration with DEH. This phase consisted of two components including an initial ‘desktop’ stratification which utilised DEH databases, and a ‘liaison’ phase which involved discussions with possible stakeholders, NHT facilitators and potential contractors. The second phase was the most challenging component of the overall project as it attempted to engage potential study sites on the basis of technical and social criteria. For instance, the stakeholders in the study region needed to have the necessary historical awareness of vegetation enhancement activities to provide useful information, they needed to have the capacity to meet contractual obligations to the project, and an appreciation of the importance of baseline mapped data to support monitoring and evaluation.

Close attention was paid from the start of the project to liaison and collaboration with staff of regional NRM bodies, and State and Australian Government agencies. Brokering of relationships involved a combination of contact and liaison. This was aimed at ensuring ‘top-down’ support for ‘bottom-up’ action on case studies. At the ‘top’ level, contact was made:

- Initially with leaders of NRM joint teams in DEH and DAFF;
- Then (where relevant) the joint team member responsible for a region being considered for a case study; and
- Then the State-based Biodiversity Facilitator.

This degree of contact ensured that joint teams and key members of the Australian Government NRM Facilitator Network were aware of the conduct of the project and associated management arrangements. It also enabled the project to access detailed knowledge and informed views on potential case studies, conditions and key contacts at State and regional levels. Some of the joint team and Facilitator Network contacts were able to assist with promotion of the project to regional and local level staff and volunteers. Ensuing contacts at the regional and local levels varied widely. In some cases, contact was recommended with a Regional Facilitator/Coordinator based with a State Government agency. In other cases, direct and initial contact was appropriate with staff of regional NRM bodies at much the same time as with local project managers. Some regional staff and some local project managers also recommended that contact be made with a chairperson or higher level coordinator to ensure clear lines of communication and accountability as contractors were engaged for mapping of case studies. Some of the relationship brokering benefited from informal contact at events such as the National Conservation Incentives Forum in July 2005, which included a presentation on the project. Such events are part of the NRM knowledge management system and provide valuable opportunities for contact and engagement.

For the desktop phase, DEH developed a list of potential case studies based on information from the DEH Program Administrator database covering NHT1 investments. Regions which received less than $1 million in investment were excluded from the analysis to ensure that a sufficient number of vegetation enhancement activities had occurred in the region. The initial stratification was based on the size of the NRM investment and the population density in that region to favour regions which had received substantial investment and had relatively high population densities. The results of this stratification are provided in Table 1.

Table 1. Result of preliminary stratification from DEH databases. Regions were selected on the basis of the population density and the investment in activities (DEH priorities areas are denoted by an asterisk). Candidate regions which have emerged from the stratification and steering committee meeting are shown in bold.

| | **Population Density of Region** | | |
|---|---|---|---|
| **Investment in region -NHT1 biodiversity related programs 1996/97 to 2003/04** | **High**<br>> 100 persons per sq km<br>(urban, peri-urban) | **Medium**<br>1-100 persons per sq km.<br>(intensive land use) | **Low**<br><1 person per sq km .<br>(extensive land-use) |
| $5 million $ greater | [none] | *Northern Tas<br>*Goulburn-Broken, Vic<br>Southern Tas<br>South West, WA | ***Cape York, Qld**<br>Northern Territory<br>**Avon, WA** |
| $1 million to less than $5 million | *Mount Lofty Ranges and Greater Adelaide, SA<br>Sydney Metro.<br>South East Qld<br>Port Phillip & Westernport, Vic<br>Hawkesbury-Nepean, NSW<br>Swan, WA | *Lachlan, NSW<br>*Murray, NSW<br>*Murrumbidgee, NSW<br>*North Central, Vic<br>Hunter-Central Rivers, NSW<br>Northern Rivers, NSW<br>Burnett-Mary, Qld<br>**Wet Tropics, Qld**<br>MDB, SA<br>North West Tas<br>Corangamite, Vic<br>Glenelg-Hopkins, Vic<br>West Gippsland, Vic<br>South Coast, WA<br>Central West, NSW<br>Namoi, NSW<br>Southern Rivers, NSW<br>Border Rivers, Qld<br>Mackay Whitsunday, Qld<br>Northern and Yorke Agricultural, SA<br>South East, SA | Northern Agricultural, WA<br>*** North East, Vic**<br>*** Rangelands, WA**<br>Wimmera, Vic<br>**Border Rivers-Gwydir NSW**<br>Burdekin-Wet Tropics, Qld<br>Condamine, Qld<br>Desert Channels, Qld<br>Fitzroy, Qld<br>Maranoa-Balonne, Qld<br>**Kangaroo Island, SA**<br>Mallee, Vic |

The second phase of the site selection process involved a more detailed assessment of potential case studies by evaluating the availability of existing databases, opportunistic site selection where existing mapping capacity presently existed in a region, liaison with NHT facilitators and via input from the project steering committee. The opportunistic site selection coincided with DEH priority regions identified in the phase one stratification. The combination of the phase one coarse stratification, and second phase assessment resulted in the following list of possible study regions:

- Wet Tropics, Qld;
- Avon, WA;
- Border Rivers, Qld/NSW;
- Kangaroo Island, SA;
- North-East, Vic; and
- Rangelands, WA - Gascoyne-Murchison (rangelands case study).

To select a study site within these broad regions operational project criteria were developed and via stakeholder liaison a final selection of case studies was made. The criteria included the following:

- Has the region received significant NHT funding to support vegetation enhancement activities which can be mapped? (i.e. on-ground works);
- Has any prior mapping occurred for these enhancement activities?
- Have polygons been mapped?
- What attributes have been collected?
- Is there a strong community network (i.e. existence of champions) to support mapping activities (i.e. a philosophy which values the importance of monitoring, evaluation and mapping)?
- Is there existing capacity to conduct the mapping? For example, have Landcare officers already conducted some mapping using GIS/GPS? Have they used contractors or consultants to conduct this mapping and if so are these individuals available to conduct additional mapping?
- Would the collaborating region be agreeable to making their data available to DEH at the conclusion of the project or are there IP issues associated with any data capture?
- Balancing the operational imperatives such as IP, technical capacity, time constraints.

Based on these criteria the following case studies were selected: (1) Nullamanna Landcare Group (Border Rivers NSW), (2) Cudgewa and Tintaldra Landcare Groups (NE Victoria), (3) Wallatin Wildlife and Landcare Inc. (Avon WA), (4) Trees for the Evelyn and Atherton Tablelands Inc. (Wet Tropics Qld.), (5) Kangaroo Island Natural Resource Management Board (SA), and (6) Murchison River (Gascoyne-Murchison WA) (see Figure 1). The results section describes each of the case studies in more detail and the following section details the engagement and collaboration process. It is important to note that within any one NHT region, these case studies represents only a small sample of potential case studies which have received funding to conduct on-ground vegetation enhancement activities. They were selected as they satisfied the greatest number of study site selection criteria rather than because their on-ground activities were of a higher quality or a greater extent. The case studies are diverse in terms of their geography and ecology, the type of on-ground activities they have conducted and their spatial extent. As such they have provided the project a useful example of the range of mapping and database issues which are encountered if the protocols were to be expanded to other study sites or regions. Consequently the methods and guidelines will be robust for other national site assessments.

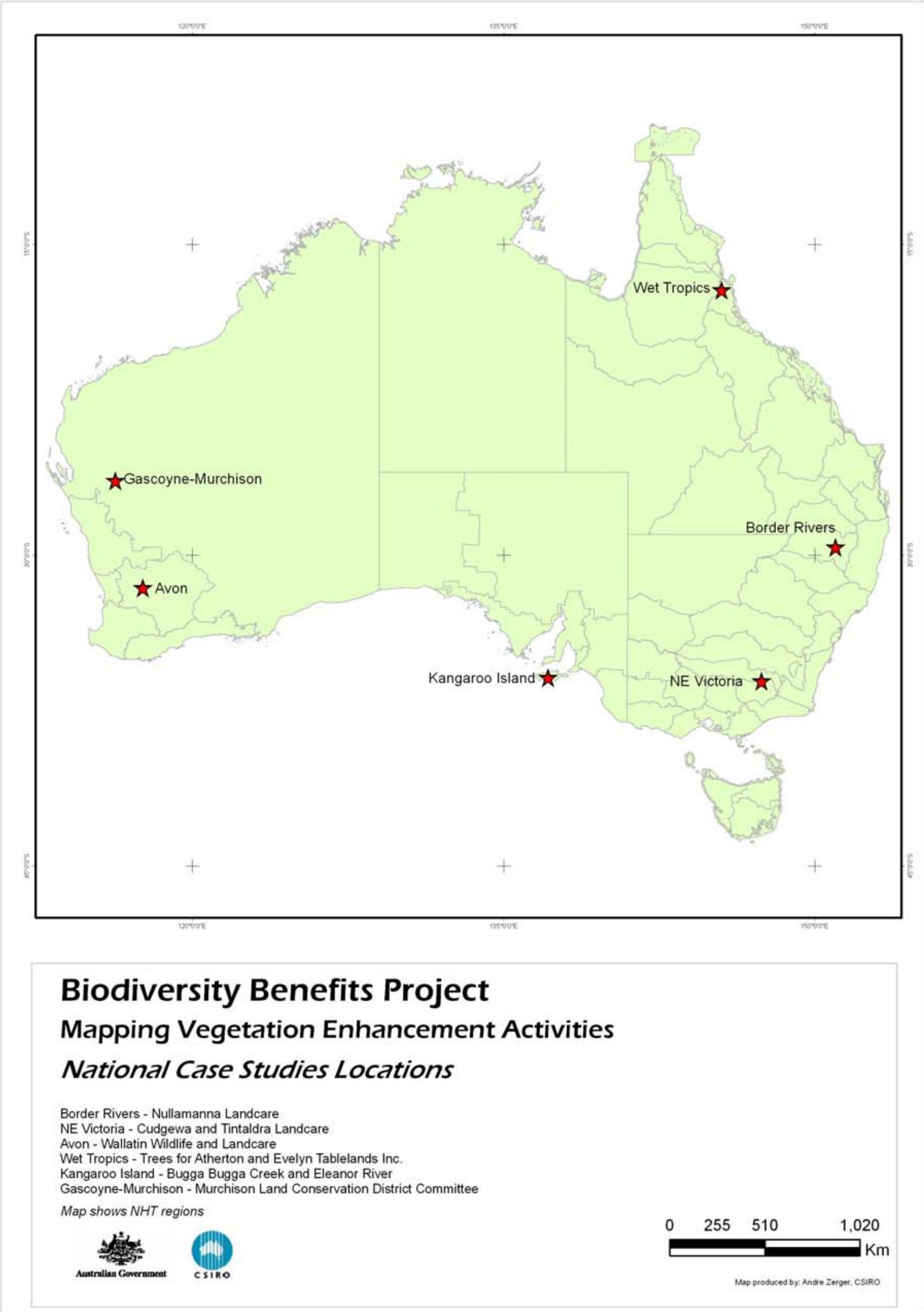


Figure 1. Location of six national Biodiversity Benefits Phase 3 case studies.