Photo: Peter Morris

Biodiversity Prioritisation and Biosequestration Modelling and Analysis for South Coast Natural Resource Management

A background paper for the Climate Adaptation Addendum to *Southern Prospects 2011 -2016.*
Prepared by Simon Neville/Ecotones & Associates for South Coast NRM.

SOUTHCOAST NATURAL RESOURCE MANAGEMENT

Australian Government

National Landcare Programme

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Kaylene Parker (SCNRM) organised the working group and workshops, and has provided project management throughout. Julian Neville (SCNRM) provided GIS support and dataset provision. Dr Paul Raper (DAFWA) carried out new analysis and provided land capability datasets, whilst Rod Safstrom (DAFWA) provided valuable assistance with the land capability component. Paul Gioia (DPaW) provided species records and advice on deriving interim species richness indicators, as well as endemism datasets. Deon Utber, Sarah Comer and Sarah Barrett (DPaW) took time out from busy schedules or holidays to attend working meetings. Karl Hansen, Penni Hewett, Justin Bellanger, Melanie Morcombe and Karen Ireland (SCNRM) attended numerous workshops/meetings and provided advice on the project. Louise Duxbury provided valuable facilitation assistance at the first (large) biodiversity workshop, and gave advice throughout the project.

Members of both Biodiversity and Land Reference groups provided massive input in workshops on the component classifications & weightings. The Biodiversity and Land Reference groups worked well to come to terms with the concepts and issues they faced.

Cover image
Biodiversity Prioritisation identifying high biodiversity areas in linkages without protection.

RFQ-NRMP-1213

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SCNRM MCAS Project Report FINAL.docx

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Abbreviations

ABARES........................... Australian Bureau of Agriculture and Resource Economics

CENRM .... Centre for Excellence in Natural Resource Management

CFI.................................. Carbon Farming Initiative

DEC .... Department of Environment and Conservation

DoW............................... Department of Water

DPAW .... Department of Parks and Wildlife

GIS .... Geographic Information System

MCAS-S........................... Multi-Criteria Analysis Shell

NACC.............................. Northern Agricultural Catchments Council

NCCARF.......................... National Climate Change Adaptation Research Facility

NRM............................... Natural Resource Management

PEC................................. Protected Ecological Community

SCNRM........................... South Coast Natural Resource Management

SWCC .... South West Catchment Council

TEC................................. Threatened Ecological Community

Executive Summary

South Coast NRM Inc. successfully received funding in 2013/14 as part of the Australian Government's Clean Energy Future program under the Land Sector Package (Stream 1). The project will update the existing regional NRM plan, *Southern Prospects 2011-2016* by incorporating current climate change information and scenarios.

One part of this project was the development and delivery of modelling and mapping of spatial products to support biodiversity prioritisation and climate planning for the South Coast NRM Region. This is the project reported on here: intended to guide the location and nature of biodiversity and revegetation activities to optimise the environmental, water and agricultural outcomes of adaptation and mitigation projects, and should take into consideration their socio-economic impacts.

This document provides the information required to meet the requirements of the Australian Government to update Regional Strategies to:

- Identify where tree plantings could fit into the landscape without causing adverse impacts.
- Provide clarity to Carbon Farming Initiative (CFI) proponents when considering whether their carbon emission abatement projects adhere to Regional NRM plans and do not have unintended impacts by taking into consideration priority agricultural land, hydrology and biodiversity.

The RFQ also makes it clear that the modelling needed to complete the Biodiversity Prioritisation process across the region. MCAS-S (the Multi Criteria Analysis Shell for Spatial Decision Support) was specified as the preferred modelling tool.

Specific outcomes from the process should include:

- High biodiversity conservation landscapes.
- High value agricultural productivity land.
- Low value agricultural land and degraded landscapes.
- Regional ecological linkages and connectivity.
- Identify areas for different types of revegetation (including higher biodiversity value plantings, single species plantation, and perennial pastures).
- Carbon sequestration exclusion zones.
- Locations for carbon sequestration activities in low biodiversity areas

The process for obtaining this information was to form a Technical Working Group and undertake a facilitated process using MCAS-S. Spatial data layers were sourced through State Agencies, CENRM and additional sources as required.

The project has involved five stages:

1. Component Planning
2. MCAS-S Model Setup
3. Internal Workshop of Pre-Draft Components
4. External Workshops for Draft Components
5. Creation of Final datasets & GIS project

The project deliverables were produced through MCAS-S processes which delivered nine major components (including map outputs), including:

Theme A – Identification of priority landscapes for (carbon) plantings

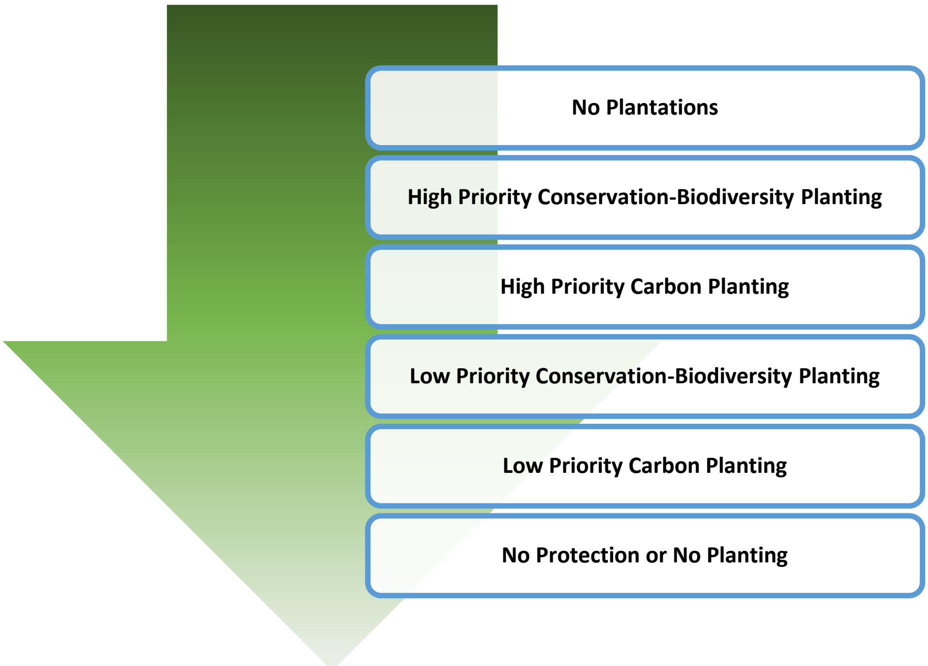
- Component A1 - Which landscapes need to be protected from plantings?
- Component A2 - Where would we encourage plantings?
- Component A3 – Where do we want plantings to enhance habitat corridors and protect high biodiversity areas? [Carbon plantings for conservation/biodiversity enhancement]
- Component A4 – Where are the priority planting areas? (from A1, A2 & A3)

Theme B – Identification of Biodiversity Priorities

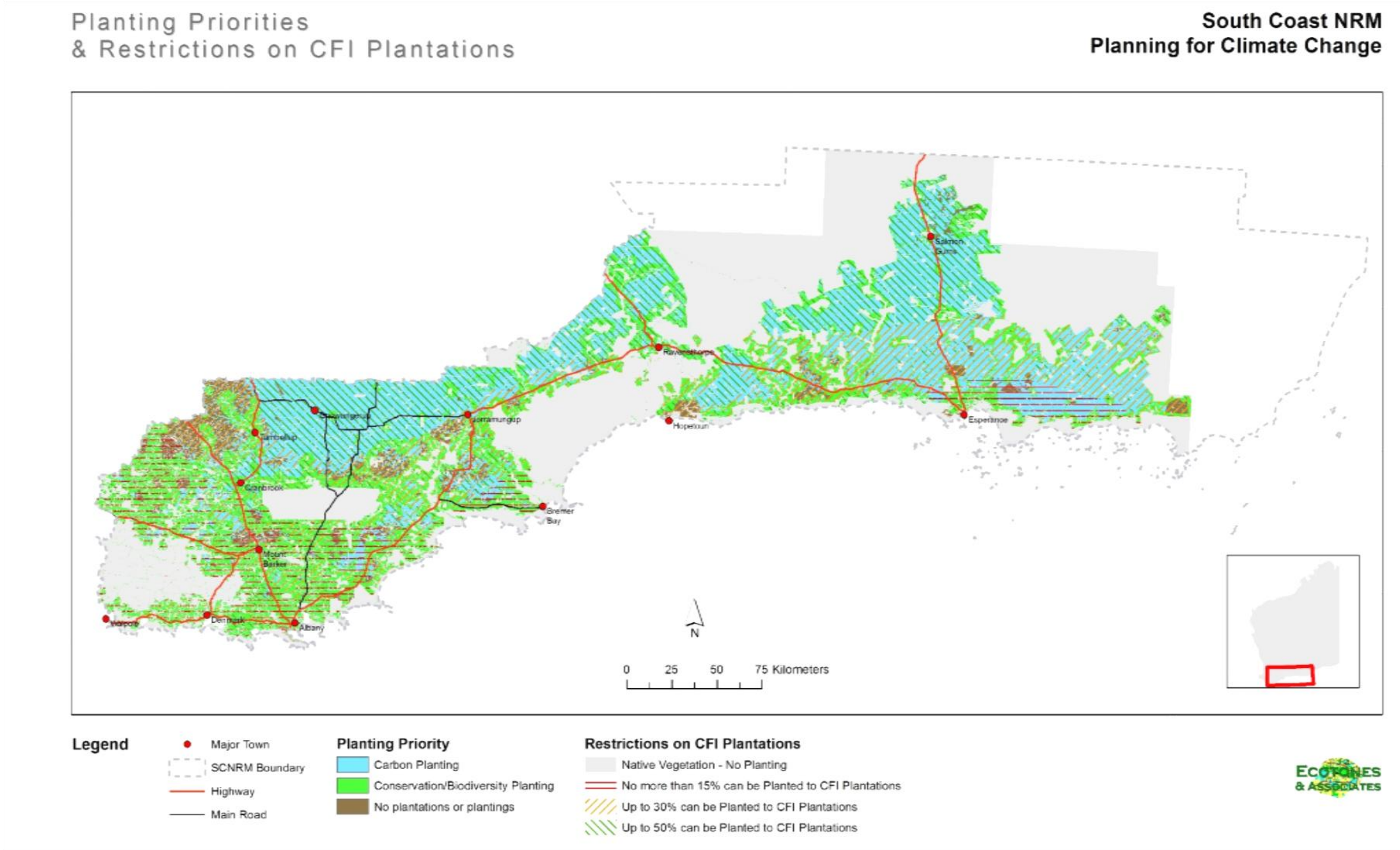
- Component B1 – Conservation and Biodiversity Value
- Component B2 – What protection is afforded under existing tenure/security?
- Component B3 – Where are the Conservation/Biodiversity Linkages/Corridors?
- Component B6 –Where are the Biodiversity Priorities? (from B1, B2, B3 & B4)

Three of these components (A1, A2 & A3 are derived from three 'Key Questions' developed in Albany on 19th February 2014, at a meeting of the south west WA NRM climate change officers. This organisation of components provides a clear framework for the deliverables under the project objectives, and provides the basis for a consistent set of guiding principles for CFI investment across NRM regions.

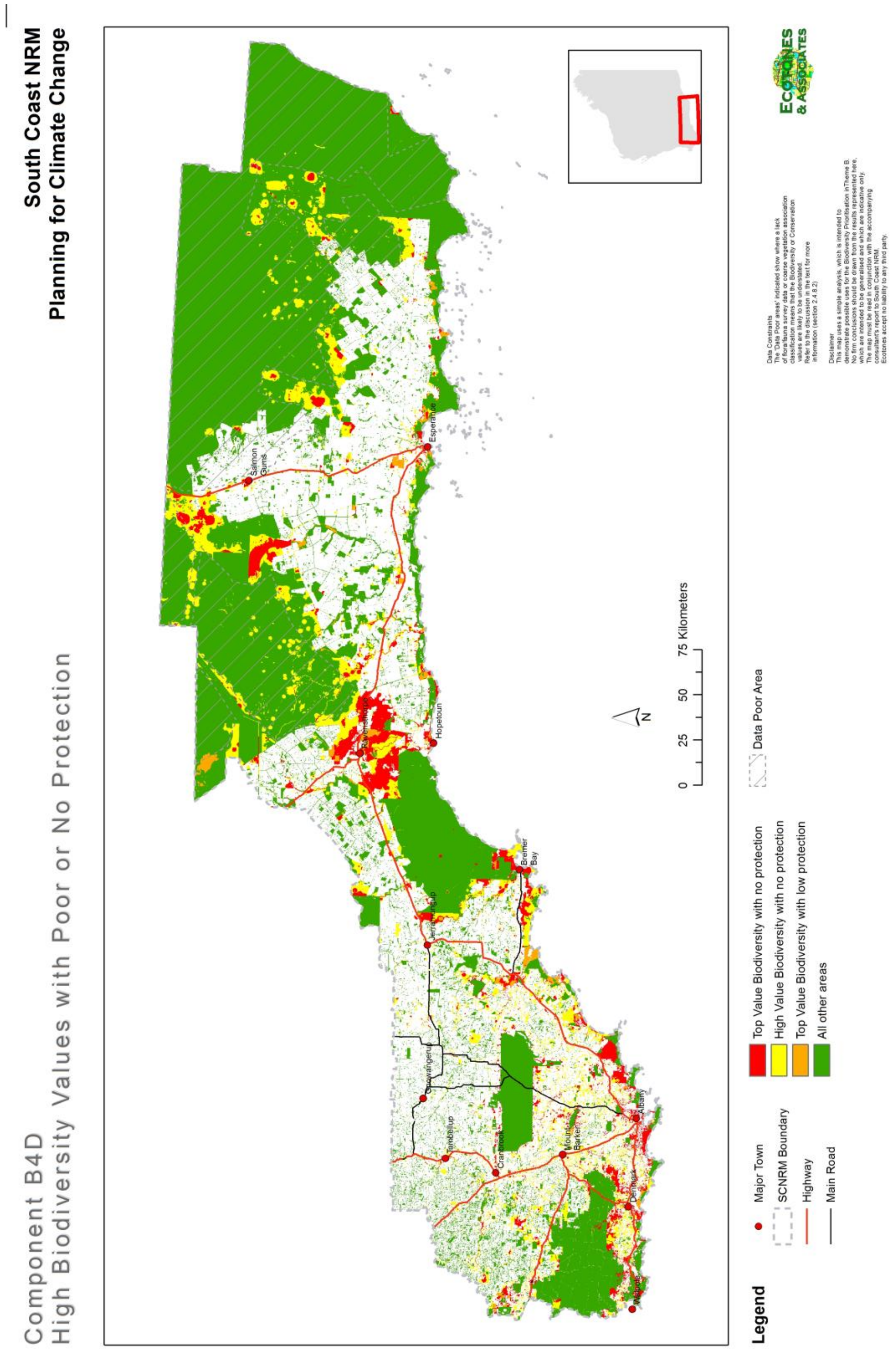
A large amount of data was processed in order to create the final outputs, which have been combined together to operational maps for the SCNRM Staff. The final map for Theme A provides a set of outcomes, based on the hierarchy of uses shown here.



The hierarchy indicates which uses take precedence and in what order. We have used this to rank different options and create the final output, indicating the priority areas for both carbon planting (e.g. plantations) and conservation/biodiversity planting. It also indicates areas where planting is not a priority use, and where restrictions on plantations should be considered.


Planting Priorities
& Restrictions on CFI Plantations
South Coast NRM
Planning for Climate Change
Salmon Gums
Ravensthorpe
Esperance
Hopetoun
Jerramungup
Cranbrook
Bremer Bay
Mount Barker
Denmark
Albany
N
0 25 50 75 Kilometers
Legend
Major Town
SCNRM Boundary
Highway
Main Road
Planting Priority
Carbon Planting
Conservation/Biodiversity Planting
No plantations or plantings
Restrictions on CFI Plantations
Native Vegetation - No Planting
No more than 15% can be Planted to CFI Plantations
Up to 30% can be Planted to CFI Plantations
Up to 50% can be Planted to CFI Plantations
Ecotones & Associates

Combination of Theme B components has provided a number of potential maps for biodiversity prioritisation. Full development of this aspect of the project was not a part of the contract, however the maps provided were intended to give direction to staff in biodiversity and conservation work. The example given here highlights areas of high biodiversity value in landscape corridors that do not have protection through tenure.



1. OBJECTIVES OF THE PROJECT

1.1 Project Objectives

South Coast NRM Inc. successfully received funding in 2013/14 as part of the Australian Government's Clean Energy Future program under the Land Sector Package (Stream 1). The project will update the existing regional NRM plan, *Southern Prospects 2011-2016* by incorporating current climate change information and scenarios.

As part of this Stream 1 funding, South Coast NRM Inc. requested quotations (Request for Quotation RFQ-NRMP-1213) to assist in the development and delivery of modelling and mapping of spatial products to support biodiversity prioritisation and climate planning for the South Coast NRM Region. Specifically, according to the RFQ, the project was to "assist in the development and delivery of products suitable for the project *Biodiversity Prioritisation and Biosequestration Modelling and Analysis."*

The RFQ states that spatial data layers currently used by SCNRM in NRM planning other layers were to be used by the consultant in modelling and analysis to assist with determining suitable locations for climate adaptation and mitigation actions for the South Coast NRM Region. The RFQ estimated that 40 datasets would be required for this project; in fact over 160 have been used or developed.

The modelling is intended to guide the location and nature of biodiversity and revegetation activities to optimise the environmental, water and agricultural outcomes of adaptation and mitigation projects, and should take into consideration their socio-economic impacts. One of the specific activities is to provide direction in locating plantation activities under the federal Carbon Farming Initiative (CFI).

This document therefore provides the information required to meet the requirements of the Australian Government to update Regional Strategies to:

- Identify where tree plantings could fit into the landscape without causing adverse impacts.
- Provide clarity to Carbon Farming Initiative (CFI) proponents when considering whether their carbon emission abatement projects adhere to Regional NRM plans and do not have unintended impacts by taking into consideration priority agricultural land, hydrology and biodiversity.

The RFQ also makes it clear that the modelling needs to complete the Biodiversity Prioritisation process across the region by collating, standardising and mapping biodiversity assets and threats (current and anticipated). The modelling outcomes should be applicable to the optimization of environmental, water and agricultural outcomes of future plantings, and take socio-economic impacts into consideration. MCAS-S is specified as the preferred modelling tool. Stakeholder consultation is required to assist with the modelling framework and involve key stakeholders in the decision making process.

The methodology and thinking behind the project was to follow the suggested approach as outlined in the *2011 Bio Prioritisation* Paper (Ravey, pp 18-20).

Specific outcomes from the process should include:

- High biodiversity conservation landscapes.
- High value agricultural productivity land.
- Low value agricultural land and degraded landscapes.
- Regional ecological linkages and connectivity.
- Identify areas for different types of revegetation (including higher biodiversity value plantings, single species plantation, and perennial pastures).

- Carbon sequestration exclusion zones.
- Locations for carbon sequestration activities in low biodiversity areas

The process for obtaining this information was to form a Technical Working Group and undertake a facilitated process using a decision support tool (MCAS-S). Spatial data layers were sourced through State Agencies, CENRM and additional sources as required.

Project area definition

The project was to be run for the SCNRM area. It was considered preferable that if possible the analysis should extend beyond SCNRM boundaries, however much of the data already held and some supplied data was clipped to this boundary (shown in Figure 1).

Figure 1: SCNRM area boundary and major towns

Dataset provision

Accessing of data for modelling and general project mapping requirements was to be undertaken by SCNRM, with data processing by Ecotones. As the project unfolded we conducted significant data accessing ourselves.

2. PROJECT METHODS

Simon Neville from Ecotones & Associates was contracted:

- To complete an existing biodiversity prioritisation process, and
- Provide models that maximise the benefits of carbon plantings for environmental, social and socio-economic outcomes across the landscape.
- Provide a written report outlining the bio sequestration risk maps, spatial layer(s) and decision support matrix, and including any electronic files developed as part of this contract, e.g. the decision-support matrix.

The main tasks for the consultants were as follows:

- Informing SCNRM about data needs and data manipulations;
- Designing models within MCAS-S (or similar);
- Facilitation of Working Group meetings (6 workshops);
- Assisting Working Groups in rating and weighting data layers;
- Confirming agreement within Working Groups on final scenario(s) and decision support maps;
- Presentation of final results to the SCNRM Board; and
- Providing simple training in the use of this work.

This section presents the process followed and the structure of the modelling components used to answer SCNRM's major objectives - to identify where tree plantings could fit into the landscape without causing adverse impacts, and to finalise a biodiversity prioritisation process.

2.1 Modelling Methodology (MCAS-S)

Integration of spatial data with spatial modelling, risk assessment frameworks and policy decision-making has been carried out in very broad variety of ways for the last 30 years. Early work in spatial environmental modelling was carried out for conservation assessment reserves in the 1980's (Margules and Usher, 1981; Margules and Nicholls, 1988; Margules, 1989). With the development of GIS techniques, more complex tools were created, and by the 2000's a very wide range of tools and techniques were being used. For example: Ortigosa et al (2000) developed a program (VVF) to integrate a range of suitability models into GIS; Heidtke and Auer (1993) created a GIS-Based Nonpoint Source Nutrient Loading Model; Boteva et al (2004) used multi-criteria evaluation to determine conservation significance of vegetation communities; Panitsa et al (2011) integrate species and habitat-based approaches to conservation value assessment within GIS. The large range of approaches use both built-in tools and customised tools for a very broad range of applications – from conservation value investigations to modelling of nutrient risk (Neville et al 2008) to modelling of ecological risk (Bartolo et al 2012). As part of these, GIS has been used as a base for a wide range of environmental models.

However the incorporation of attitudes and preferences into modelling requires more specific tools, especially where the choices are, in effect, being made on the basis of judgements and opinions rather than quantifiable data. This is often the case in NRM policy-making, and is the case in the current situation: some of the grounds for spatial location will be based on "science", others on opinions. It is therefore necessary to use a modelling tool that fulfils two functions:

- It must allow the use of varying qualities and types of data; and
- It must allow the combination of criteria based on anything from hard science to judgements based on political preference.

Multi-criteria analysis is one such framework, and with its incorporation into the package MCAS-S (Multi Criteria Analysis Shell for Spatial Decision Support - ABARES, (2011)), it brings this framework to spatial decision making, suitable for NRM bodies. MCAS-S is a spatial software shell which can display spatial data but does not have full GIS functionality. This software is relatively easy to use and can easily be provided to 3rd parties for their use and modification. In addition it allows rapid combination of spatial datasets & criteria specification, and thus allows real-time development with interested parties/experts etc. This modelling vehicle was chosen for the current study by SCNRM.

Usage of MCAS-S has been developing constantly since its development in the 2000 to allow the use of Multi-Criteria analysis in a spatial context (ABARES, 2011). A key reason for using MCAS in the current project is that is explicitly allows for the incorporation of different levels of information in the same analysis. It does this through rendering all inputs into the same scale through a process of "fuzzification" – converting criteria in fuzzy scales from 0 to 1 – in terms of satisfaction of the intended purpose. In addition, its spatial presentation of the process suits the use of a working group with a range of members, viewpoints and preferences as well as technical expertise. By involving the working group in the process to develop the spatial criteria, SCNRM not only benefit from the members experience and expertise, but can gain the support of these members in accepting and promoting the outcomes of the process.

2.1.1 MCAS Requirements & Workflow

A fundamental aspect of MCAS-S is that it renders the datasets used as grids. This provides very fast and flexible processing of multiple datasets, but means that all input data has to be rendered as grids, and this can result in the loss of detail (depending on the grid size used).

Data held within MCAS-S must conform in spatial extent and projection. Because of this the user of MCAS-S therefore still requires GIS software for data preparation. ArcGIS is the recommended software for the conversion process, and we would recommend that SCNRM maintain at least one ArcGIS licence with the necessary extension (Spatial Analyst) to maintain full raster processing capabilities.

There were a variety of ways in which datasets were processed to make them suitable for MCAS-S. The major components of the workflow are:

- Identify the dataset required
    - Identify the way in which it will be used – as continuous data or categorical data.
- Pre-Processing - Undertake any necessary initial processing, such as
    - Conversion from shapefile to raster.
    - Re-classification.
    - Euclidean distance for proximity features, or
    - Calculations on fields (such as area to create rasters of area).
- MCAS-S Processing
    - Sample or re-sample the dataset to the standard resolution and location,
    - Re-project the raster during re-sampling or export
    - Export the raster to the appropriate MCAS Folder.

Output rasters were generally controlled in a series of simple toolbox tools for specific operations (such as gridding shapefile). Settings for all MCAS-S analysis were:

- Output coordinates [GDA_1994_MGA_Zone_50]
- Processing extent [standard South Coast NRM region shapefile, and a single snap raster to ensure exact coincidence of rasters in analysis]
- Raster Analysis [cell size fixed at 200m, and mask set for the study area].

The use of a 200m grid cell allowed for high resolution data analysis at the whole of region scale, but was coarser than originally hoped due to processing constraints. The MCAS-S software can handle larger grids, however these come with a penalty in terms of the time taken to display maps at larger scales (ie close-up). Initially we used a 100m grid, which had over 20 million cells, but processing time and software response were poor. Using a 200m grid cell size allows reasonably rapid real-time display of changes in the process outputs (maps) brought about by the workshop group. However we note that the smallest cell is still 4ha in size, which represents a potentially large area at the sub-regional scale. SCNRM will need to treat the results with caution when using them at a farm-scale.

2.2 Project Process

The project has involved five stages:

1. Component Planning
    a. Develop draft component structure
    b. Develop draft component diagrams (criteria)
    c. Test with Project manager

Discussions were held with Kaylene Parker (project manager) and Julian Neville (GIS project officer) regarding the workshop process & structure, and additional workshops included.

2. MCAS-S Model Setup
    a. Source spatial datasets fit for use in each component
    b. Convert datasets for MCAS-S
    c. Create MCAS-S Components with initial (draft) classification and rating for criteria and criteria weighting

Datasets were handed to us by Julian Neville, and following discussions and testing we agreed on the final 200m model grid.

3. Internal Workshop of Pre-Draft Components
    a. Present components at initial (internal SCNRM) workshop
    b. Confirm structure; test initial settings (ratings & weightings)
    c. Modify, source additional data if required

A workshop was held with SCNRM staff (Kaylene Parker, Julian Neville, Karl Hansen [Biodiversity Program Leader], Penny Hewitt [Land Program Leader], Dylan Gleave (Coastal, Water and Marine program leader), Melanie Morcombe [Biodiversity Project Officer], and Justin Bellanger [Operations Manager]) and the component structure discussed to ensure consistency with SCNRM planning requirements.

4. External Workshops for Draft Components
    a. Present components at TWO workshops for each reference group and DPAW staff (6 workshops)
        i. Theme A (Components A1, A2 & A3) to Land Reference Group
        ii. Theme B (Components B1, B22, B3, B4) to Biodiversity Reference Group and to DPAW staff separately.
    b. Confirm structures
    c. Test (draft) classification and rating for criteria
    d. Test criteria weighting

Note that stakeholder and expert consultation was sought by Kaylene Parker for all workshops. The unavailability of DPAW staff at either of the Biodiversity stream workshops meant that they had an initial workshop prior to the 1st round Biodiversity workshop, and a second workshop after the 2nd round Biodiversity workshop. This was not ideal but unavoidable given time constraints. See the appendices for a full list of workshop attendees.

5. Create Final datasets & GIS project
    a. Complete components & produce maps form these
    b. Combine maps in ArcGIS
    c. Use maps to identify planting options.

Mapping options and methods were informed by the outputs of the workshops, in particular the ways in which workshops modified the component structure and introduced the division of normal commercial plantations and CFI Plantations as quite different land uses.

2.3 Component Framework

The project deliverables were produced through an MCAS-S process with two major themes which delivered many major components (including map outputs):

Theme A – Identification of priority landscapes for (carbon) plantings

- Component A1 - Which landscapes need to be protected from plantings?
    - A1A - What landscapes need to be protected from commercial plantations?
    - A1B - What Landscapes need detailed assessment of carbon plantings?
- Component A2 - Where would we encourage plantings?
    - A2A - Where would we encourage Commercial Plantations?
    - A2B - Where would we encourage Carbon plantings (e.g. monocultures, tree-crops)?
- Component A3 – Where do we want plantings to enhance habitat corridors and protect high biodiversity areas? [Carbon plantings for conservation/biodiversity enhancement]
- Component A4 – Where are the priority planting areas? (from A1, A2 & A3)

Theme B – Identification of Biodiversity Priorities

- Component B1 – Conservation and Biodiversity Value
    - B1A - Where are the high value Biodiversity areas? (intrinsic/internal values)
    - B1B - Where are the High Conservation Value areas?
- Component B2 – What protection is afforded under existing tenure/security?
- Component B3 – Where are the Conservation/Biodiversity Linkages/Corridors?
- Component B4 – Where are the current or potential threats (change processes)?
- Component B6 –Where are the Biodiversity Priorities? (from B1, B2, B3 & B4)

The components in Theme A are derived from three 'Key Questions' developed in Albany on 19th February 2014, at a meeting of the south west WA NRM climate change officers. This organisation of components provides a clear framework for the deliverables under the project objectives, and has the advantage of being informally endorsed by the other NRM groups in SW WA. It therefore provides the basis for a consistent set of guiding principles for CFI investment across NRM regions.[1]

[1] A version of this framework has been adopted by SWCC and NACC in their biosequestration planning process, for the same reasons.

The Theme A components also conform to the SCNRM "Carbon Farming Guiding Principles" provided in Appendix 1 – SCNRM Carbon Farming Guiding Principles, which provide a set of broad objectives for carbon farming as well as a detailed list of Carbon Farming Considerations. The purpose of the Carbon Farming Guiding Principles is to:

(i) Assist carbon farming proponents ensure their CFI projects adhere to South Coast NRM's Regional Strategy.

(ii) Provide guidance to avoid and mitigate potential risk and adverse impacts associated with carbon sequestration in the landscape (including impacts to biodiversity, water resources and productions systems).

The SCNRM process made some changes to the framework used by other NRM groups in both Theme A and Theme B. Following discussions in the working group, plantations were divided into traditional commercial plantations, which been established in the south-west for over 20 years, and CFI-funded Carbon plantings, which will be funded in part through government investment and have much longer potential impacts on the landscape (25 – 100years). Biodiversity or Conservation area identification was divided into Biodiversity Value and Conservation value, due to the different nature of these concepts and values. This will be discussed below.

The actual criteria used in each component (indicated in the figures that follow) were selected by the Reference group in the six workshops and data sourced to fill them, usually on the recommendation of Reference group members.

2.4 Component Model Logic

2.4.1 Model Diagram Conventions

In the model diagrams, the boxes represent the criteria and sub-criteria that contribute to identifying the outcome. The green box on the right is the outcome, the orange boxes indicate key input criteria; and the grey boxes are contributing criteria. In some Components there are further sets of yellow boxes indicating further sub-divisions of contributing criteria or sub-criteria.

Yellow or dark brown outlines mean the data is either not available at present (in some cases data will be made available in the future as work is completed, such as with species richness data from DPaW) or not available at all.

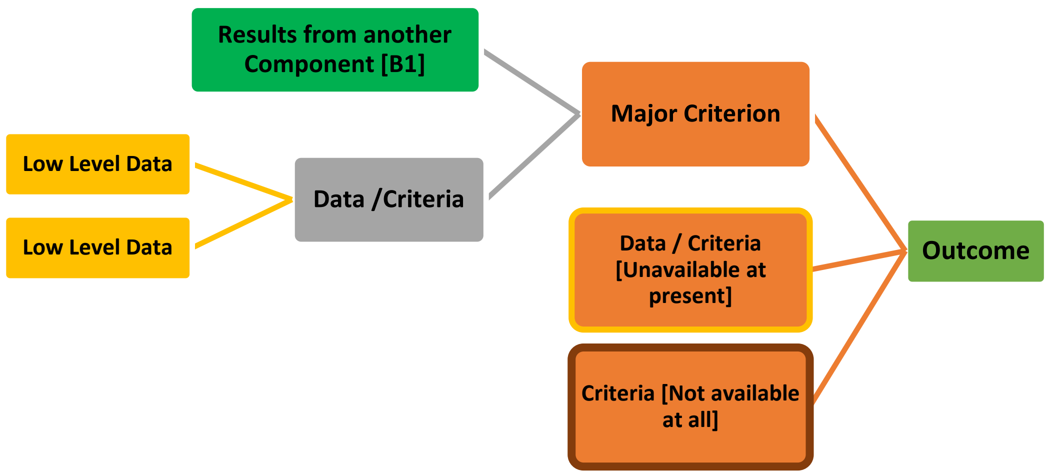


Figure 2: Model Diagram Conventions

2.4.2 A1A –Landscapes that need to be protected from commercial plantations

A distinction was made between standard commercial plantations, which tend to be on short rotations (8-15 years) and CFI-funded plantations, which will have minimum time periods of at least 25 years and may be as long as 100 years. The impacts of the CFI model were felt to be substantial in terms of the agricultural landscape. The Component A1 has therefore been developed as two separate maps:

- Component A1A - What landscapes need to be protected from commercial plantations?
- Component A1B – What landscapes need detailed assessment of carbon plantings?

The structure for this component (1A1) is based around identifying and avoiding high-value water & groundwater resources, protection cultural sites and remnant vegetation. High-value agricultural land was not used as an exclusion criterion, as the group felt comfortable that commercial plantations are a valid agricultural land use. The inclusion of protection zones for public declared water supply areas protects certain water resources from inappropriate plantations, while proclaimed groundwater areas, areas close to groundwater-dependant ecosystems (GDEs) and catchments with significant ecological requirements were all felt to require protection from large-scale commercial plantations. However (GDEs) and catchments with significant ecological requirements are not available as a spatial dataset.

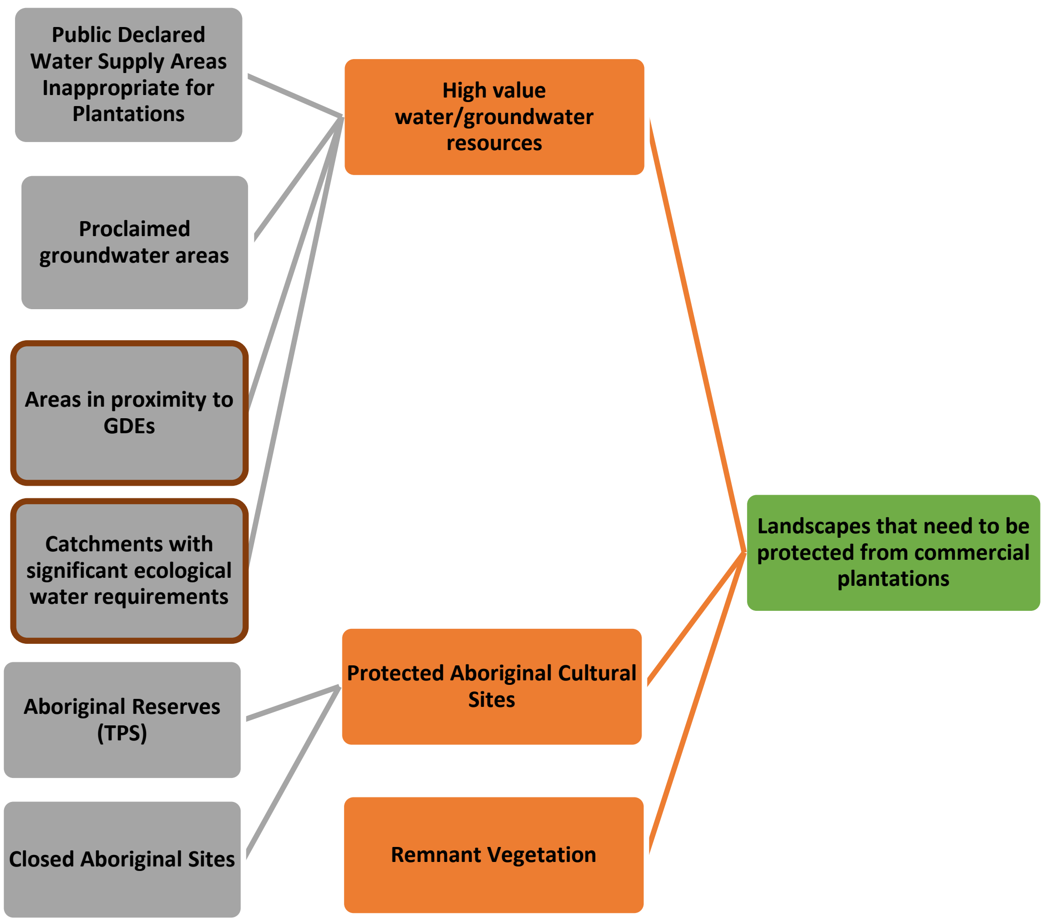


Figure 3: Component A1A – Protection from Commercial Plantations

2.4.3 A1B – Landscapes where detailed assessment of carbon plantings is recommended

This component has a much broader range of criteria, in light of the broader implications of the CFI plantations. All of the criteria from 1A1 are included, but the groups added high quality agricultural land and distance to port (Albany or Esperance) as an important determinant of whether assessment would be required to protect the best agricultural land. The intention of the assessment is not to exclude CFI-funded plantations, but to restrict them to no more 25% of the landscape in the highest-protection areas

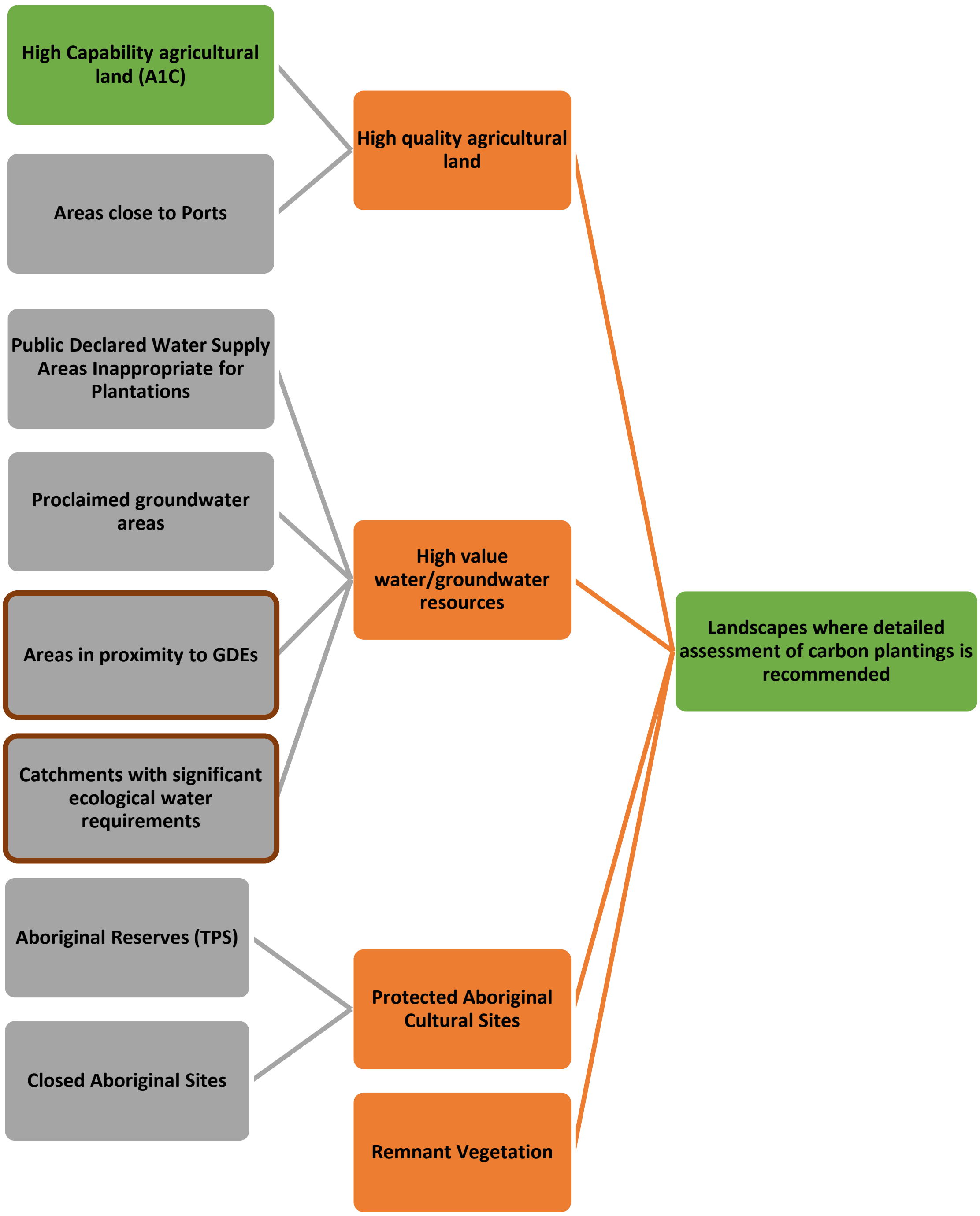


Figure 4: Component A1B – Assessment of Carbon Plantations

2.4.4 A1C – Agricultural Land Capability

Components 1AB and A2 require an indicator of agricultural land capability. This component is based on land capability mapping based on the DAFWA soil/landscape mapping developed over the last 20 years or so. This land capability mapping is combined with rainfall specific to the various landuse types. Rainfall is as projected to 2020, i.e. near current rainfall. Data on Dry Sheep equivalents (DSE's) was wanted as an indicator of grazing value but this was not available.

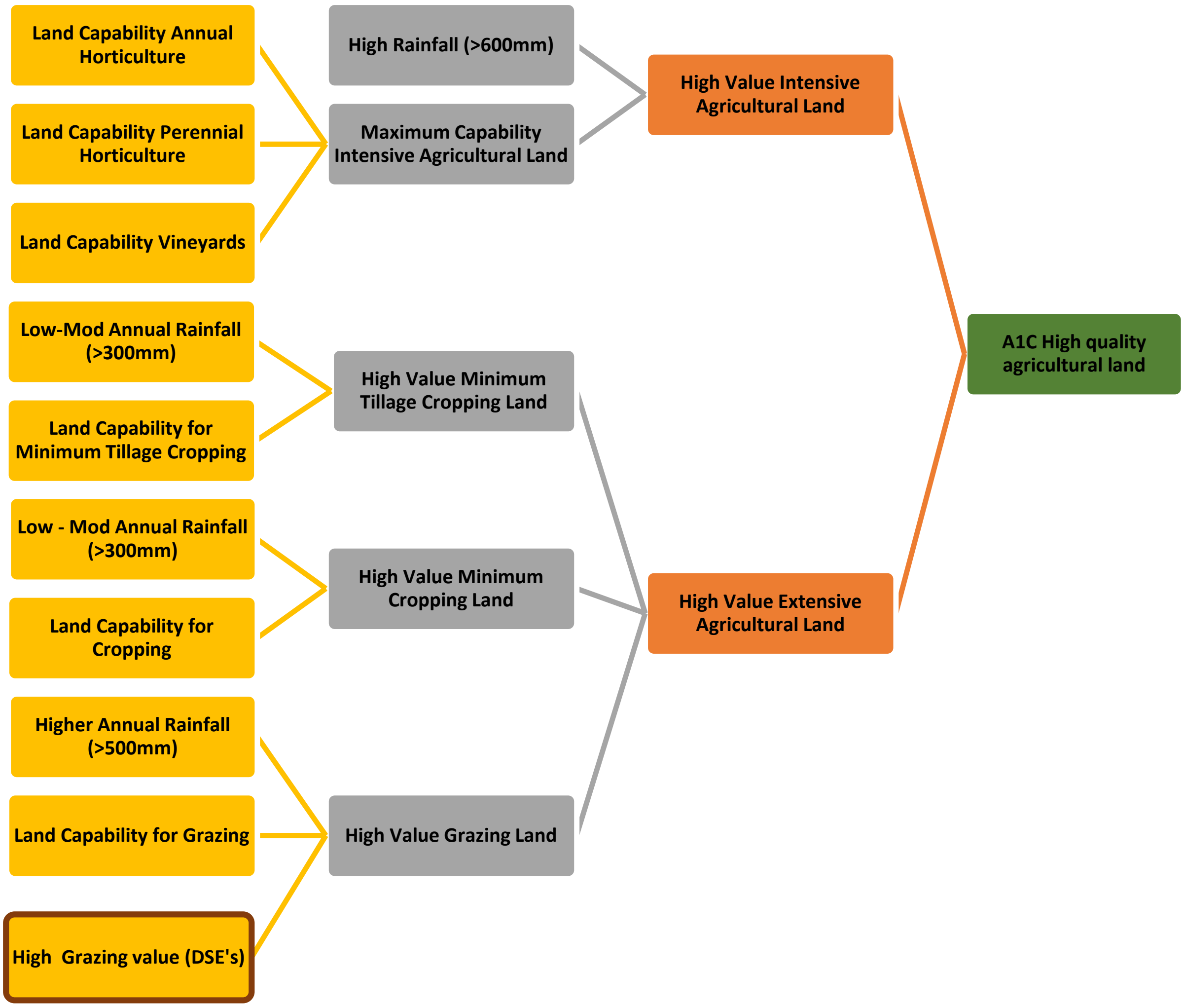


Figure 5: Component A1C – High Quality Agricultural Land

2.4.5 A2A – Locations for commercial plantations

As in component 1, separate models were developed for identifying areas for commercial & CFI-funded plantations.

This component focuses traditional commercial forestry away from high-value agricultural areas, and into recovery catchments. One aspect of agricultural value is projected yield sustainability - a set of crop yield projections based on rainfall projections for 2050, used to identify areas that appear unlikely to remain productive under climate change. It also specifically targets areas close to potential salinity areas - areas that have identified salinity risk but no expression as yet (salinity hazard), or where there is a high level of such hazards at the sub-catchment scale. Salinity data comes from LandMonitor/DAFWA and involves a combination of salinity hazard mapping from Land monitor satellite imagery analysis and salinity risk from terrain analysis.

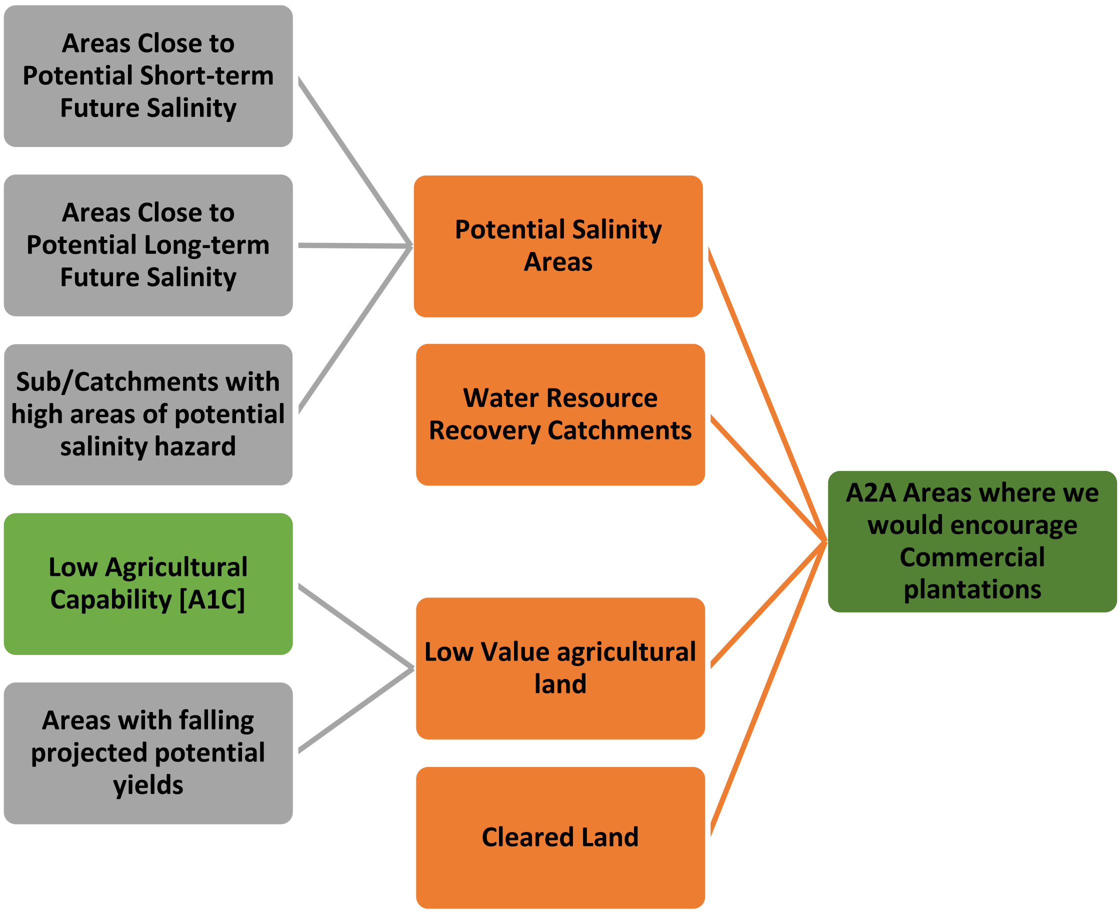


Figure 6: Component A2A – Locations for commercial plantations

2.4.6 A2B - Where would we encourage Carbon plantings (e.g. monocultures, tree-crops)?

A2B adds areas with low socio-economic resilience to the A2A criteria, using a relative economic resources index from ABS as a surrogate for resilience. There is still some debate within the group as to the merits of this criterion, which was intended to focus this federal funding into areas where it would have an economic co-benefit. It was felt that the economic benefit of plantations was more likely to be felt in the regional towns such as Albany and Esperance rather than at the local level. A second criterion was requested (economic resilience by Agricultural zone) to better address these concerns, but this is not available.

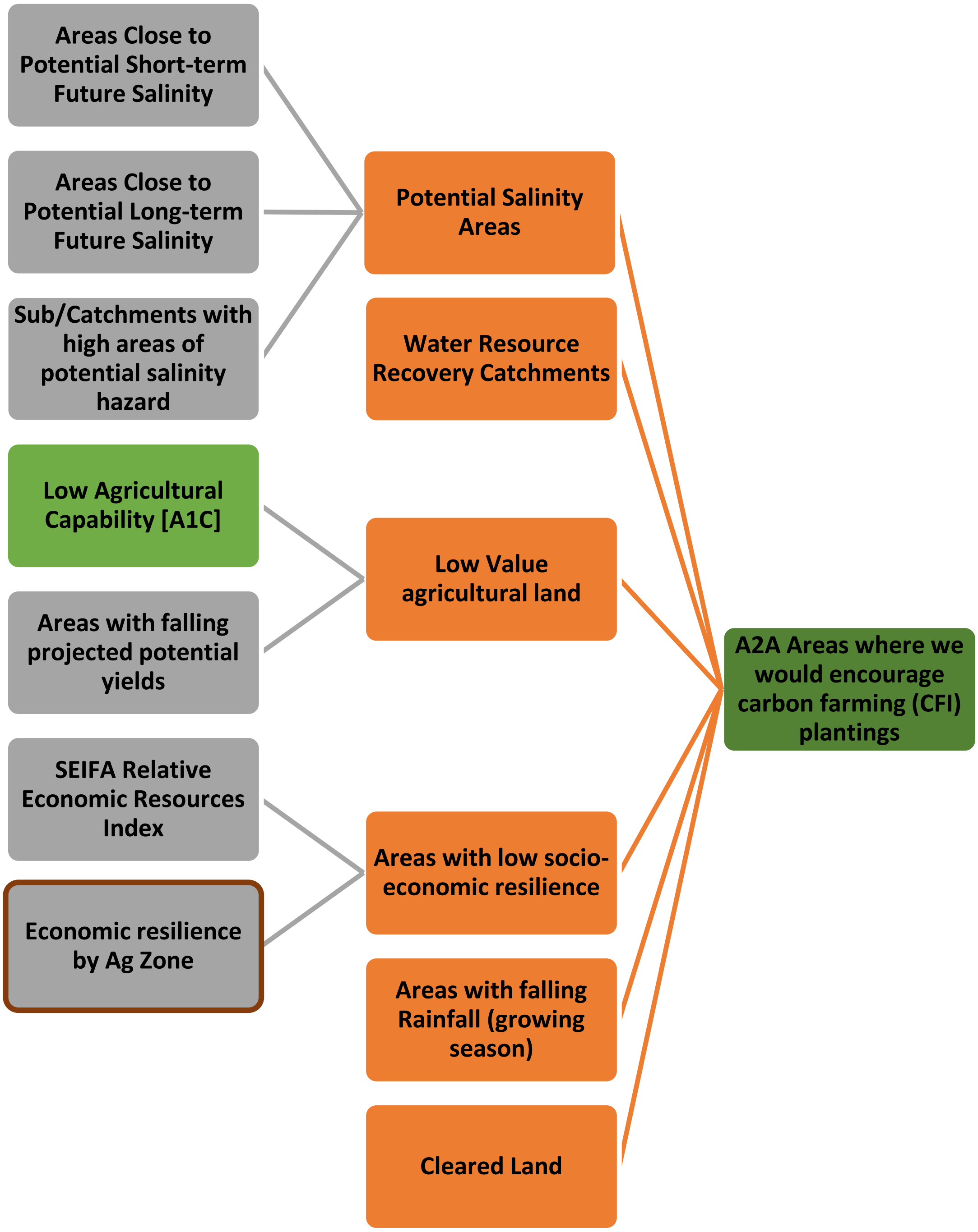


Figure 7: Component A2B – Locations for commercial plantations

2.4.7 A3 –Carbon plantings for conservation/biodiversity enhancement

This final component uses three major criteria:

- Proximity to High Biodiversity Value Areas [Component B1A];
- Proximity to Landscape Corridors [Component B3]; and
- Proximity to known biodiversity assets

Two of these are the output of separate Components, identifying high biodiversity value [B1A] and landscape corridors [B3], and known biodiversity assets includes a range of datasets to establish locations of reserves, wetlands and rivers and buffer zones. In all cases proximity to these various assets is used as indicating a priority for Biodiversity plantings – plantings intended to enhance habitat (connectivity) corridors and protect high biodiversity areas.

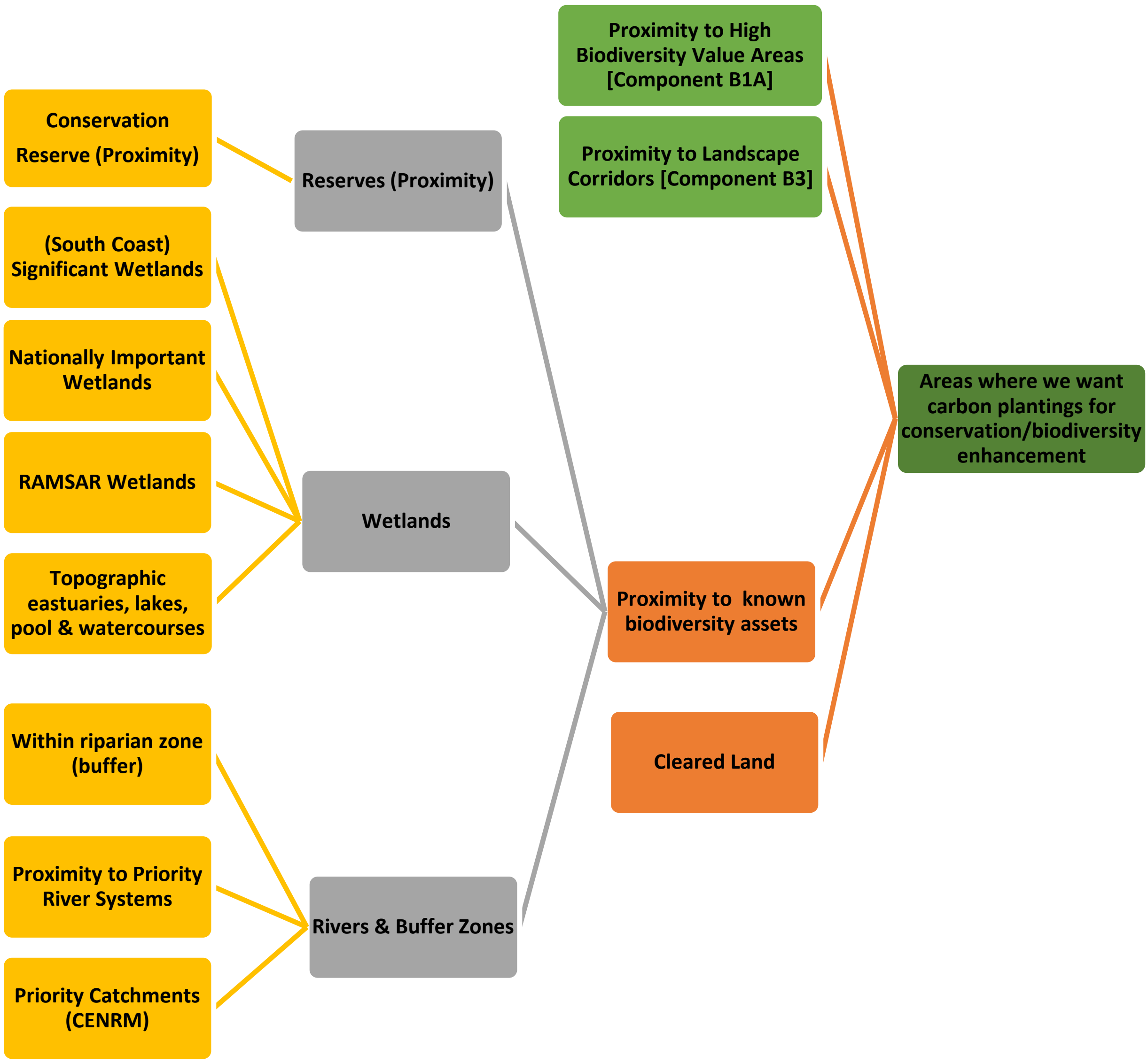


Figure 8: Component A3 – Location of Biodiversity Plantings

2.4.8 B1 – Identifying High Value Biodiversity values and Conservation Areas

Our tender proposed to use classic conservation reserve principles to identify high values areas from both biodiversity as well as conservation perspectives. We had to conform to the criteria outlined by the Biodiversity Reference Group, (2011:3):

- Uniqueness
- Representativeness
- Diversity
- Naturalness/condition
- Connectivity
- Special features

We have drawn from similar approach used to evaluate conservation value of remnant vegetation in the south west (Neville, 2009). A series of criteria based on existing GIS data where used. The criteria are taken from basic conservation value assessments, which emerged in the 1980's (Margules & Usher (1981), Margules et al (1982), Austin (1983), Margules and Nicholl (1988)).

These have been further developed and their relative importance quantified (Boteva et al (2004), Panitsa et al (2011):

- Diversity (30%)
- Rarity (33%)
- Naturalness (26%)
- Area
- Threat/replaceability (9%)

2.4.8.1 Workshop discussion

There is a significant difference between an identification of intrinsic values and other indicators of conservation value, in that this component can indicate conservation value even where no protection has been given to an area, such as through reserve status. Biodiversity value recognises that not all areas of high value have been accorded formal status, and that in a highly-fragmented landscape small areas can contain values of uniqueness and representativeness.

These issues were discussed at length in the workshops, and the overlap between biodiversity and conservation value led us to split these two indicators of value into:

- Component B1A - Where are the high value biodiversity areas? (intrinsic/internal values); and
- Component B1B - Where are the High Conservation Value/Potential areas?

We have kept them both as Component B1, given their close relationship.

2.4.8.2 Limitations of the datasets used for Biodiversity and Conservation Values

The Biodiversity Reference group has indicated a significant issue with the biodiversity prioritisation that impacts on the values for biodiversity and conservation values in the Great Western Woodlands (GWW) area of the region.

Flora/fauna data

Much of the north and east of the region has high levels of species diversity but this is not reflected in the data used in this analysis. This is due to two reasons:

- Flora & fauna surveys carried out in the past by the WA Museum (see Hall et al 1993 and How et al 1988) are not available as digital data, although DPAW is currently working to add these records to Naturebase. These surveys are known to indicate very high levels of diversity for both plants and animals, but were absent from the datasets used in this project.
- Surveys have never taken place in some of the north and eastern areas of the SCNRM region, due to the large areas involved, a lack of access and the general remoteness.

The existing state of the surveys can be seen in the following two maps, showing flora and fauna collection records, with conspicuous absences in parts of the region, especially for fauna. Road-based surveys can clearly be seen. This impacts upon both diversity and rarity/uniqueness in component B1A, and through B1A on Conservation value (B1B), as these data are used for species diversity and proximity to rare/endangered species, as well as endemism.

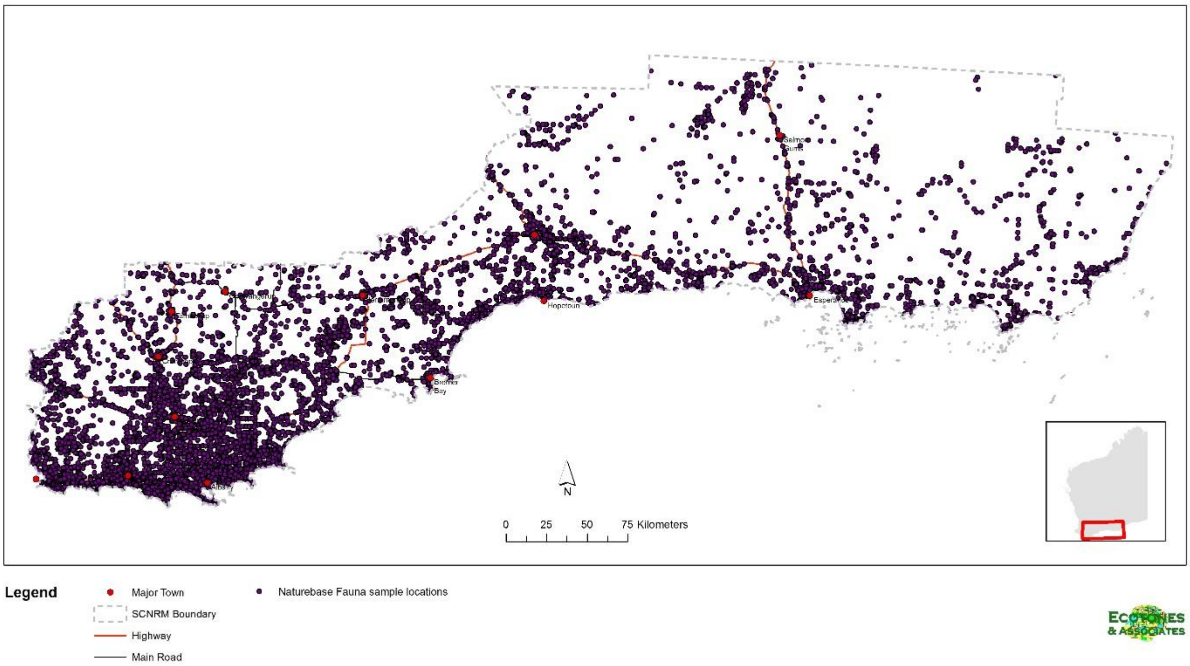


Figure 9: Naturebase Fauna collection locations

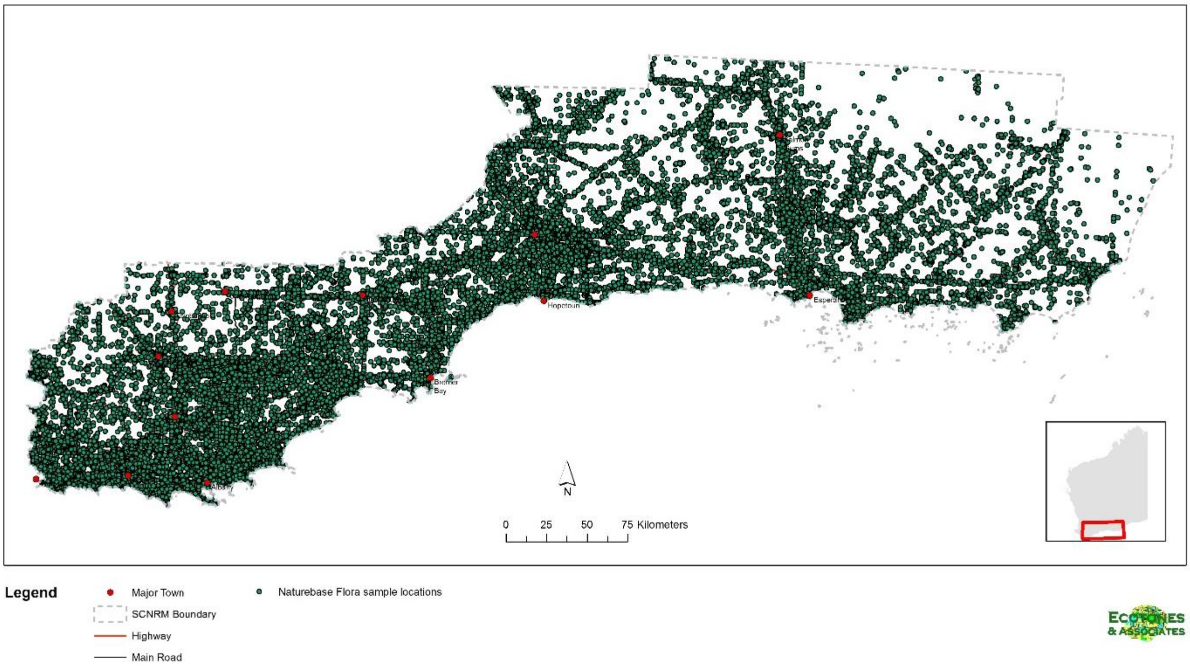


Figure 10: Naturebase Flora collection locations

Pre-European Vegetation classification

Another factor impacting on the values for the GWW is the vegetation mapping used to indicate vegetation diversity (Pre-European vegetation – Beard), which is also used to derive other indicators of conservation status such as vegetation association reduction and patch importance. This dataset indicates very simple vegetation association structures in parts of the GWW, which are associated more with the nature of the assessment than the real structural diversity. In essence, the remoteness and poor understanding of the area, combined with a lack of field work, has resulted in very coarse mapping in the GWW and other areas.

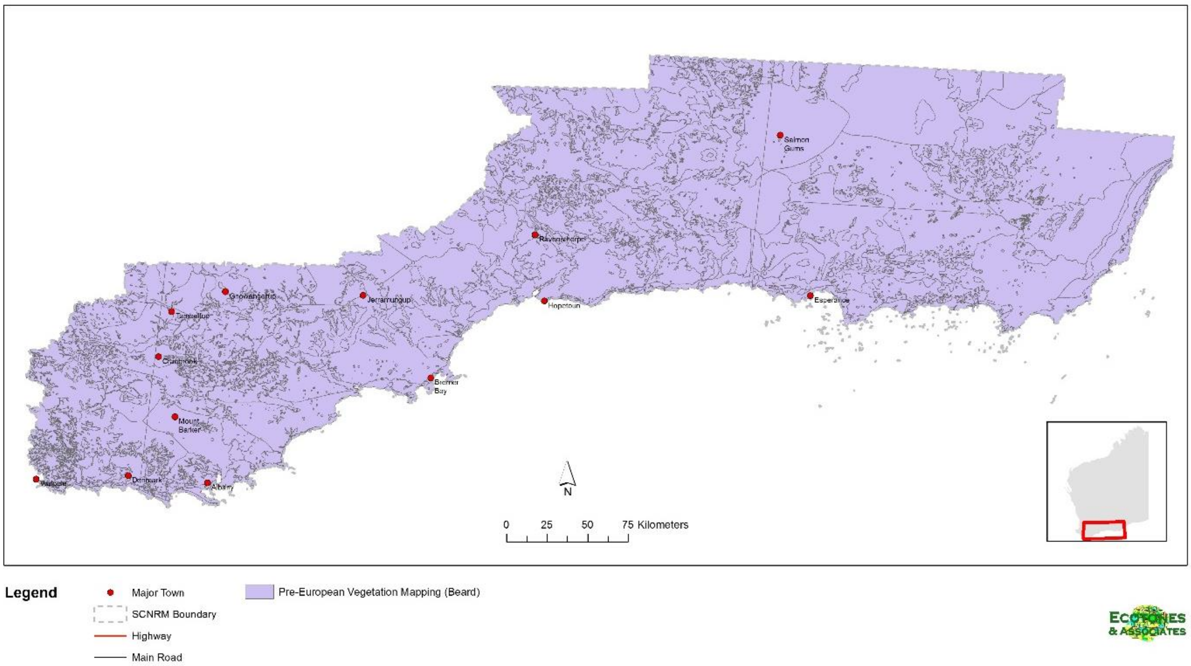


Figure 11: Pre-European Vegetation Mapping (Beard), showing varying levels of assessment.

We have indicated areas where data is poor in in terms of at least two of these three datasets in an overlay on the component maps, and have included a note to this effect in each map as well as on the maps that use these components. The generalised area is shown below.

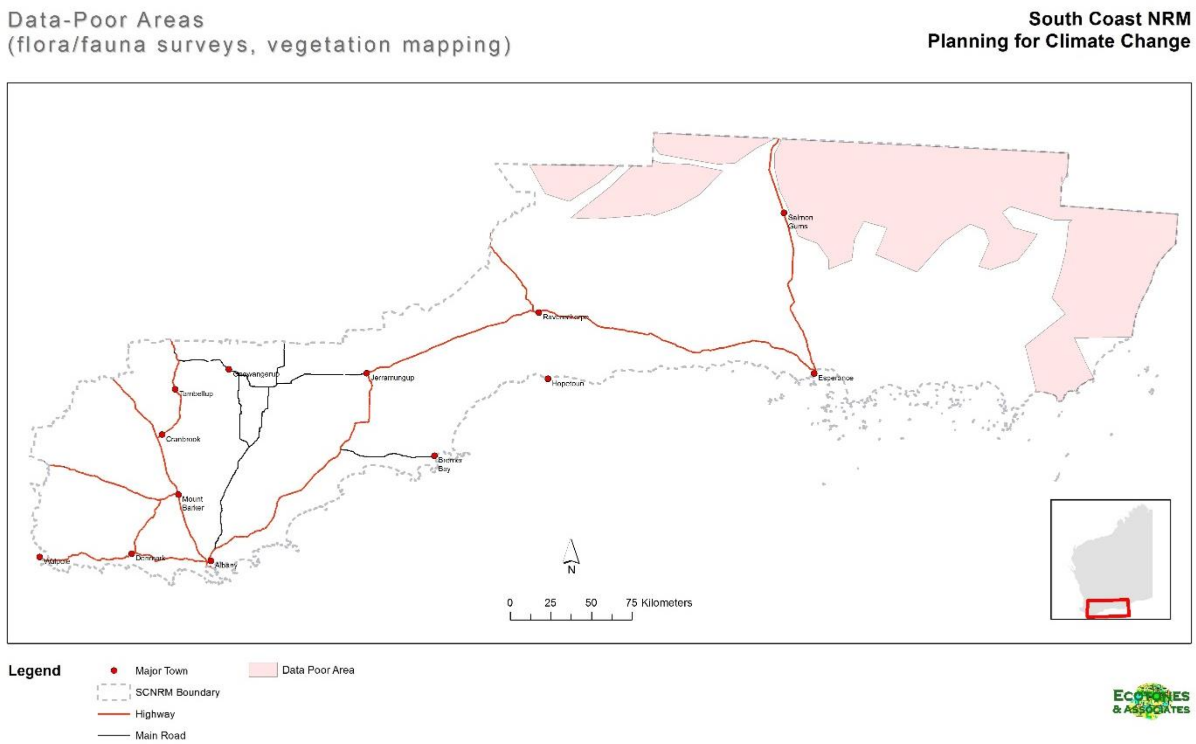


Figure 12: Data-Poor areas

2.4.9 B1A – Identifying Areas of High Value Biodiversity (intrinsic/internal values)

Component B1A uses at its core three criteria:

- Rarity/uniqueness;
- Naturalness; and
- Diversity

Most of the component is a search for datasets that embody these concepts. Note that representativeness is not included in this component – it forms an important part of B1B.

Rarity is served by a series of indicators, including level of endemism, the rarity of the vegetation association (in WA), river environment rarity (a measure from a range of variables mapped by CENRM); whether the site has unusual geology, relict invertebrate value, whether the site is a TEC or PEC; and proximity to rare or threatened species.

Naturalness is measured by the area of contiguous vegetation, proximity to large contiguous areas (>1000ha), dieback status, fire frequency (last 20 years) and river naturalness.

Diversity was measured by measures of the number of different types of a vegetation associations and wetland types; presence of perennial lakes and pools; plant and animal species richness; and a measure of river diversity. The plant and animal species richness figures are at present raw data that will need to be replaced in future as better and sampling bias-free data becomes available.

Many of the datasets used were available (such as proximity to rare flora, granite areas, TEC/PECs and & NCCARF Terrestrial Refugia value). However others had to be developed from a (2014) remnant vegetation cover dataset from DAFWA and from the best available vegetation association data. Endemism and % remaining in reserve datasets were supplied by staff from DPAW. DPAW staff are current analysing the species richness datasets – these require significant work in order to adjust them for the strong sampling bias that exists.

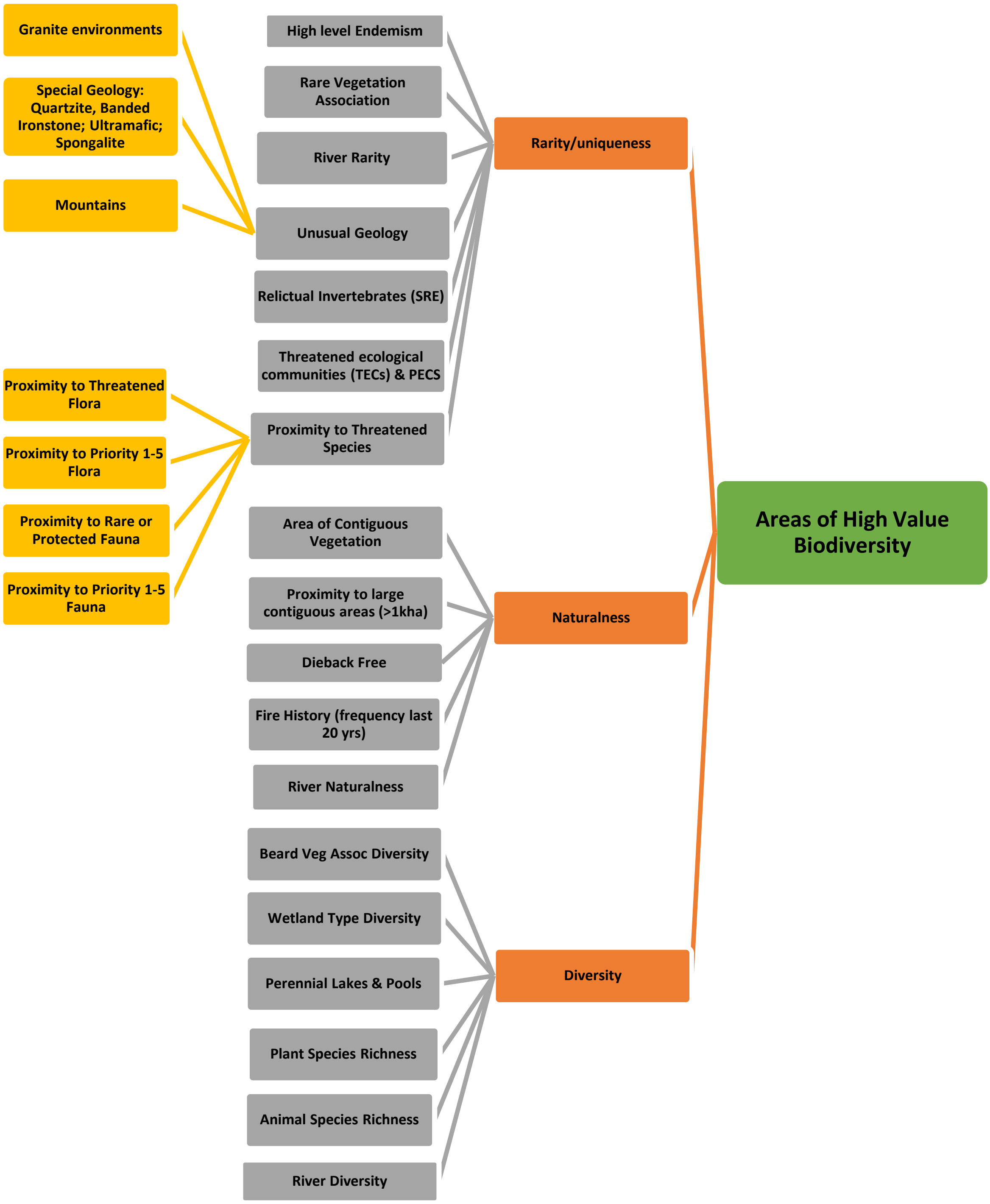


Figure 13: Component B1A – Areas of High Value Biodiversity

2.4.10 B1B – Identifying Areas of High Conservation Value/Potential

Component B1 uses at its core five criteria:

- High Biodiversity Value [B1A];
- Proximity to Linkages and Corridors [B3];
- Representativeness;
- Climate Resilience; and
- Management Potential

High biodiversity value and proximity to linkage and corridors are embodied in the defining framework for conservation value, and derived from their own components. Representativeness uses three criteria to embody the value of each patch in terms of its representativeness of vegetation association type, which affects its conservation value – i.e. has this vegetation association been significantly reduced, or was it always rare in the south west? Is this patch a significant portion of the remaining area of this association type? Is this vegetation already well represented in reserves?

Climate resilience is a measure of the likelihood of the continued maintenance of this area from a bio-climatic perspective. Management potential lists a number of criteria which assess the suitability of the area for on-going conservation, including the size of the contiguous area, the shape relative to the size of the area (to reduce edge effects), and the localise potential for infill (re-planting between existing vegetation to make larger contiguous areas).

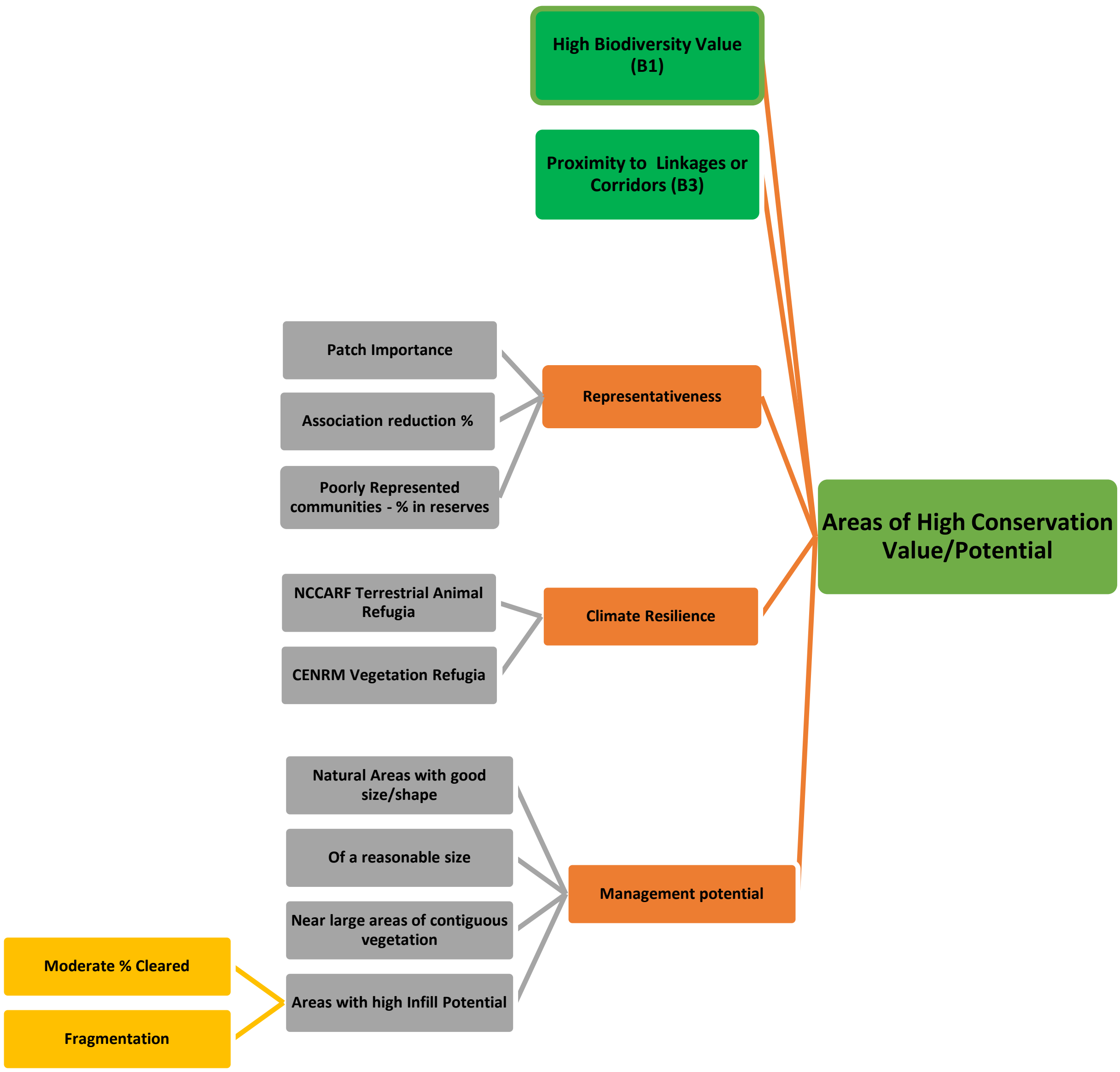


Figure 14: Component B1B – Areas of High Conservation Value/Potential Areas

2.4.11 B2 - Protection afforded under existing tenure/security

Component B2 is a simple component designed to provide a consolidated map of the protection afforded to vegetation through a range of instruments. It serves two purposes: identifying protection allows the better understanding of risk to vegetation, and the potential value of areas for longer-term conservation.

In the absence of good information on the threats to vegetation from a range of factors including many associated with climate change (see Component B4), identifying the protection accorded identifies areas which will be best suited to avoid at least some threats (such as vegetation clearing, ferals etc).

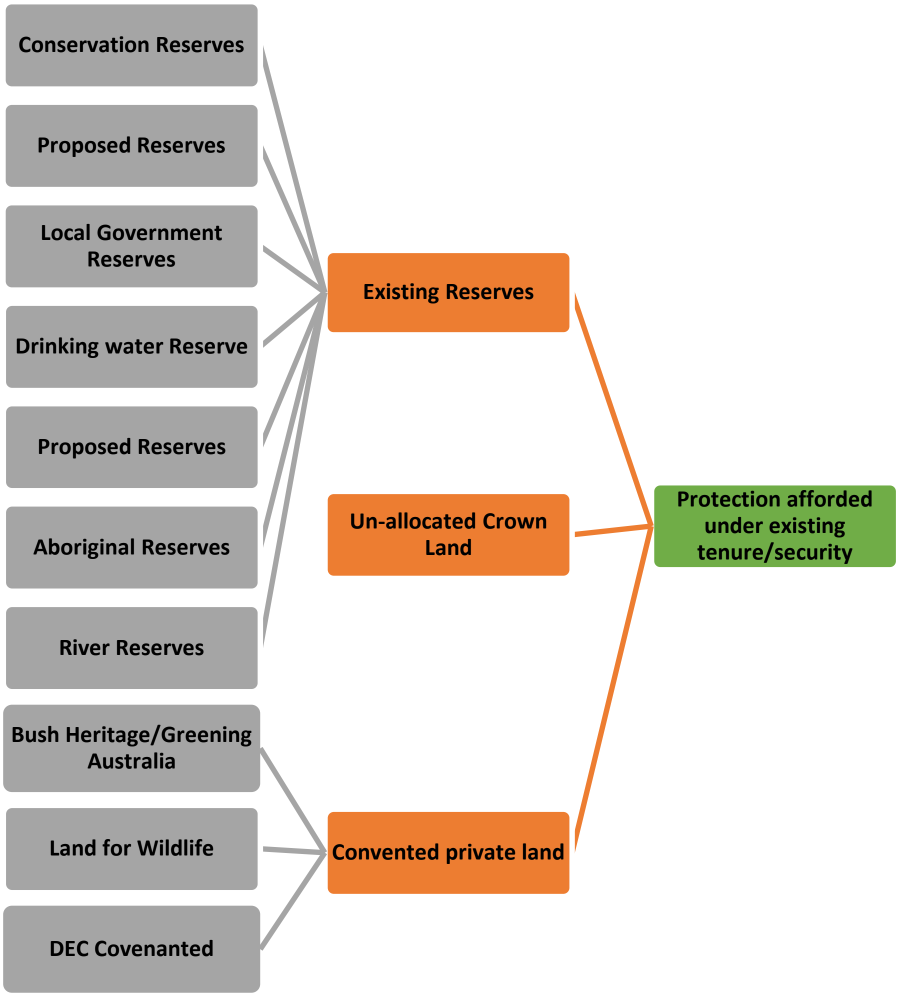


Figure 15: Component B2 – Protection afforded under existing tenure/security

2.4.12 B3 - Landscape Linkages/Corridors

One of the core components, identified in the terms of reference, this provides a framework to assist in both plantation establish for conservation outcomes, as well as the valuation of areas that are in potential or actual landscape linkages.

The model is based on three top-level criteria (or concepts): Cores, Natural corridors and Connectivity.

Cores are the link-pins of the system, representing the reservoirs of natural values. They are identified by using the outputs of component B2 (high protection and the Shape/Area ratio used in the conservation component). This ensures the linkages are grounded in the most suitable and best protected values.

Natural corridors represent existing areas of connectivity, either along rivers of other riparian zones, or along the coast. These are known as places of significant movement of animals and sometime plants by natural vectors. Connectivity is the real or potential connectivity in the landscape, characterised by the existing macro-corridor network, proximity to the large areas, and Connectivity Potential – a measure of connectivity between all patches of vegetation - all existing connectivity measures. The infill potential index combines the level of clearing and the amount of fragmentation in a 2km radius, to highlight areas with the best potential for improvement of connectivity.

Figure 16: Component B3 – Landscape Linkages/corridors

3. RESULTS AND OUTPUTS

3.1 Theme A

This section presents the results of the Components in two separate ways

- Component Maps – showing the results of the components as high, low or no priority planting or protection areas. This first set of basemaps does not account for competing demands (ie from other components).
- Combined Components – The maps are produced by combining the output of Components in Theme A and Theme B. In Theme A this produces maps of acceptable areas for commercial and carbon plantations, and for carbon plantings for biodiversity/landscape restoration (see Section 3.1.2). In Theme B this produces a range of maps regarding the current status of biodiversity and conservation (Section 3.2.2)..

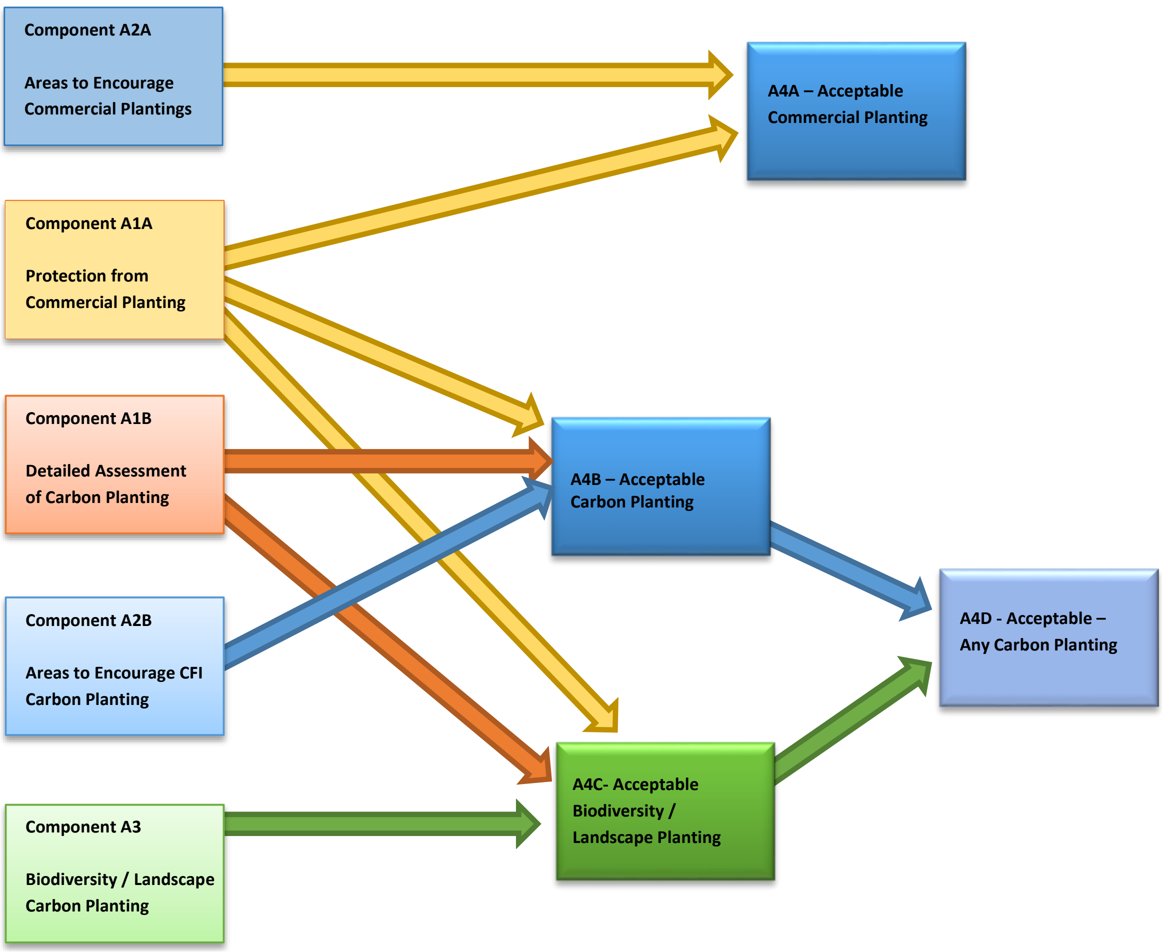


Figure 17: Component A4 design

For Theme A, the resolution of conflict, and the provision of easily-interpreted recommendations requires the combination of these separate outcomes (for the two types of planting) into a single Outcomes map. Such an outcome requires a hierarchy of uses which indicates which outcomes have precedence when they overlap. This is carried out in Section 3.1.3.

3.1.1 Theme A Component Maps

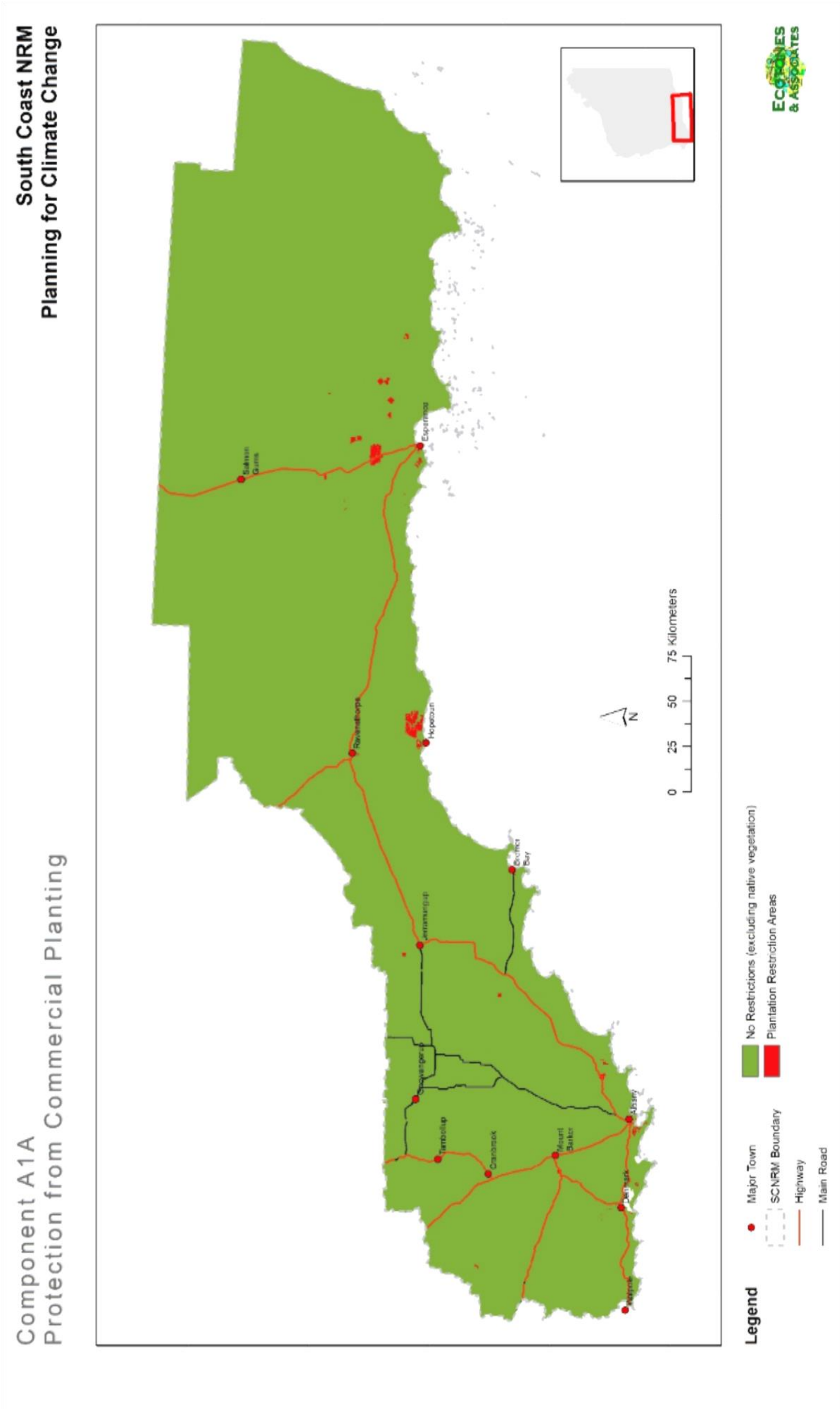


Figure 18: Component A1A – Landscapes that need to be protected from Commercial Plantings

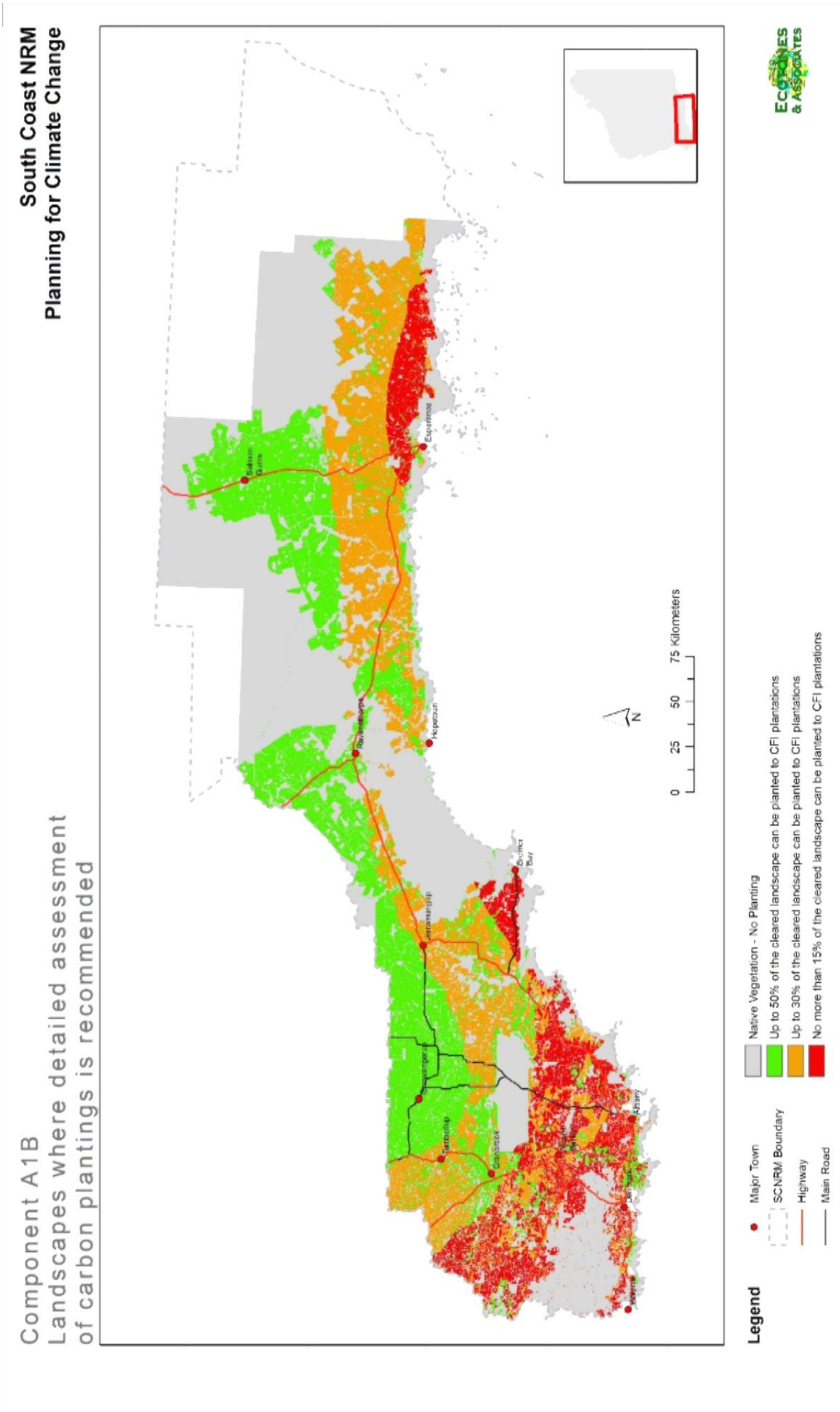


Figure 19: Component A1B – Landscapes that need to be protected from Carbon Plantings

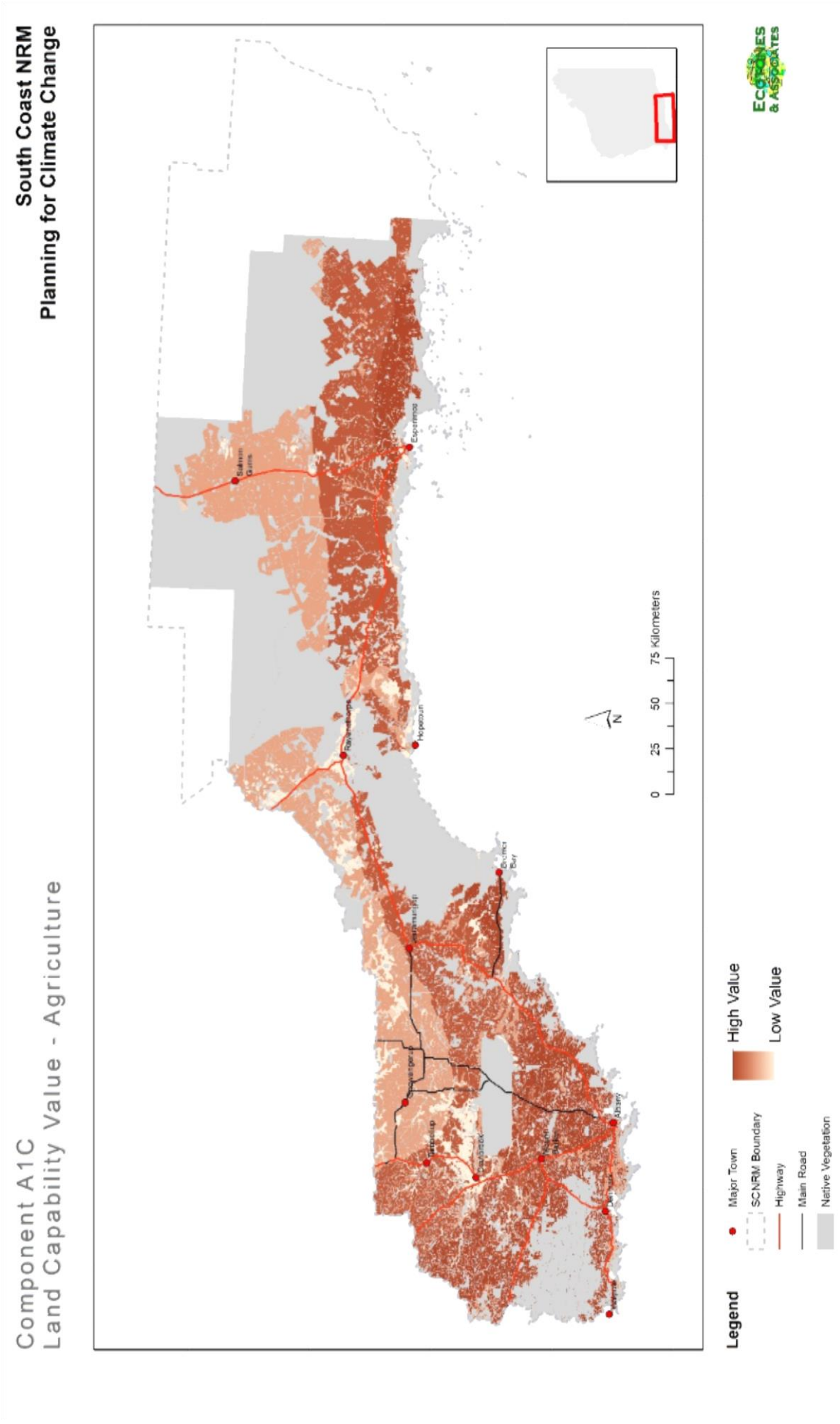
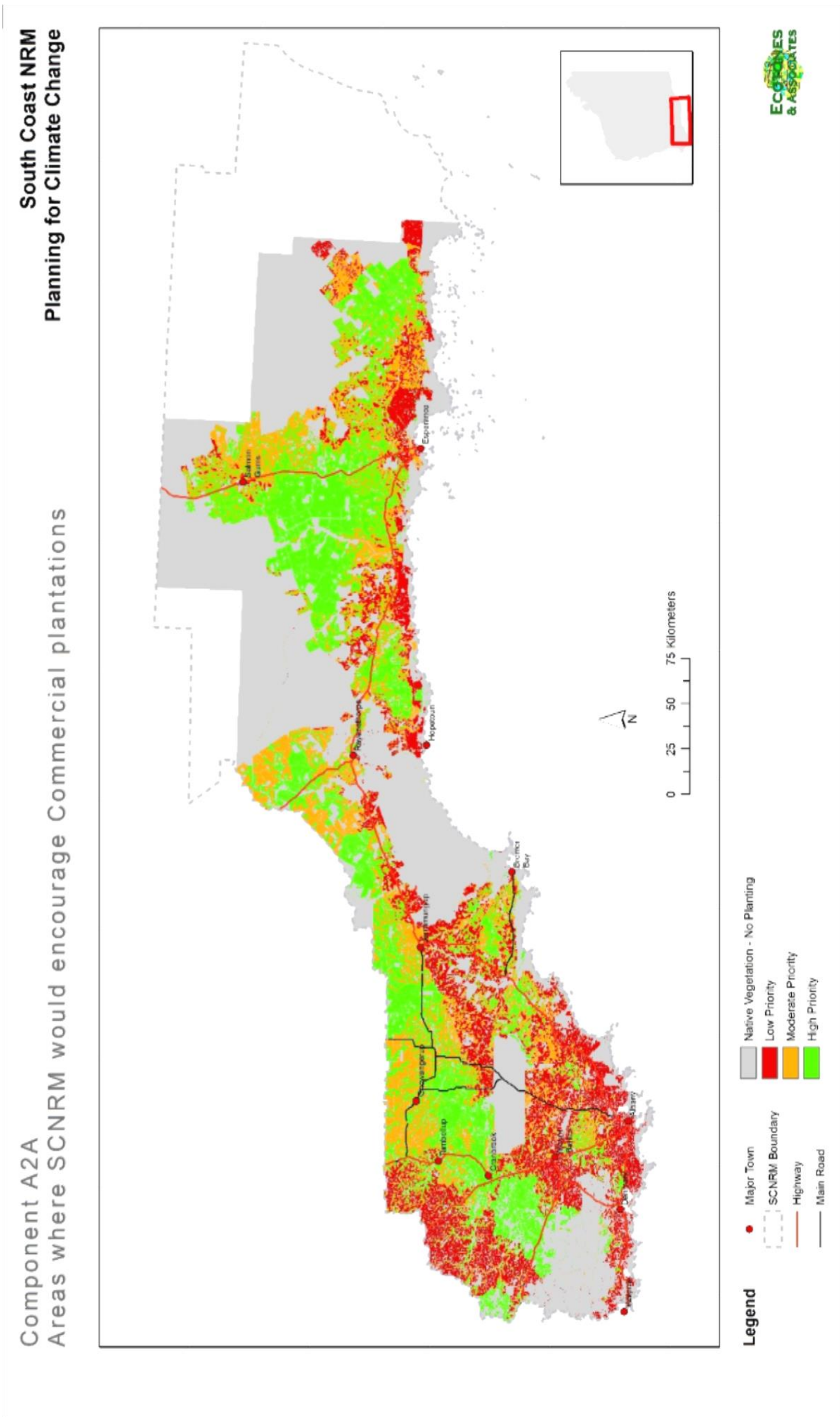
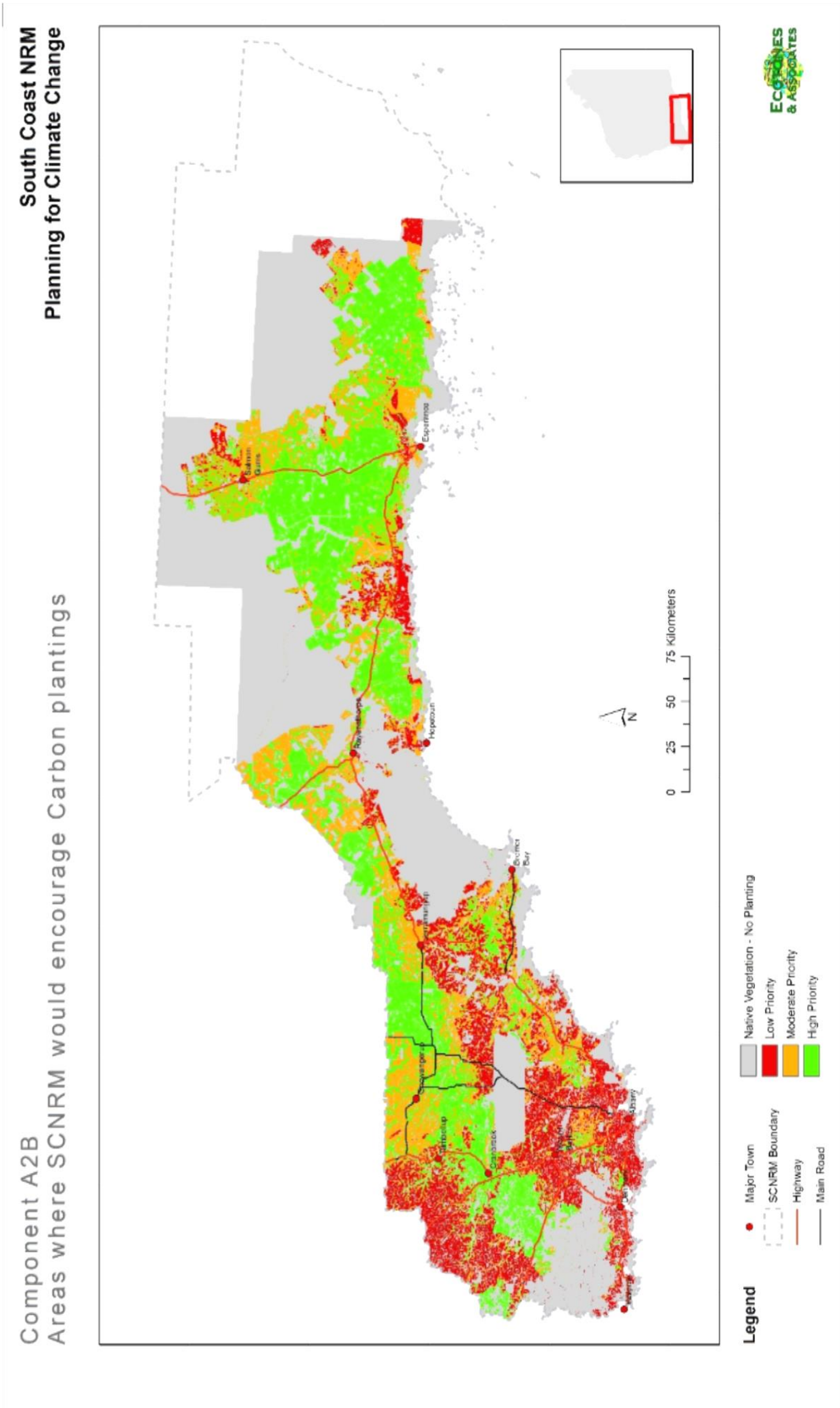


Figure 20: Component A1C – Land Capability Value – Agriculture



Component A2A – Areas where SCNRM would encourage Commercial plantations



Component A2B – Areas where SCNRM would encourage Carbon plantations

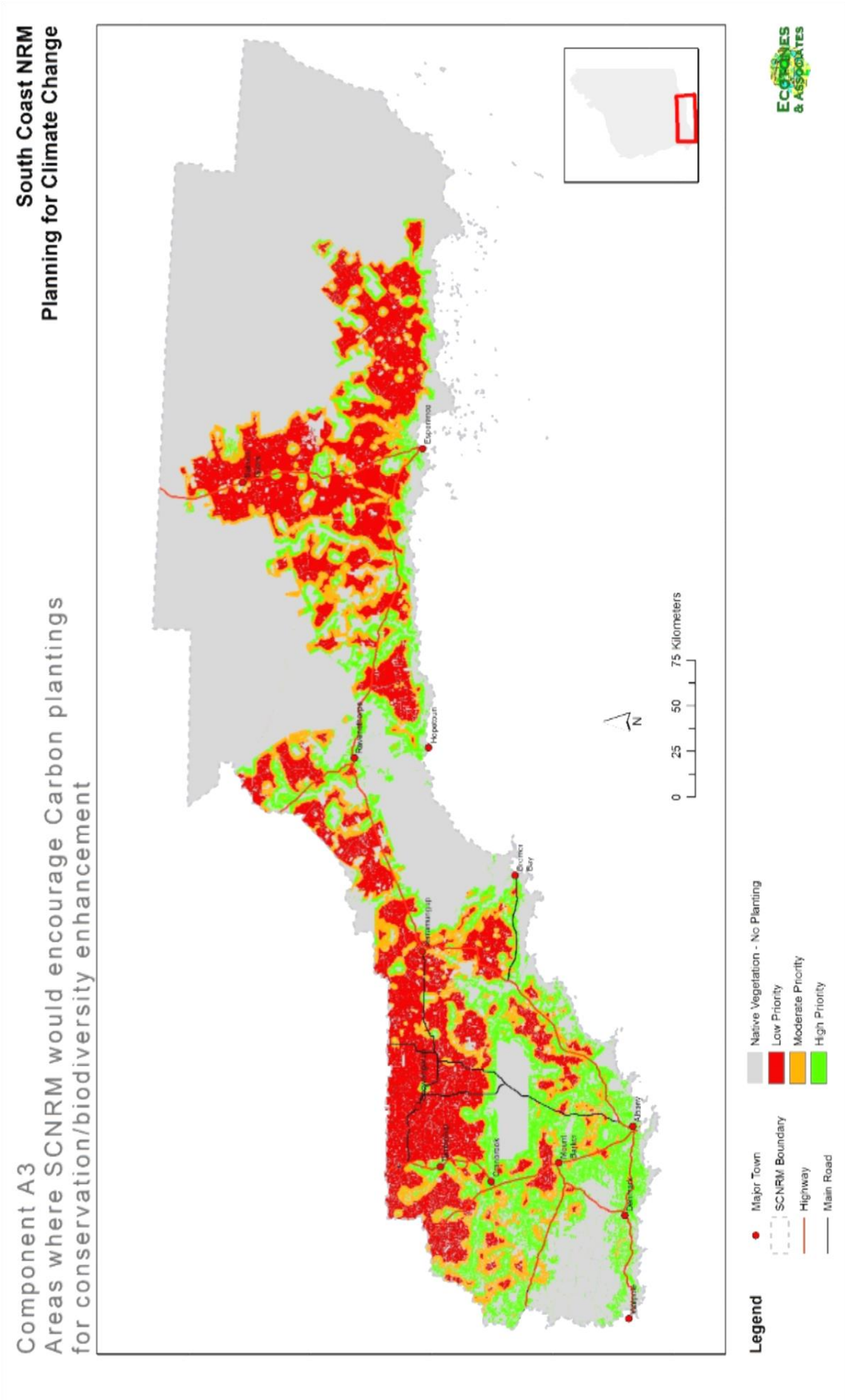


Figure 21: Component A3 – Carbon plantings for conservation/biodiversity enhancement

3.1.2 Component A4 - Combining Theme A Components.

We have developed a further MCAS Component to combine the outputs from Components A1, A2 & A3. This has allowed the production of maps of locations for the three major classes of planting (or both) in the context of the restrictions on planting from Component A1A & B.

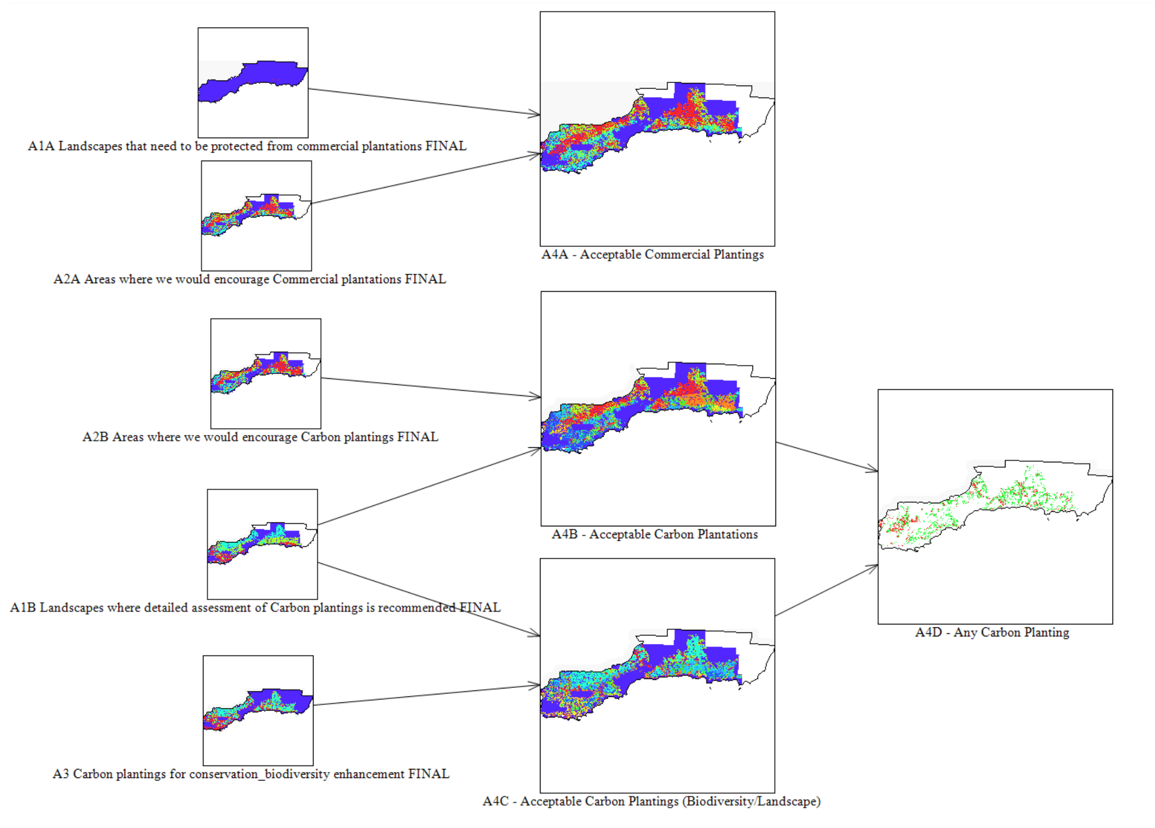


Figure 22: Component A4 – Combinations of Theme A Components

The outputs from Component A4 indicate, individually, locations for the three types of planting that exist: Commercial plantations, Carbon plantings and Carbon biodiversity plantings. We have also combined Carbon plantings and Carbon biodiversity plantings to indicate the areas that probably represent the highest priority areas for carbon planting.

Note that this mapping is complicated for carbon plantings by the use of a three-tier scale of restrictions in the form of suggested limits to the amount of the landscape covered by plantations (15%, 30% and 50% maximum). In practice it was felt by the Land Workshops dealing with these components that this would be unlikely to have any real impact on carbon plantations, given the collapse of the carbon price and a general lack of interest in carbon planting on the south coast.

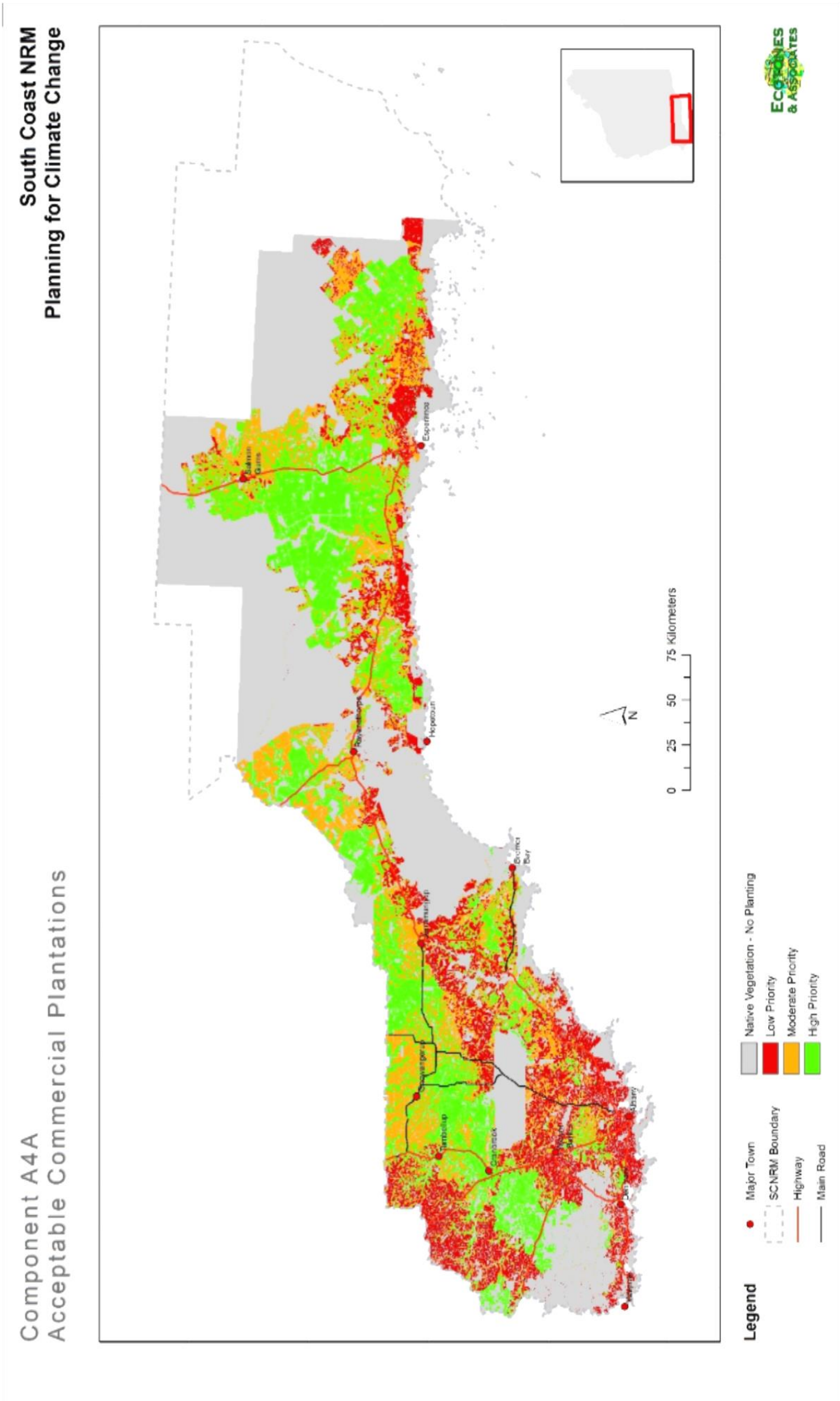


Figure 23: A4B - Acceptable Commercial Plantations

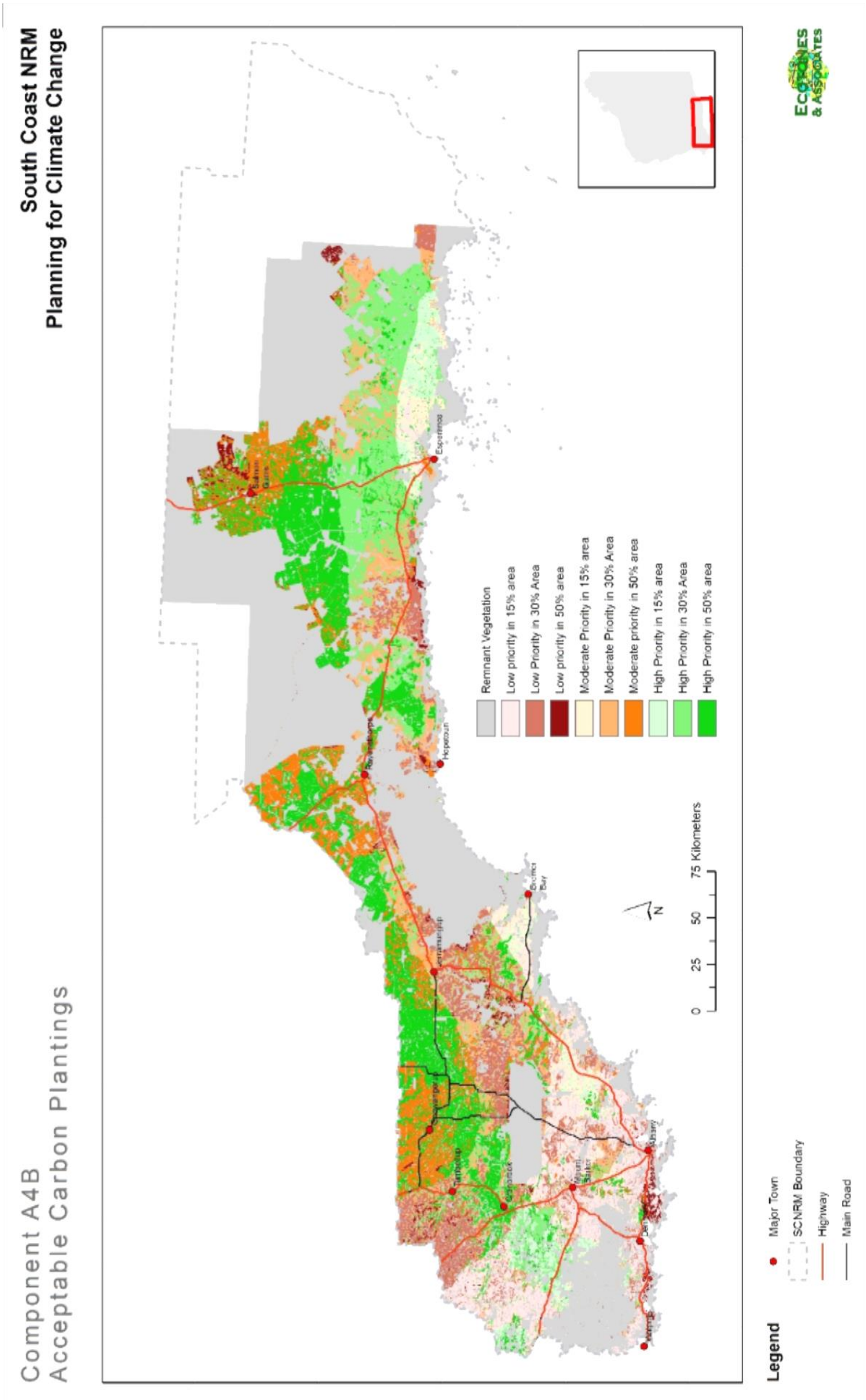


Figure 24: A4B - Acceptable Carbon Plantings

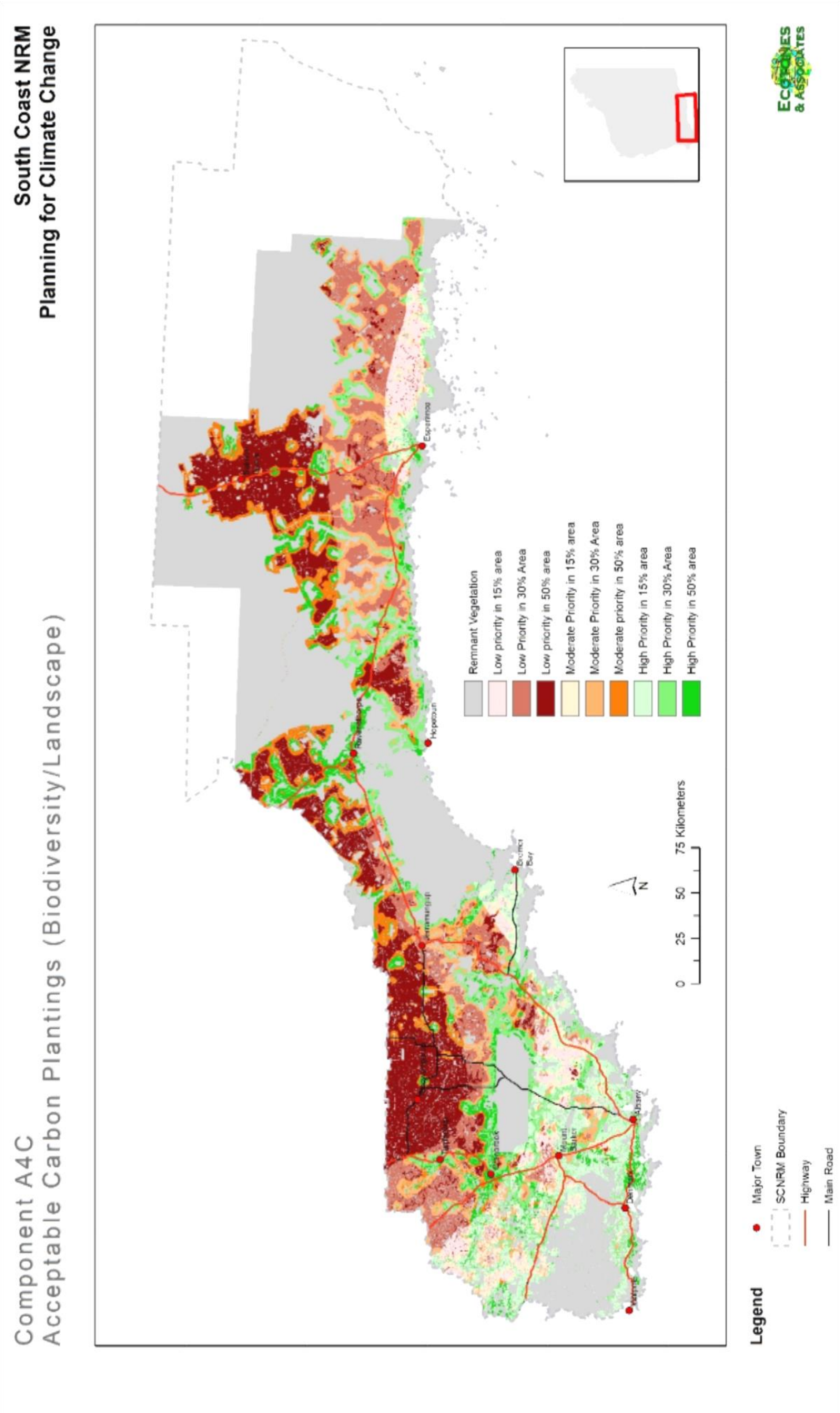


Figure 25: A4C - Acceptable Carbon Plantings (Biodiversity/Landscape)

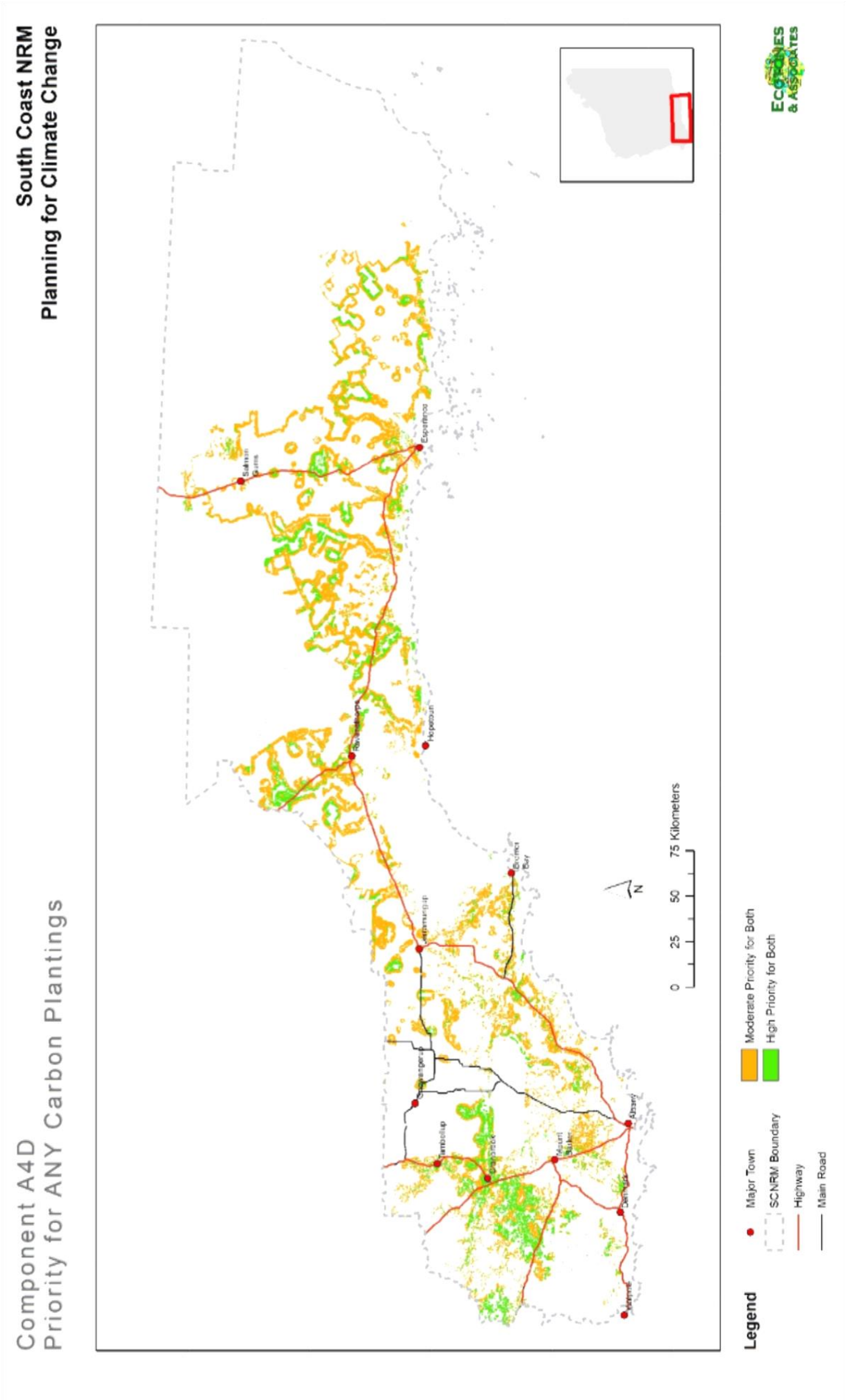


Figure 26: A4D – Priority for both Carbon Plantings AND Biodiversity Plantings

3.1.3 Carbon Planting Decision Support

The results maps presented in the previous section provide multiple options for any one cell, and so do not give clear direction to SCNRM staff. In order to provide this clearer direction, we have combined the results for the three components that refer to Carbon plantings (A1, A2B & A3) in a single map.[2]

Producing this map requires the adoption of a hierarchy of outcomes to select a preferred outcome from multiple options for each cell. For example, if a cell was indicated as being Low Priority for High-Biodiversity Planting, and High Priority for Low-Biodiversity planting and Low Priority for Protection, which usage should be preferred? The hierarchy provides the answer.

The hierarchy of outcomes is based on discussion in the working group about the issues generally surrounding plantations and carbon plantations in particular. It is shown in the figure below.

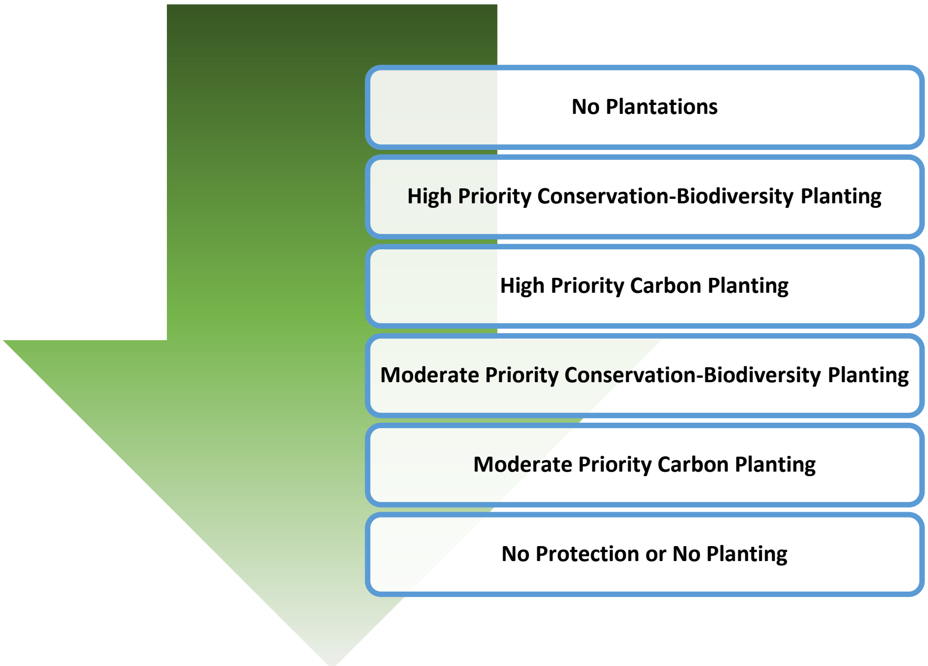


Figure 27: Outcome Hierarchy

This hierarchy provides a resolution for each conflict in the matrix of possible outcomes, listed in Table 1 below. The highest ranking outcome is indicated with green shading, and in some cases may be 2 cells where planting outcomes are equally ranked.

[2] This final map has been created in ArcGIS by making a grid of each component output, and multiplying the grids together to create a composite grid with every different combination of component outputs indicated by a unique cell value.

Grid Value	Outcome for Conservation/Biodiversity Planting	Outcome for Carbon Planting	Outcome for Protection
14	No Conservation-Biodiversity Planting	No Carbon Planting	No Protection
26	Low Priority CB Planting	No Carbon Planting	No Protection
28	No Conservation-Biodiversity Planting	Low Priority Carbon Planting	No Protection
34	Moderate Priority CB Planting	No Carbon Planting	No Protection
38	High Priority CB Planting	No Carbon Planting	No Protection
42	No Conservation-Biodiversity Planting	No Carbon Planting	Full Protection
52	Low Priority CB Planting	Low Priority Carbon Planting	No Protection
56	No Conservation-Biodiversity Planting	Moderate Priority Carbon Planting	No Protection
68	Moderate Priority CB Planting	Low Priority Carbon Planting	No Protection
76	High Priority CB Planting	Low Priority Carbon Planting	No Protection
78	Low Priority CB Planting	No Carbon Planting	Full Protection
84	No Conservation-Biodiversity Planting	Low Priority Carbon Planting	Full Protection
102	Moderate Priority CB Planting	No Carbon Planting	Full Protection
104	Low Priority CB Planting	Moderate Priority Carbon Planting	No Protection
112	No Conservation-Biodiversity Planting	High Priority Carbon Planting	No Protection
114	High Priority CB Planting	No Carbon Planting	Full Protection
136	Moderate Priority CB Planting	Moderate Priority Carbon Planting	No Protection
152	High Priority CB Planting	Moderate Priority Carbon Planting	No Protection
156	Low Priority CB Planting	Low Priority Carbon Planting	Full Protection
168	No Conservation-Biodiversity Planting	Moderate Priority Carbon Planting	Full Protection
204	Moderate Priority CB Planting	Low Priority Carbon Planting	Full Protection
208	Low Priority CB Planting	High Priority Carbon Planting	No Protection
228	High Priority CB Planting	Low Priority Carbon Planting	Full Protection
272	Moderate Priority CB Planting	High Priority Carbon Planting	No Protection
304	High Priority CB Planting	High Priority Carbon Planting	No Protection
312	Low Priority CB Planting	Moderate Priority Carbon Planting	Full Protection
336	No Conservation-Biodiversity Planting	High Priority Carbon Planting	Full Protection
408	Moderate Priority CB Planting	Moderate Priority Carbon Planting	Full Protection
456	High Priority CB Planting	Moderate Priority Carbon Planting	Full Protection
624	Low Priority CB Planting	High Priority Carbon Planting	Full Protection
816	Moderate Priority CB Planting	High Priority Carbon Planting	Full Protection
912	High Priority CB Planting	High Priority Carbon Planting	Full Protection

Green Shading indicates priority outcome.

Table 1: Decision Matrix - All Possible Combinations of Outcomes from Components A1A, A2B and A3.

Each possible outcome leads to a single resolution, as shown in Table 2. We have kept the option of listing and mapping these with the attached description, which indicates the alternative options for the cell.

Value	Outcome	Details
14	No Planting	No Planting priorities
26	No Planting	No strong planting priority
28	No Planting	No strong planting priority
34	CB Planting	Moderate Priority Conservation/Biodiversity Planting only
38	CB Planting	High Priority Conservation/Biodiversity Planting only
42	No Planting	Full Protection only
52	No Planting	Low Priority Conservation/Biodiversity Planting overriding Low Priority Carbon Planting
56	Carbon Planting	Moderate Priority Carbon Planting only
68	CB Planting	Moderate Priority Conservation/Biodiversity Planting overriding Low Priority Carbon Planting
76	CB Planting	High Priority Conservation/Biodiversity Planting overriding Low Priority Carbon Planting
78	No Planting	Full Protection overriding Low Priority Conservation/Biodiversity Planting
84	No Planting	Full Protection overriding Low Priority Carbon Planting
102	No Planting	Full Protection overriding Moderate Priority Conservation/Biodiversity Planting
104	Carbon Planting	Moderate Priority Carbon Planting overriding Low Priority Conservation/Biodiversity Planting
112	Carbon Planting	High Priority Carbon Planting only
114	No Planting	Full Protection overriding High Priority Conservation/Biodiversity Planting
136	CB Planting	Moderate Priority Conservation/Biodiversity Planting overriding Moderate Priority Carbon Planting
152	CB Planting	High Priority Conservation/Biodiversity Planting overriding Moderate Priority Carbon Planting
156	No Planting	Full Protection overriding Low Priority Conservation/Biodiversity Planting and Low Priority Carbon Planting
168	No Planting	Full Protection overriding Moderate Priority Carbon Planting
204	No Planting	Full Protection overriding Moderate Priority Conservation/Biodiversity Planting and Low Priority Carbon Planting
208	Carbon Planting	High Priority Carbon Planting overriding Low Priority Conservation/Biodiversity Planting
228	No Planting	Full Protection overriding High Priority Conservation/Biodiversity Planting and Low Priority Carbon Planting
272	Carbon Planting	High Priority Carbon Planting overriding Moderate Priority Conservation/Biodiversity Planting
304	CB Planting	High Priority Conservation/Biodiversity Planting overriding High Priority Carbon Planting
312	No Planting	Full Protection overriding Low Priority Conservation/Biodiversity Planting and Moderate Priority Carbon Planting
336	No Planting	Full Protection overriding High Priority Carbon Planting
408	No Planting	Full Protection overriding Moderate Priority Conservation/Biodiversity Planting and Moderate Priority Carbon Planting
456	No Planting	Full Protection overriding High Priority Conservation/Biodiversity Planting and Moderate Priority Carbon Planting
624	No Planting	Full Protection overriding Low Priority Conservation/Biodiversity Planting and High Priority Carbon Planting
816	No Planting	Full Protection overriding Moderate Priority Conservation/Biodiversity Planting and High Priority Carbon Planting
912	No Planting	Full Protection overriding High Priority Conservation/Biodiversity Planting and High Priority Carbon Planting

Table 2: Decision Matric - Priority Options and Description

The mapping of these provides the best options for each cell (as shown in Figure 28: Planting Priorities). This represents the final recommendations arising out of the entire process.

The planting priority outcomes have been mapped in combination with an overlay of A1B – Areas where detailed assessment of carbon plantings is required. This Component indicates the extent to which the Reference Group felt that CFI plantings should be taken to, to limit the amount of landscape that is bound up in long-term plantation commitments. Note that this can be taken to apply to both large-scale Carbon plantations as well as conservation/biodiversity plantings – but that such a restriction would have a much smaller impact on conservation/biodiversity plantings due to their likely smaller scale.

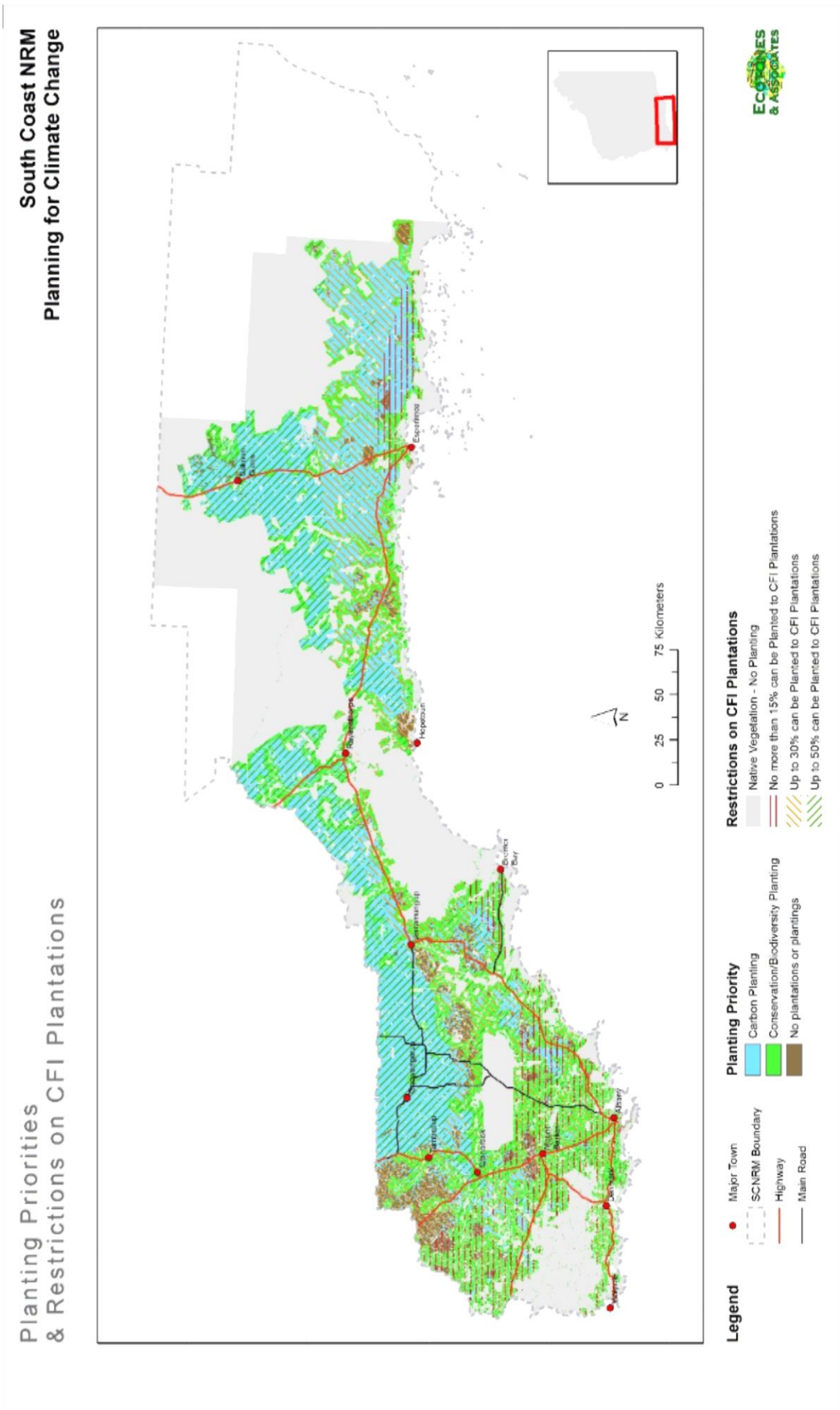


Figure 28: Planting Priorities & CFI Restrictions

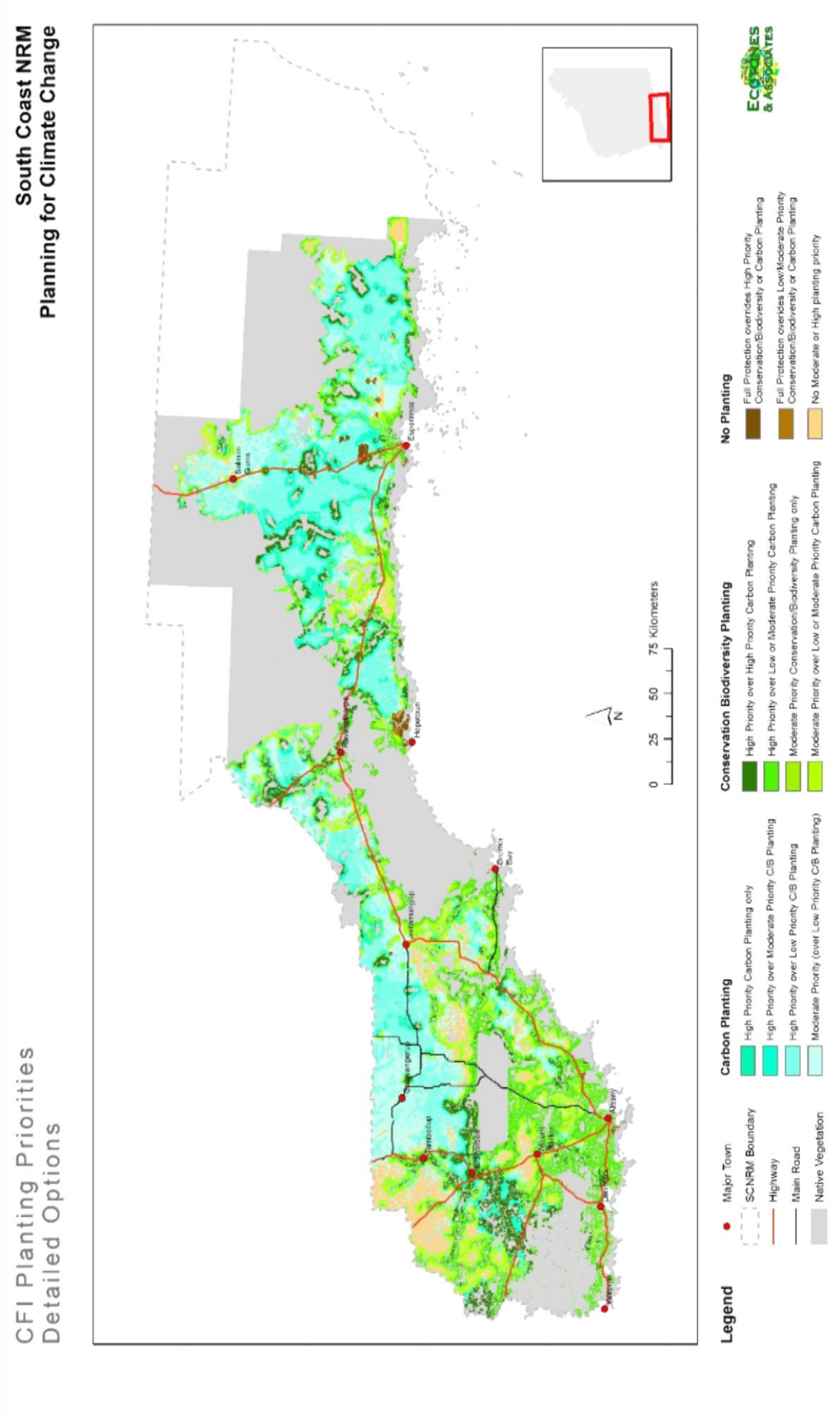


Figure 29: Decision Matrix - Priority Outcome Descriptions

3.2 Theme B

3.2.1 Theme B Component Maps

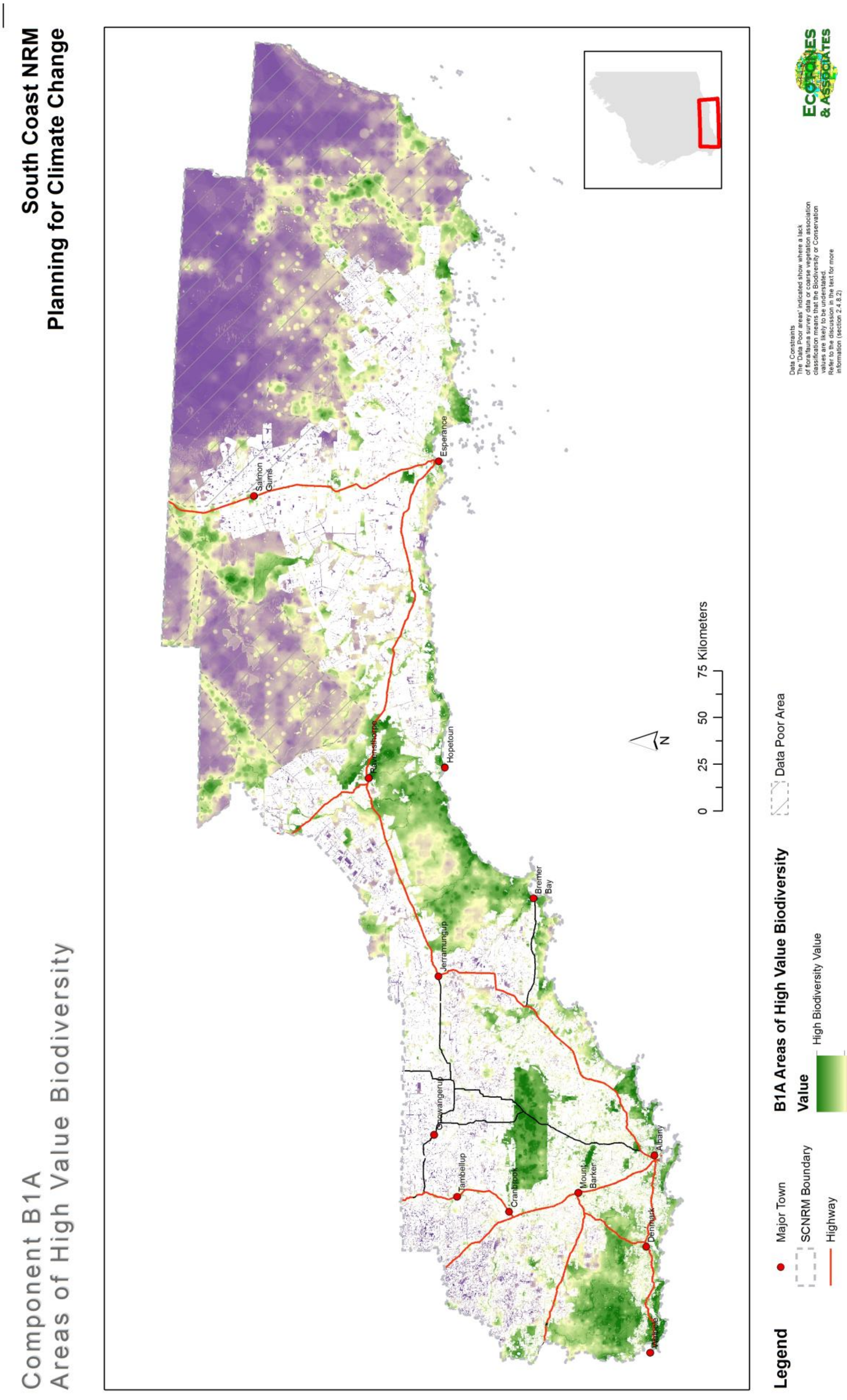


Figure 30: Component B1A – Identified Areas of High Value Biodiversity

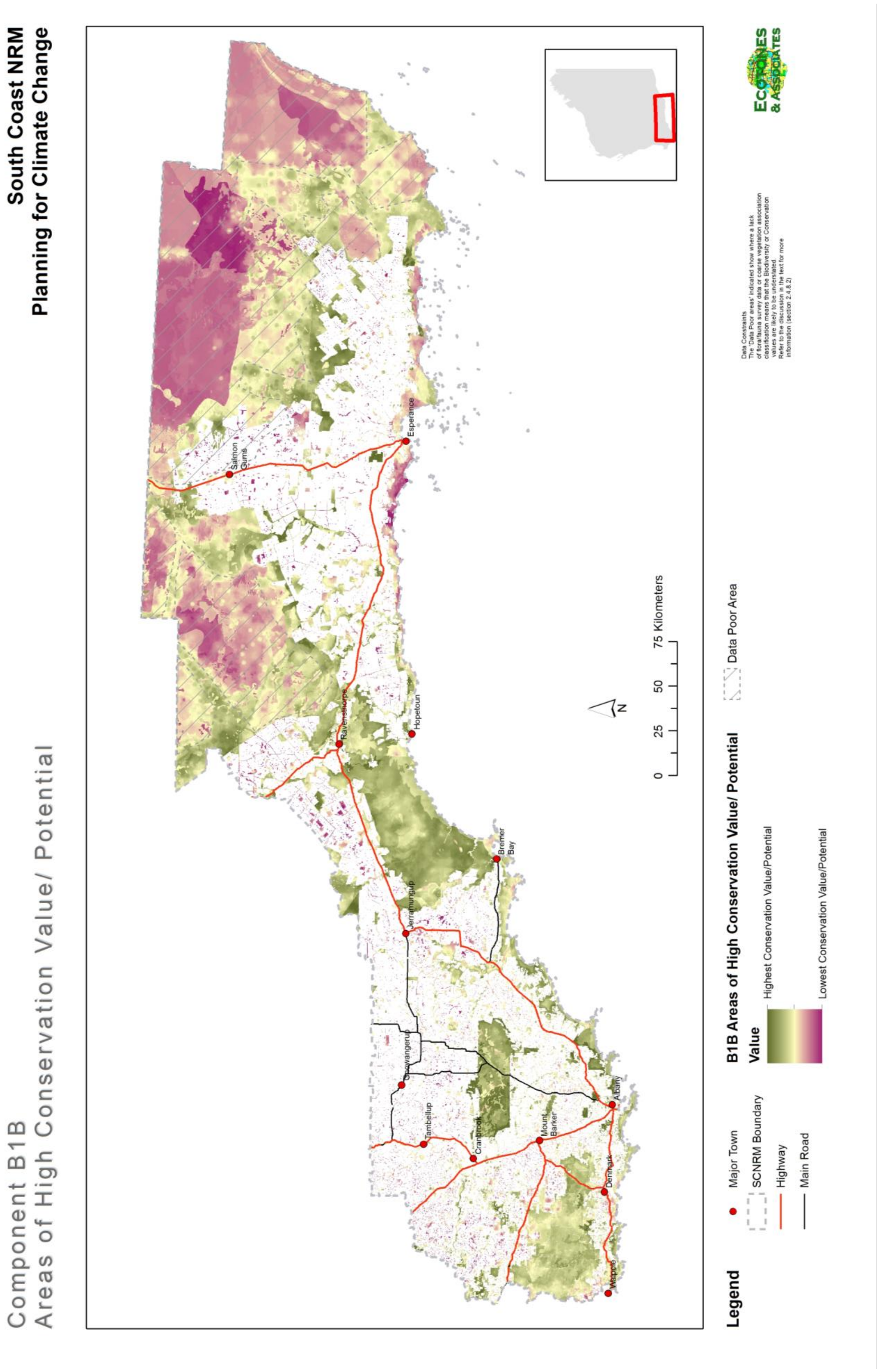


Figure 31: Component B1B – Identified Areas of High Conservation Value

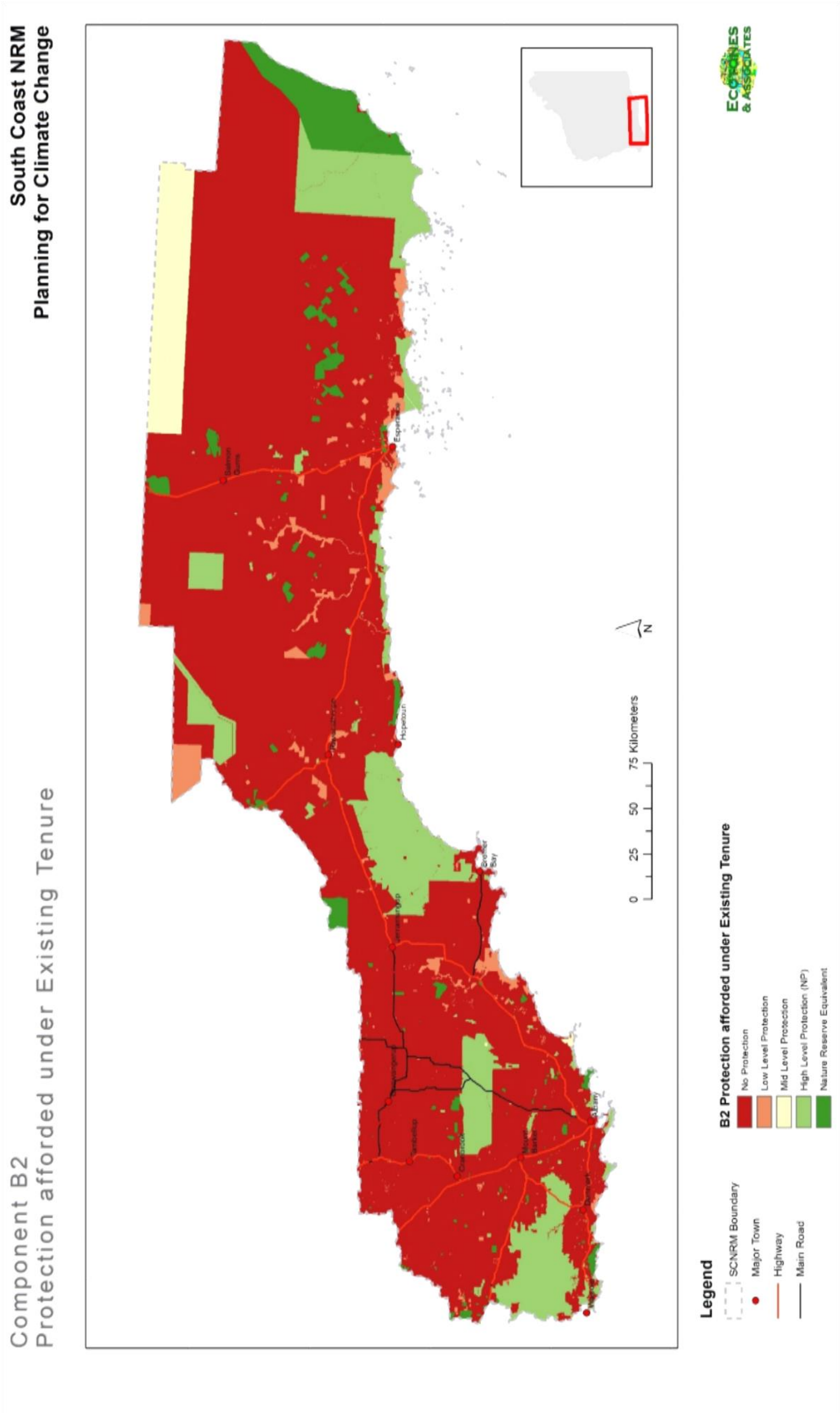


Figure 32: Component B2 - Protection afforded under existing tenure

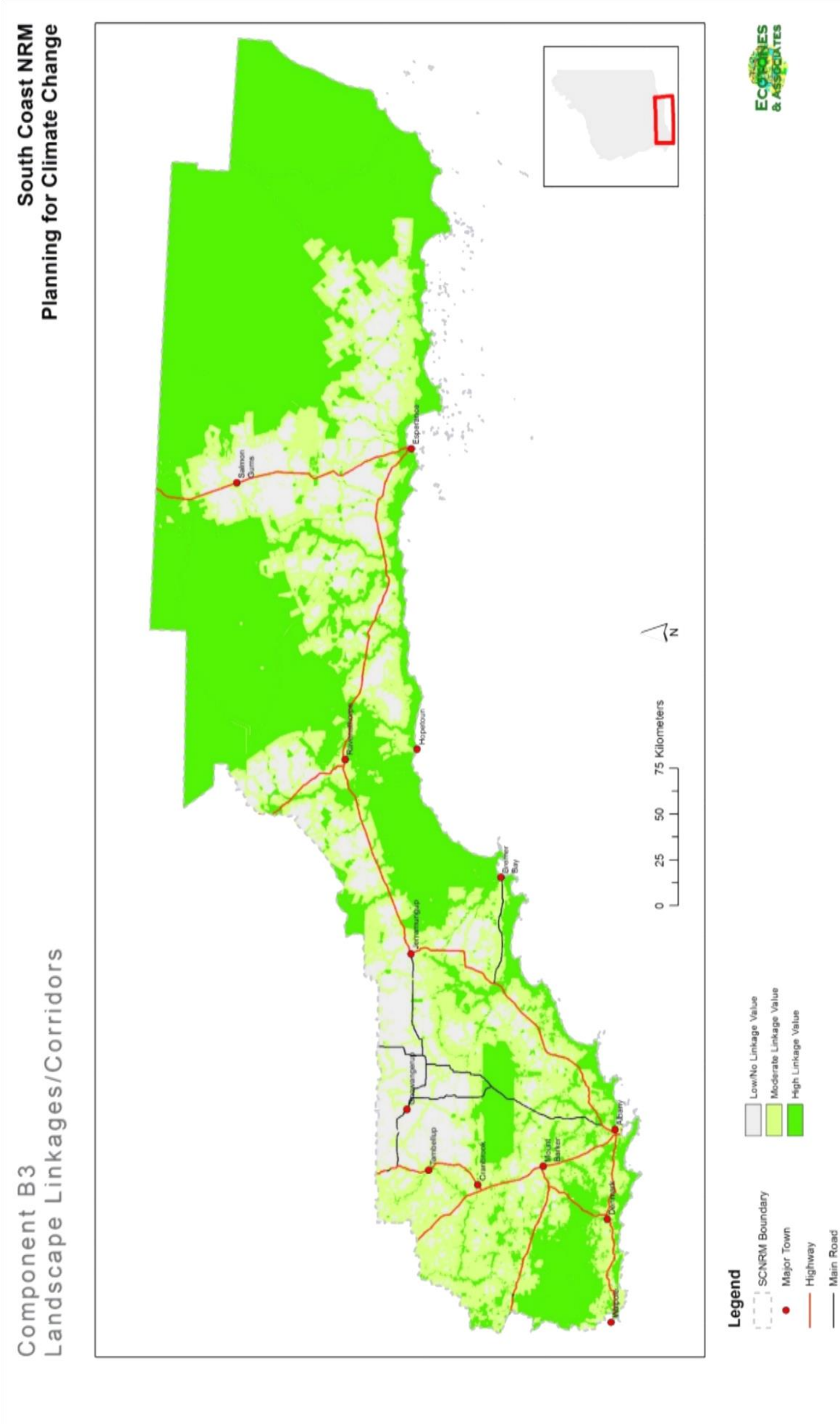


Figure 33: Component B3 – Landscape Linkages/Corridors

3.2.2 Component B4 - Combining Theme B Components

We have developed an MCAS Component to combine the outputs from Theme B - B1A, B1B and B2 and B3. This has allowed the production of maps which may be useful for specific aspects of biodiversity conservation in respect to protection and linkages. It must be noted that these are intended only as indications of how the Theme B outputs may be used in biodiversity prioritisation – both in work directly by and for SCNRM, but also in efforts that SCNRM may undertake in conjunction with other agencies (such as DPAW) .

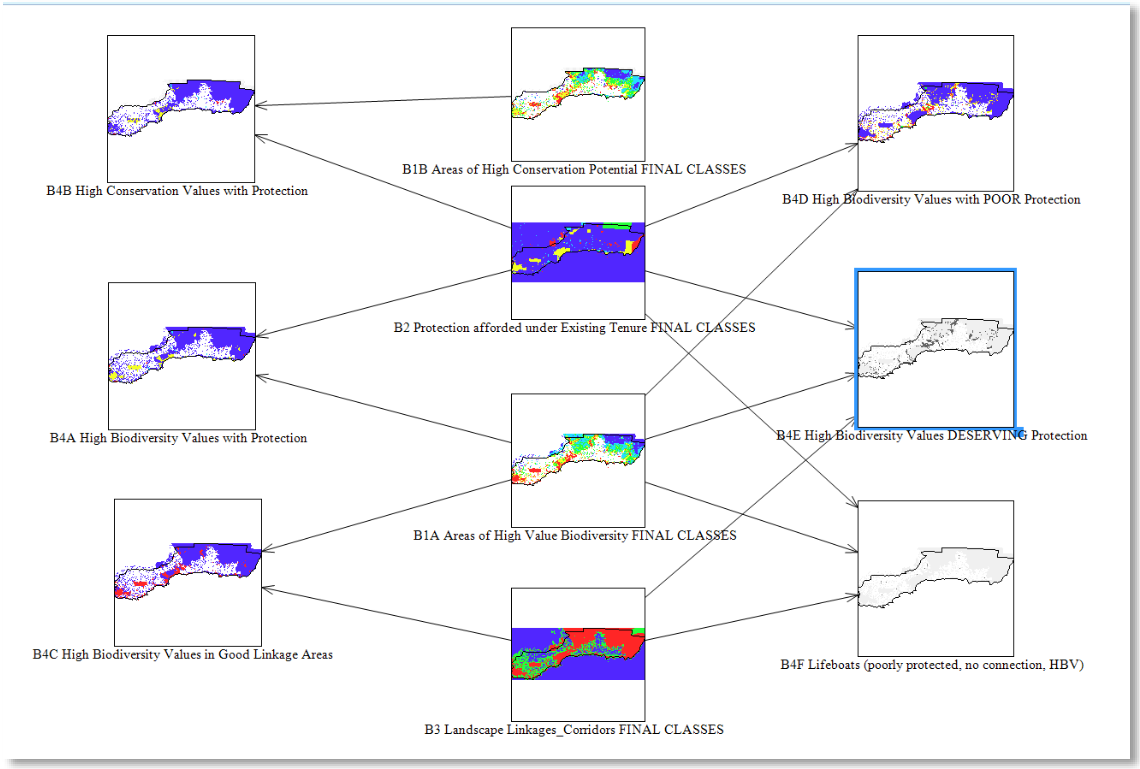


Figure 34: Component B4 – Combinations of Theme B Components

The outputs from Component B4 indicate:

- The protection status of High Biodiversity values;
- The protection status of High Conservation Values;
- Where High Biodiversity Values exist in areas with good linkage potential;
- Where High Biodiversity Values exist in areas with poor protection (= requiring protection);
- Where High Biodiversity Values exist in areas with poor protection but with good linkage values (= deserving protection); and
- "Lifeboat Areas" – area with high biodiversity values that are poorly protected and with poor linkage potential. These have been described as "lifeboat areas" – collect seed/specimens but do not invest. A harsh but probably accurate reflection of their fate, unless they have high resilience along the lines of an OCBIL classification of Stephen Hopper (Hopper, 2009).

3.2.2.1 Indicative Theme B results

B4A - High Biodiversity Values with Protection

This map shows areas with 'high' biodiversity value (using the highest class value from the output of Component B1A), with their current level of protection from tenure and vesting. It indicates that the bulk of high biodiversity values identified are currently protected with significant levels of support, notably in the Stirling Range and Fitzgerald National Parks, and the Walpole wilderness areas north of Walpole. However a number of small areas of high biodiversity value, particularly along the coast but also in a few isolated blocks of vegetation, have low levels of protection.

B4B High Conservation Values with Protection

This map shows areas with 'high' conservation value (using the highest class value from the output of Component B1B), with their current level of protection from tenure and vesting. It also indicates that the bulk of high conservation values identified are currently protected with significant levels of support, notably in the Stirling Range and Fitzgerald River National Parks, and in areas of Nature Reserve north-east of Esperance. However a number of small areas of high conservation value, particularly a few isolated blocks of vegetation, have low levels of protection.

B4C High Biodiversity Values in Good Linkage Areas

This map indicates where high biodiversity values occur in areas with good landscape linkage potential.

B4D High Biodiversity Values with Poor Protection

This map identifies high biodiversity values (using the class values from the output of Component B1A), which currently have poor protection from tenure and vesting (ie they effectively have no protection). It clearly indicates a significant channel of high value between the eastern end of the Fitzgerald River National Park and the south-western edge of the Great Western Woodlands, as well as un-protected areas of value along the coast. These indicate potential areas for future reservation of additional protection.

B4E High Biodiversity Values Deserving Protection

Map B4E uses three criteria to identify all areas that combine high or very high biodiversity value and no tenured/security protection with high landscape linkage value. We have used the descriptor "deserving protection" due to this intersection of values. Additional reservation, protection through covenants, or even biodiversity plantings to provide better connectivity and to augment current smaller areas would assist in meeting multiple objectives of protection of biodiversity and landscape re-connection.

B4F "Lifeboat Areas"

This is an exploratory map of areas that meet a different set of criteria: high biodiversity values and poor protection combined with being outside of landscape linkages. Such isolated, poorly protected land has fewer reasons for investment, and even if given better protection is likely to remain isolated. Unless these areas are extremely robust (i.e. OCBILS according to Hopper, 2009) they are likely to continue to decline over time. The suggestion of a "lifeboat" is that we would consider forms of off-site conservation (such as relocation of species) but not invest additional resources.

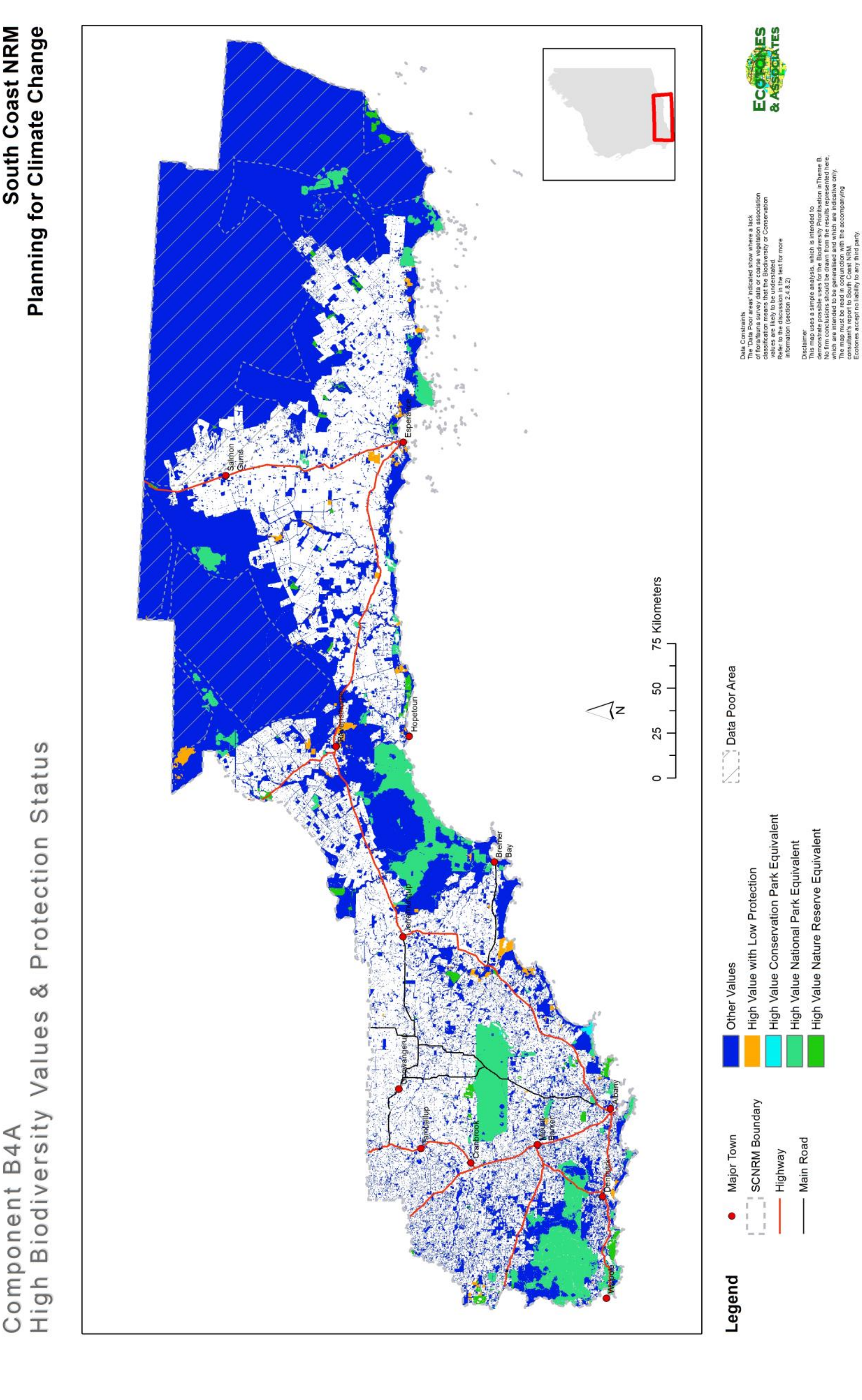


Figure 35: B4A High Biodiversity Values and Protection Status

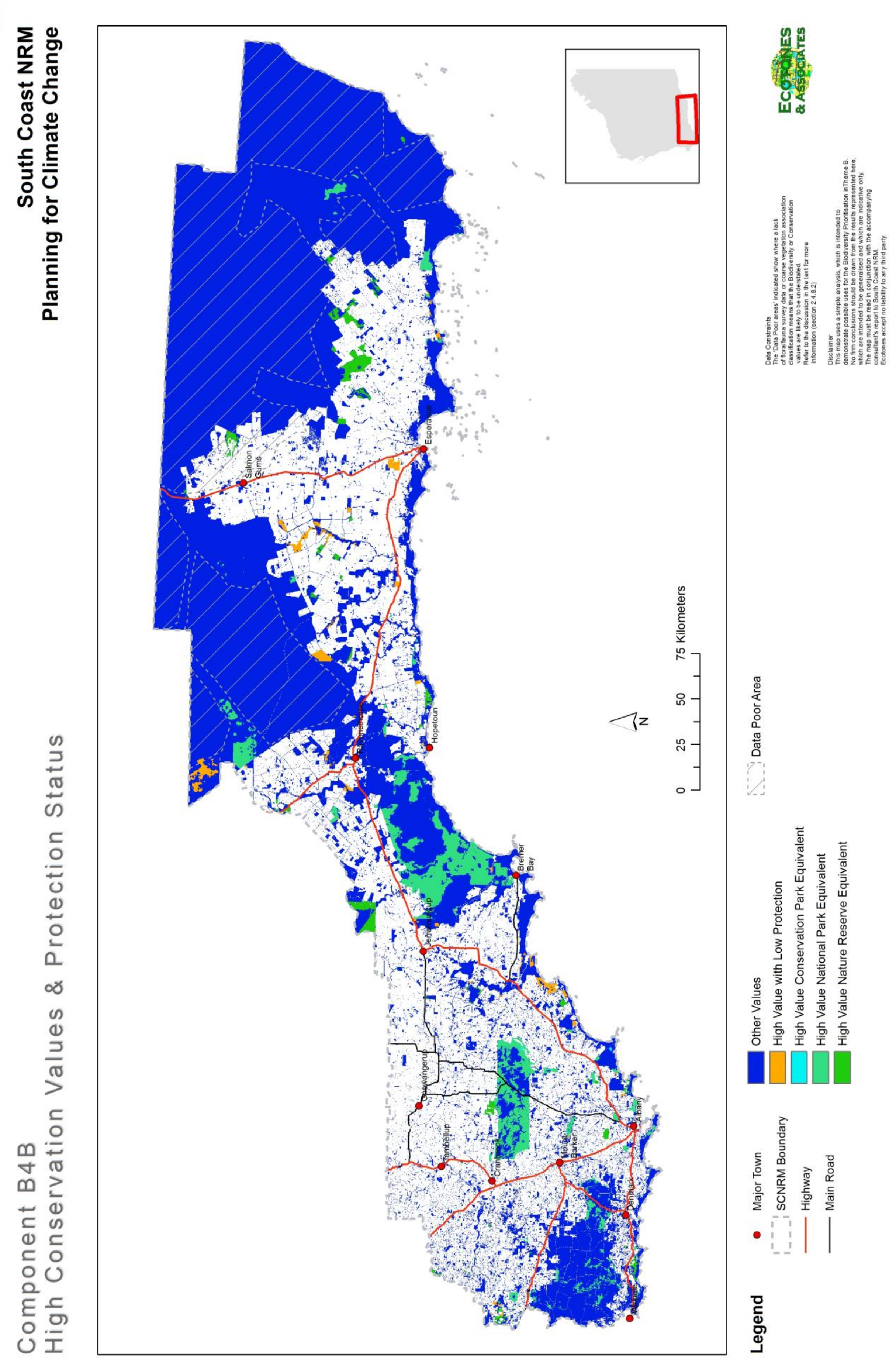


Figure 36: B4B High Conservation Values and Protection Status

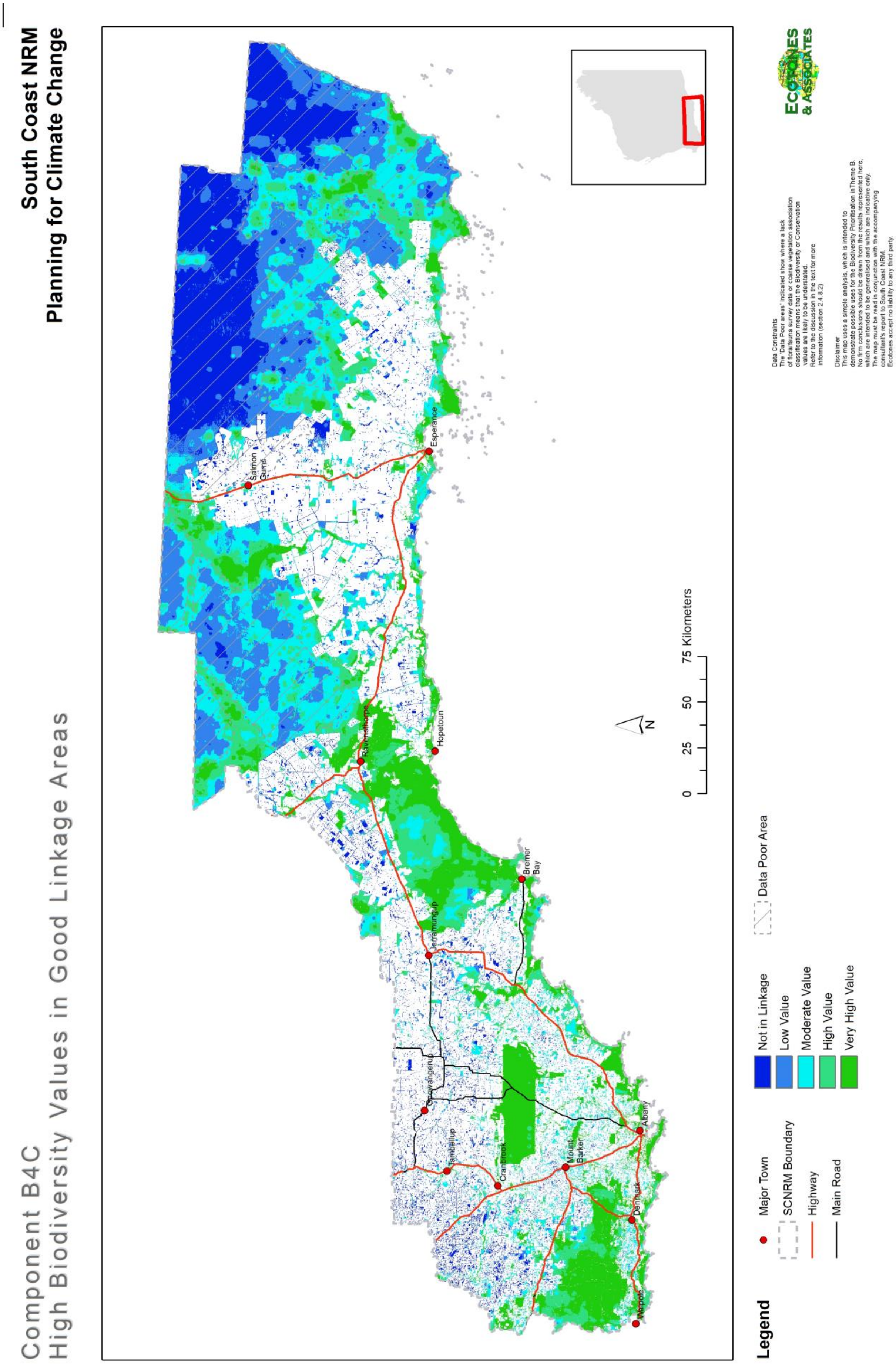


Figure 37: B4C High Biodiversity Values in Good Linkage Areas

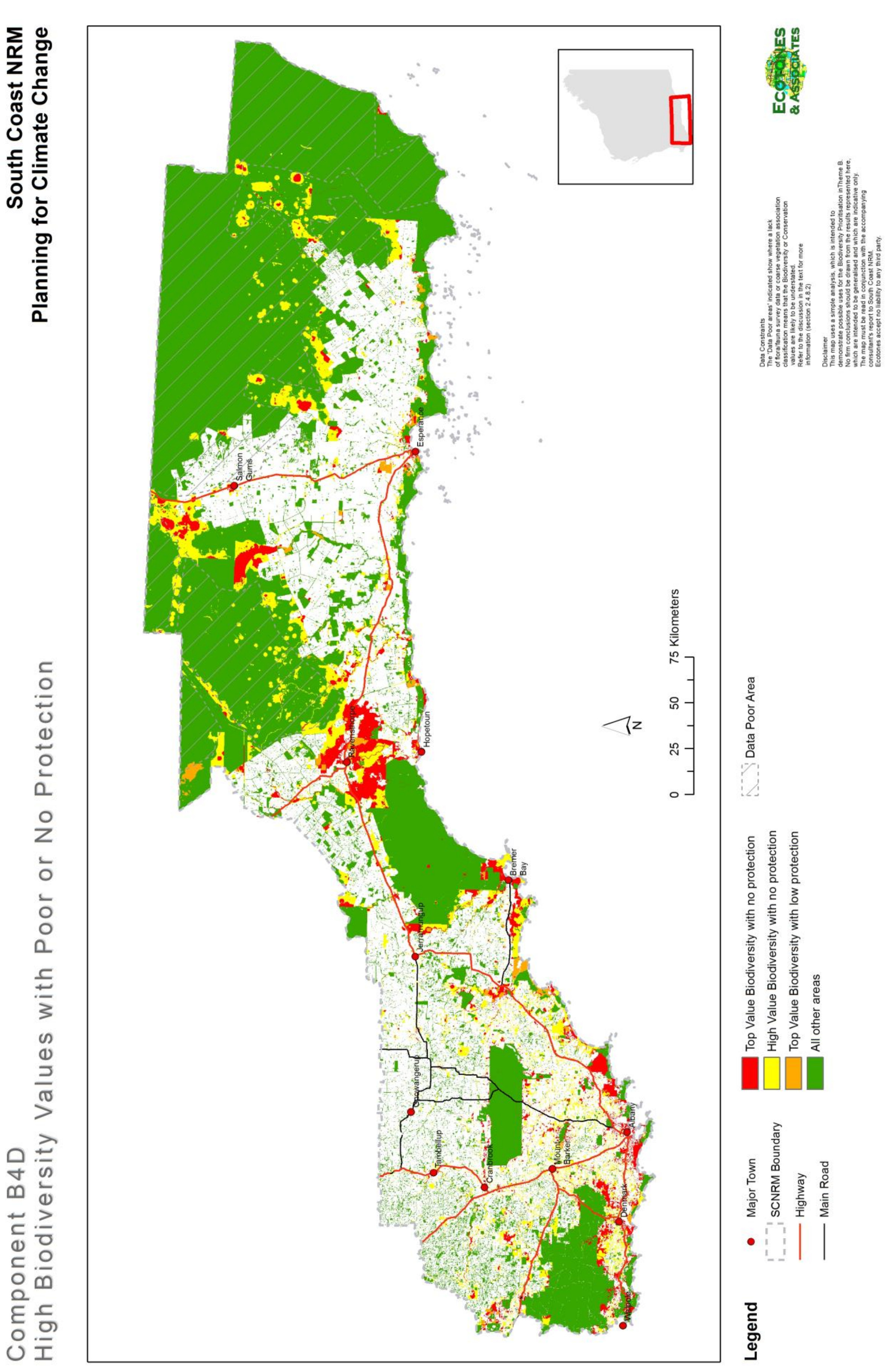


Figure 38: B4D High Biodiversity Values with Poor Protection

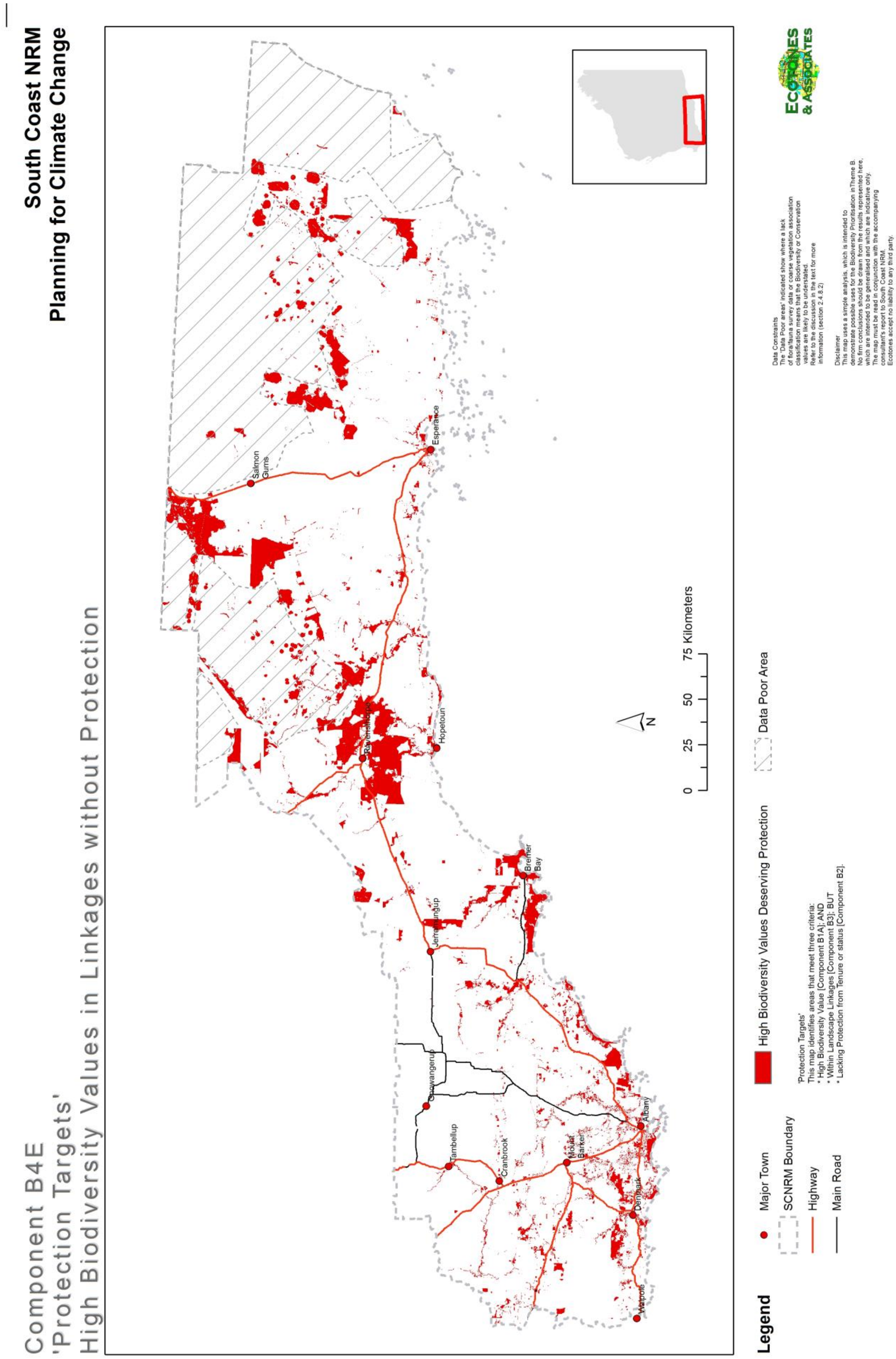


Figure 39: B4E High Biodiversity Values Deserving Protection

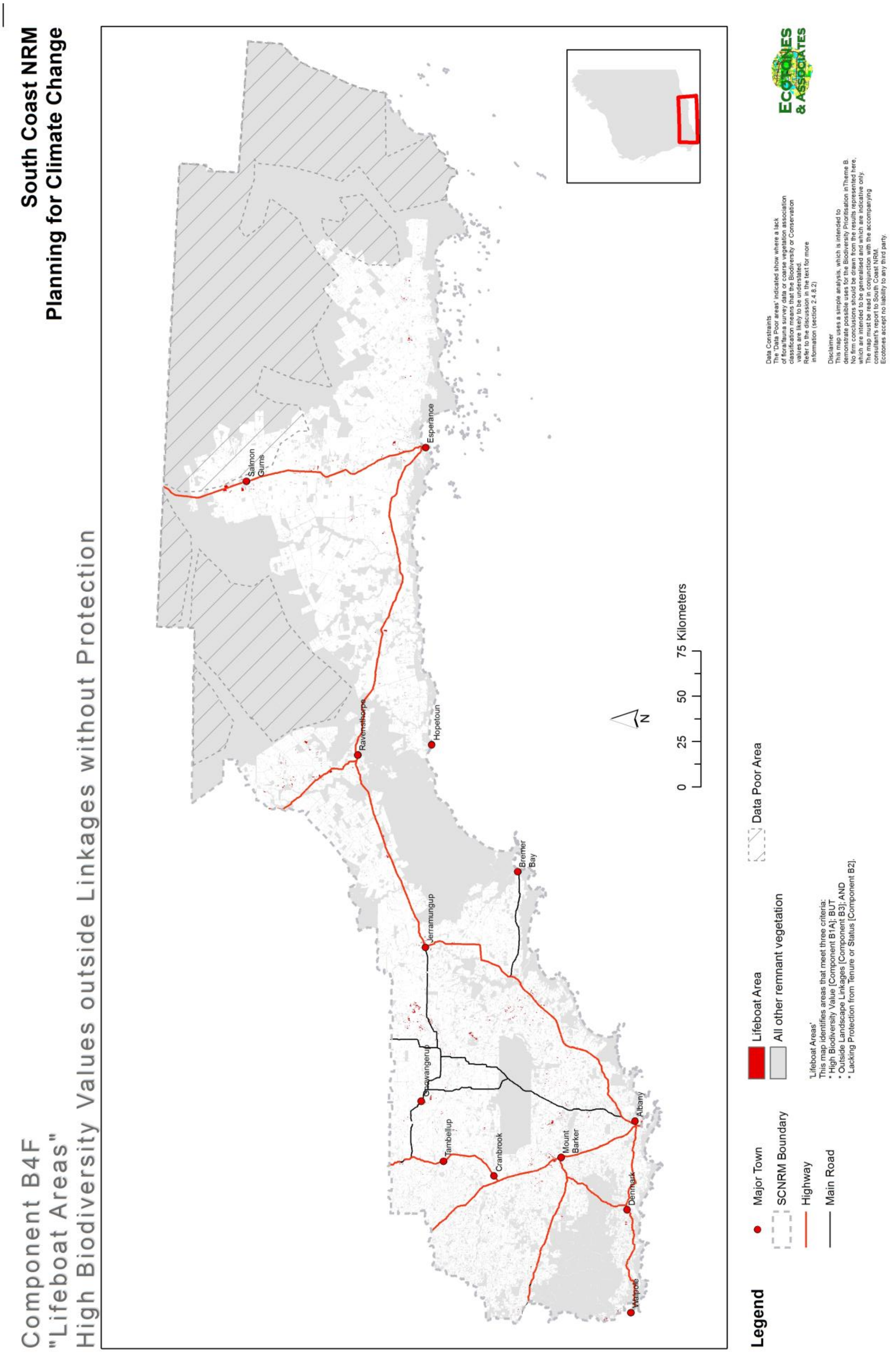


Figure 40: B4F "Lifeboat Areas"

4. MCAS-S COMPONENTS IN DETAIL

4.1 Theme A

The figures illustrating the MCAS-S components (like MCAS-S) use a number of conventions. Key amongst these is the use of a Red-Blue colour ramp to indicate values. Depending on the number of value classes selected, the ramp will be more or less complex, but in all cases, Red = high value, Blue = low value, and Green = middle value.

Note that unless otherwise stated, the colours used in the maps of individual criteria use red as the highest value ("hot") and blue as the lowest ("cold"):

Figure 41: Classification Figures in MCAS-S

4.1.1 Components A1A & A21B – Protection from commercial plantations and detailed assessment of carbon plantings.

As discussed in the component logic section, Component A1 has been split into two parts: Component A1A – Landscapes that need to be protected from commercial plantations, and Component A1B – Landscapes where detailed assessment of carbon plantings is recommended. Because of a large number of shared logic and datasets, the A1A and A1B analysis is carried out in a single MCAS model. This section will outline the criteria used for both parts of the model.

The MCAS-S diagram for component A1A & A1B is as follows:

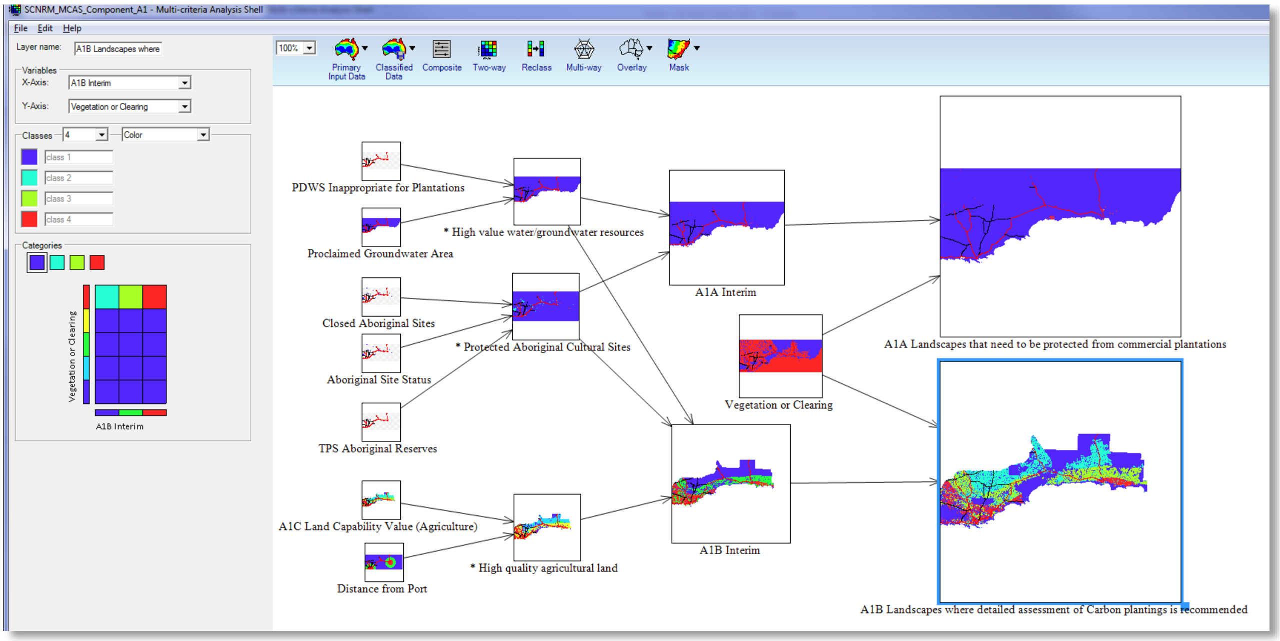


Figure 42: Component A1A & A1B MCAS-S Diagram

4.1.1.1 PDWSA areas inappropriate for plantations

PDWSA (Public Drinking Water Source Areas) include underground water pollution control areas and water reserves, where planting large scale plantations will impact on the provision of water. These are relatively small areas in SCNRM, and the two types of zone are given the same value.

The PDWSA areas inappropriate for plantations are indicated in red:

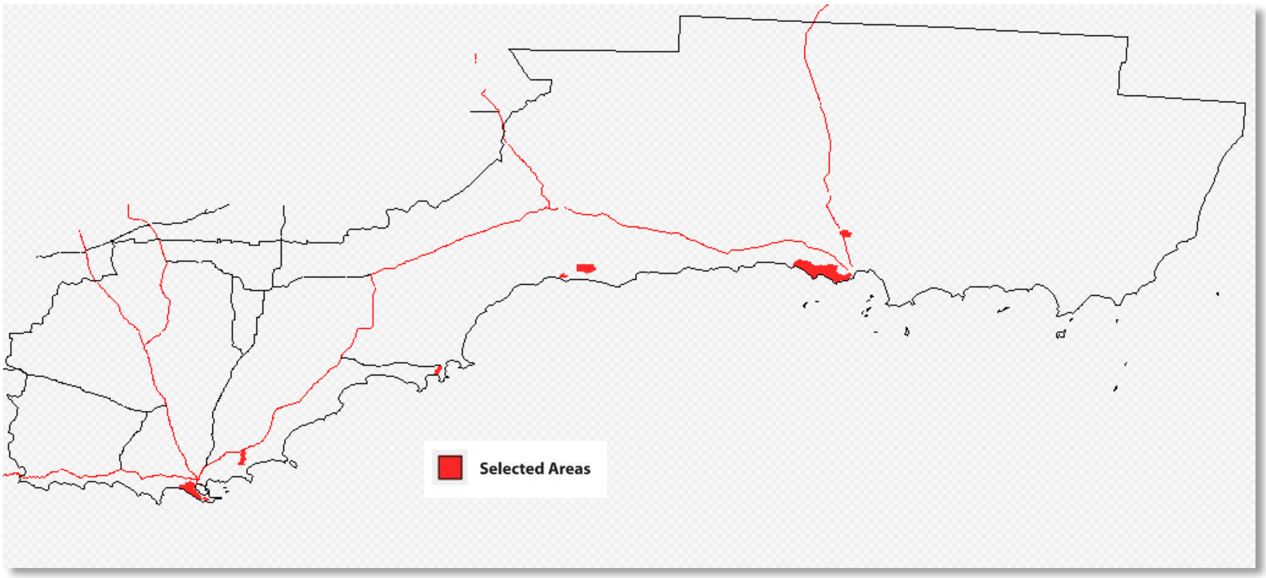


Figure 43: PDWSA areas

4.1.1.2 Proclaimed Groundwater Areas

Proclaimed Groundwater Areas are a DOW dataset indicating areas where groundwater extraction is a priority. Plantations in these areas would negatively impact on these water resources. These areas are shown in red below.

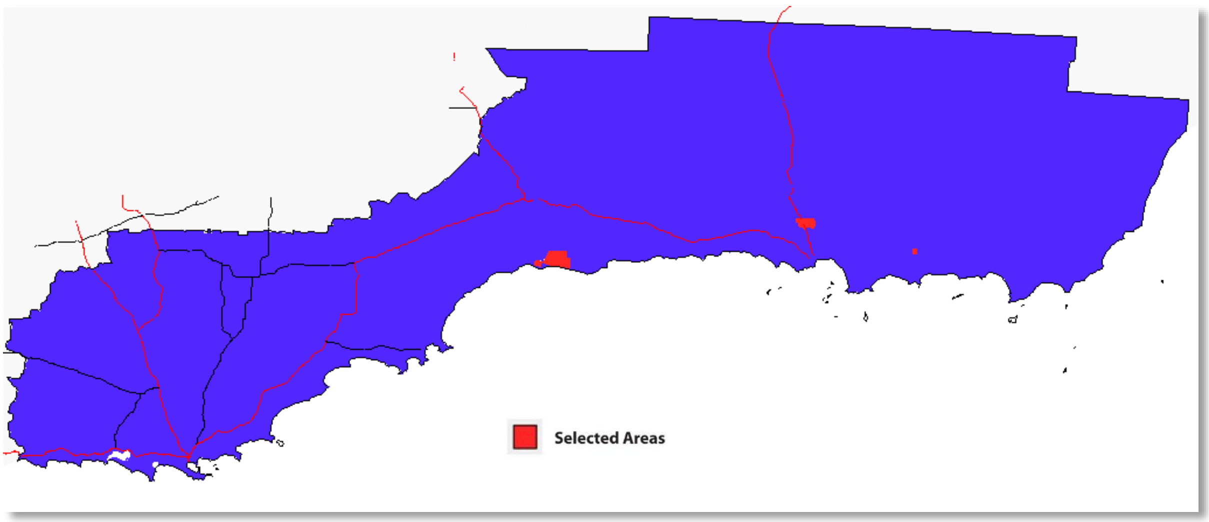


Figure 44: Proclaimed groundwater areas

4.1.1.3 High Value Water Resources

High value water/groundwater resources' is a composite layer generated from the maximum of:

1 x 'PDWS Inappropriate for Plantations' & 1 x ' Proclaimed Groundwater Area'.

All areas in each layer are represented in the final map.

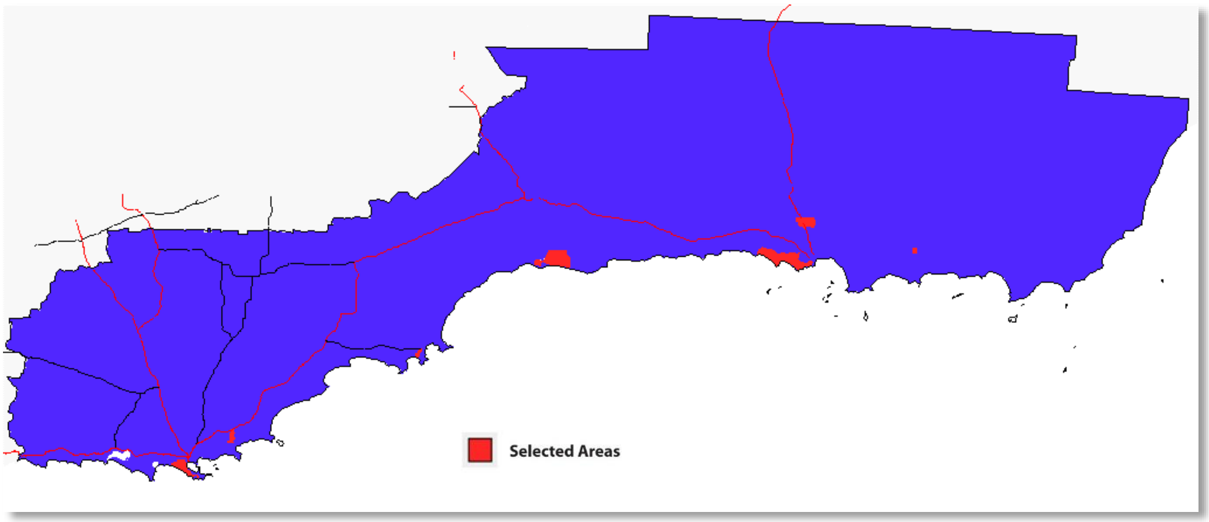


Figure 45: High value water resources

4.1.1.4 Closed Aboriginal Sites

This layer is based on Aboriginal Heritage Sites - Site Access, a layer from the Department of Indigenous Affairs, and shows sites that are closed and should be avoided by plantations to avoid de-valuing them. Note that these sites have had their locations masked by using a (2x2) km square cell. Restricted sites that do not fit within a single 4 Km square, will be represented by multiple 4 Km squares. In the map below closed sites are represented in red, other sites in blue. Some of these sites are very large, covering both cleared and remnant vegetation.

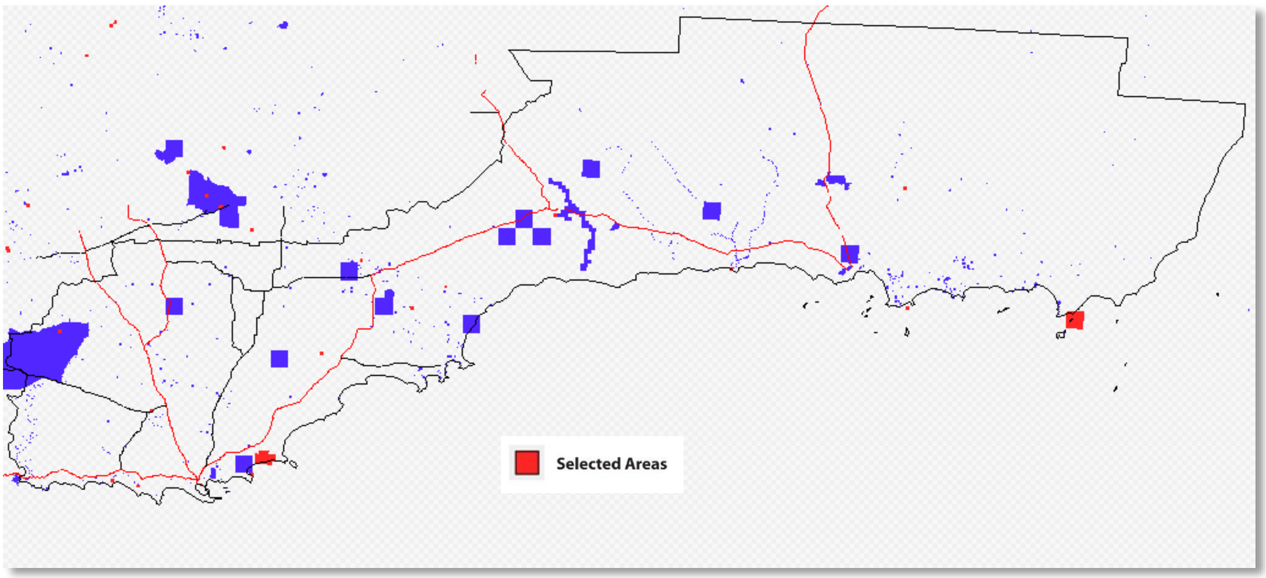


Figure 46: Closed Aboriginal Cultural Sites

4.1.1.5 Aboriginal Site Status

This layer is based on Aboriginal Heritage Sites - Site Status, a layer from the Department of Indigenous Affairs, and shows a small number of registered sites (IR or PR) that should be avoided by plantations to avoid destroying cultural heritage.

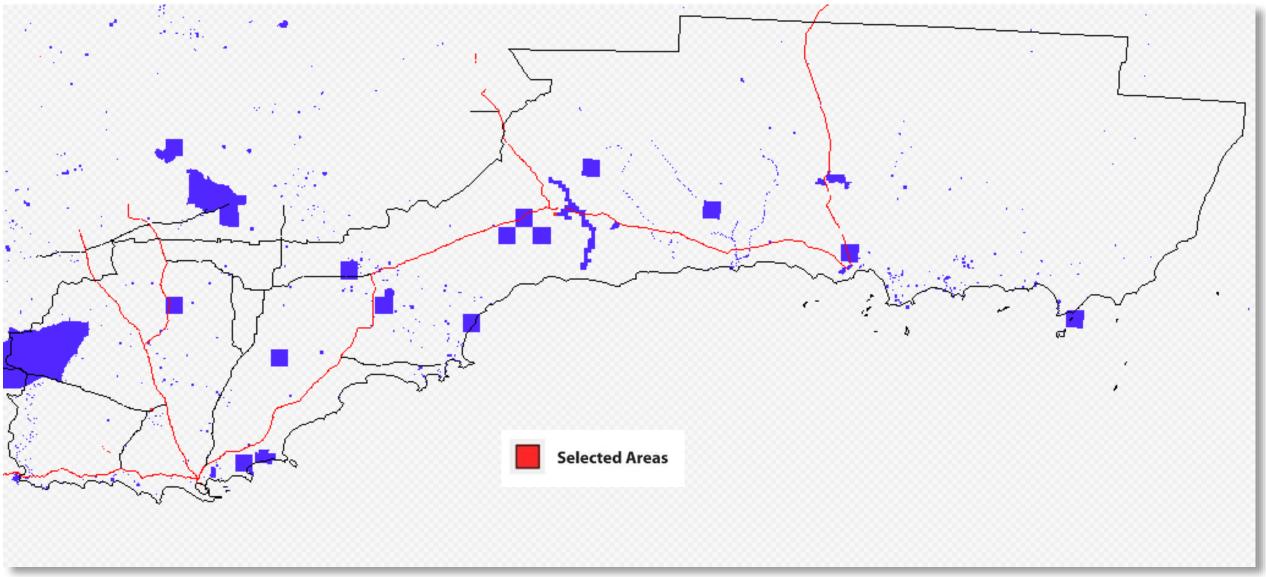


Figure 47: Registered Aboriginal Sites

4.1.1.6 TPS Aboriginal Reserves

TPS Aboriginal Reserves are extracted from the consolidated Town Planning Schemes for the SCNRM region. They represent valued cultural areas shown in red below.

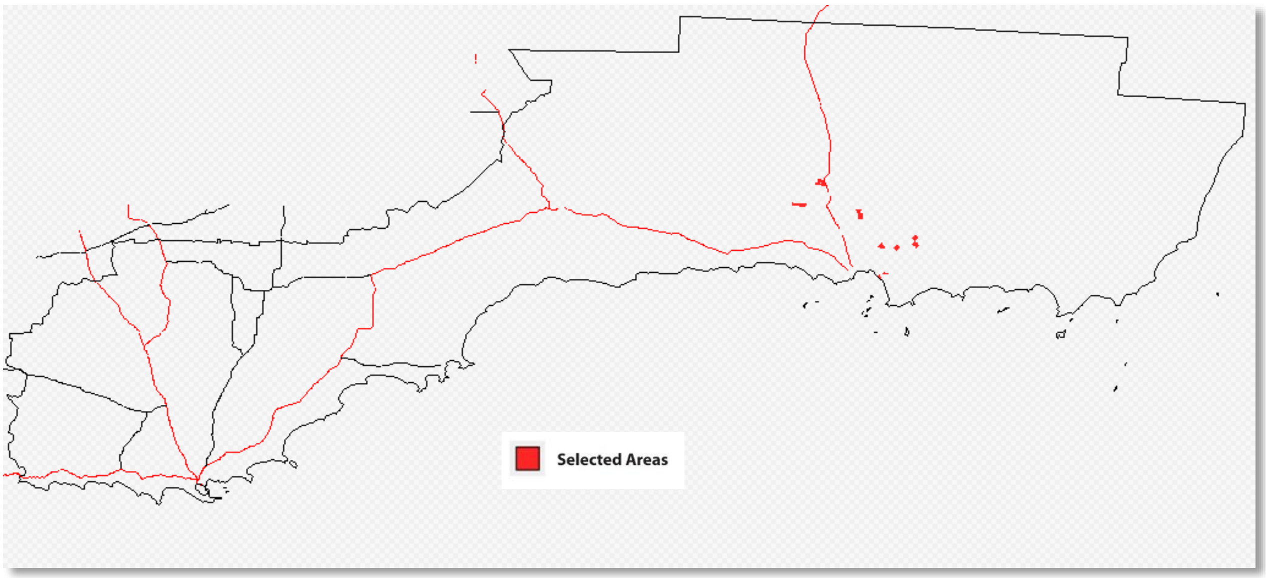


Figure 48: TPS Aboriginal Reserves

4.1.1.7 Protected Aboriginal Cultural Sites

Layer 'Protected Aboriginal Cultural Sites' is a composite layer producing 5 classes

The composite function is generated from the maximum of:

1 x 'Closed Aboriginal Sites'

1 x 'Aboriginal Site Status'

1 x 'TPS Aboriginal Reserves'

The classification means that the final map still indicates aboriginal sites that are not highly rated.

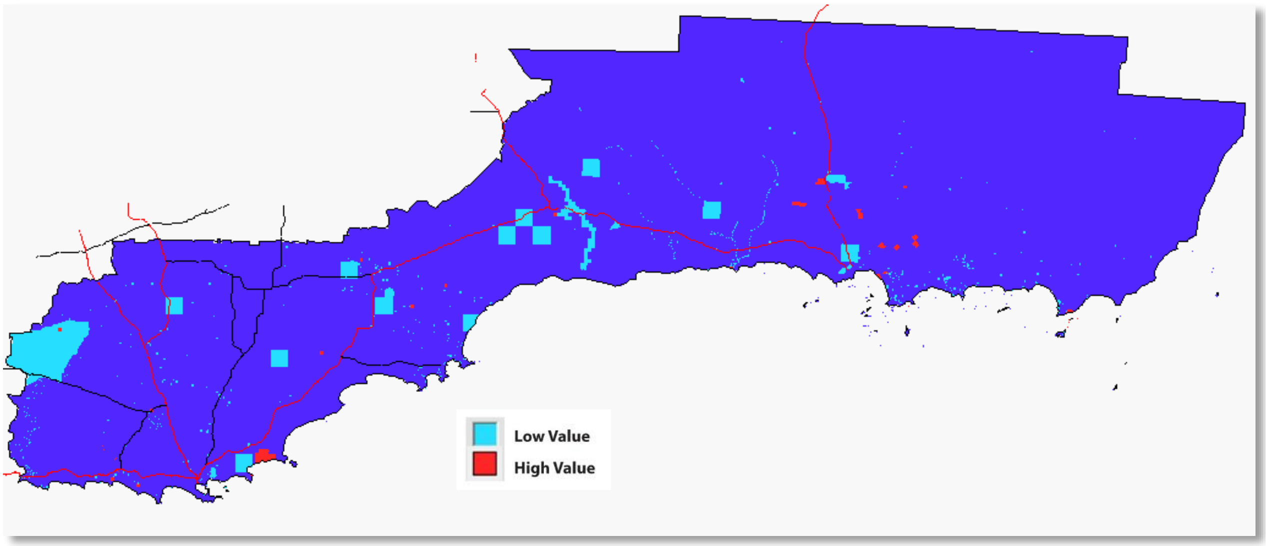


Figure 49: Protected Aboriginal Sites

4.1.1.8 Remnant Vegetation

A basic policy of SCNRM is that there will be no clearing of native vegetation for plantations of any sort. Remnant vegetation is included in this component as an exclusion – no planting will occur on areas still vegetated. This component therefore masks out all areas where vegetation still exists, as shown in the figure below.

The dataset Native Vegetation Contiguous Area 2014 was originally compiled as part of the vegetation theme of the National Land and Water Resource Audit (NLWRA). The dataset has been progressively updated by the Department of Agriculture and Food post-NLWRA with assistance of the Department of Environment and Conservation. This has been carried out using digital aerial photography (orthophotos) acquired 1996 to 2013.

The remnant vegetation layer is classified into 2 classes:

2 – red – cleared (or sea)
1 - blue – remnant vegetation.

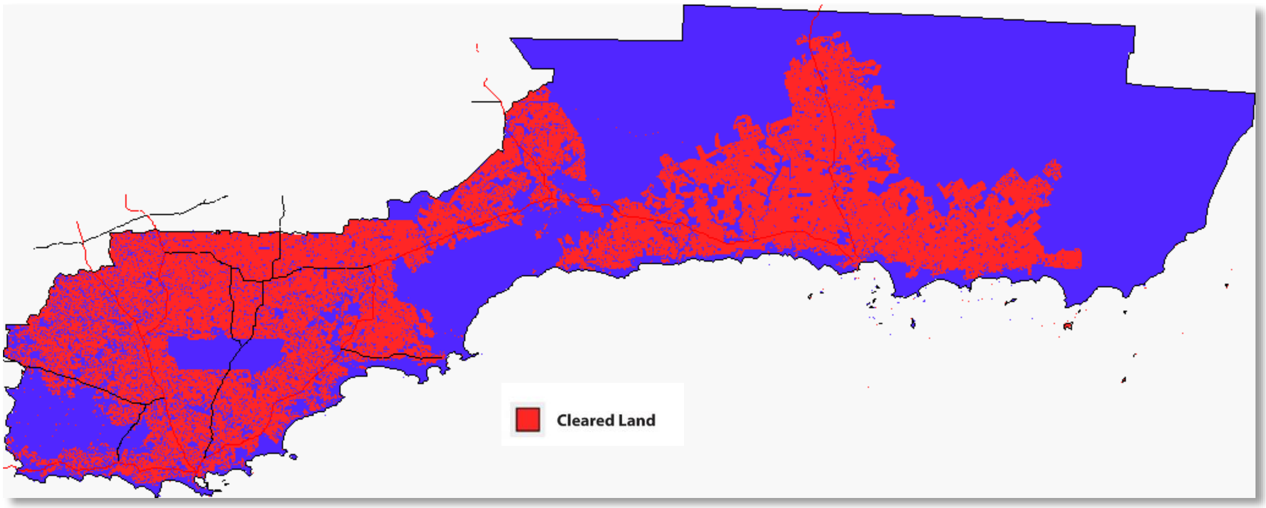


Figure 50: Remnant Vegetation mask

4.1.1.9 High Quality Agricultural Land

The Layer 'High quality agricultural land' is a composite layer producing 5 classes, based on equal area classification. It is only used in Component A1B.

The composite function is generated from the sum of:

6 x 'A1C Land Capability Value (Agriculture)'

0.5 x 'Distance from Port'

Distance from port was added to reflect the decline in agricultural viability with increasing distance from the export ports (Albany and Esperance), but given a low weighting. Land capability value (Agriculture) is the output of Component A1C.

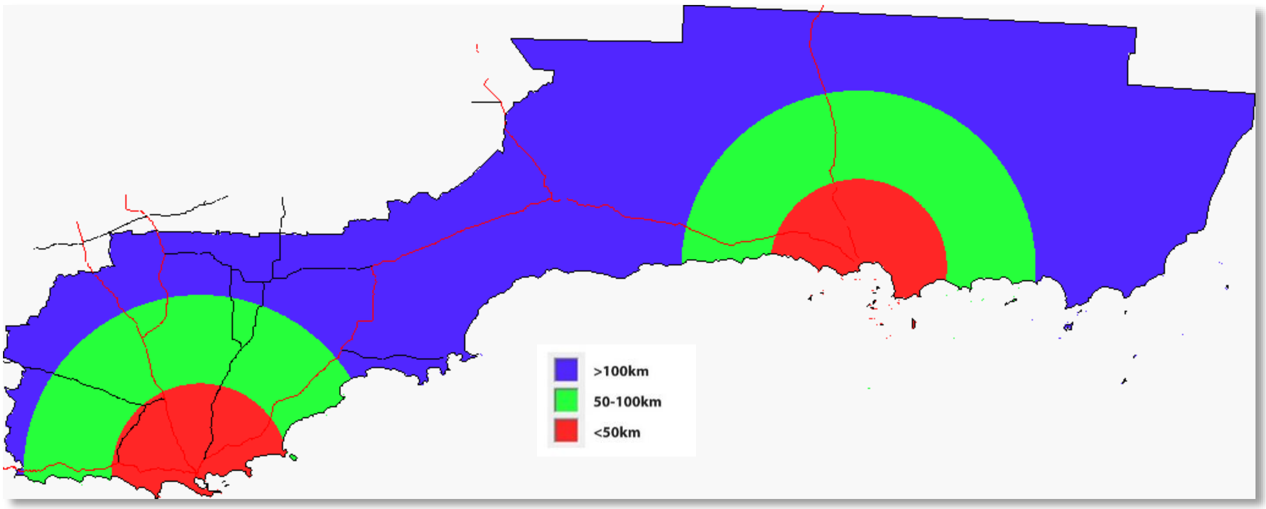


Figure 51: Distance from Port

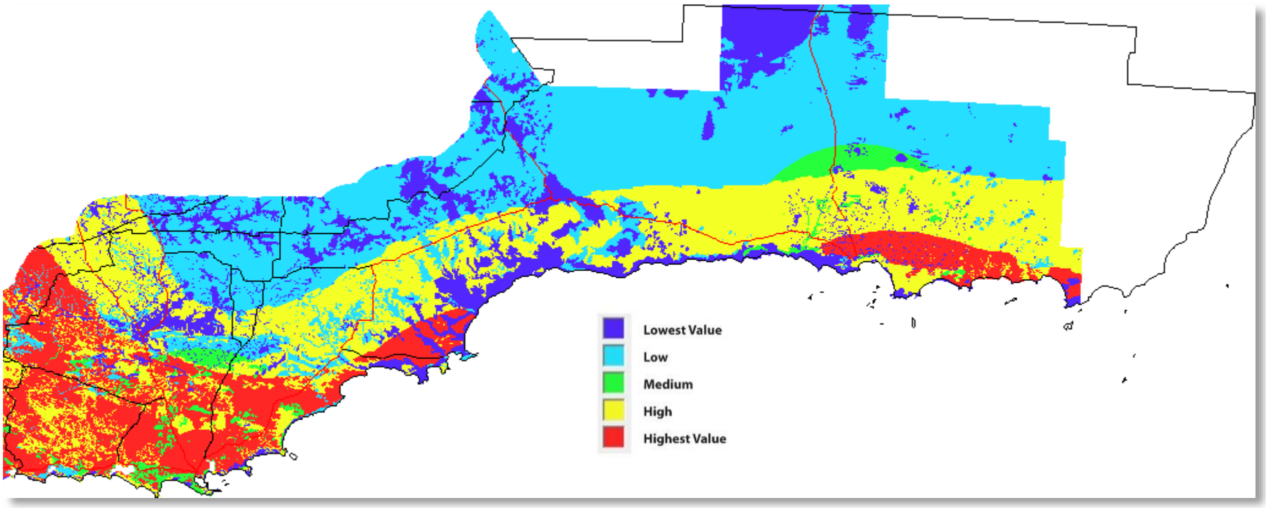


Figure 52: High Quality Agricultural Land

4.1.1.10 Component A1 Outputs

A1A - Landscapes that need to be protected from commercial plantings

The output layer 'A1A Landscapes that need to be protected from commercial plantations' is generated with a Two Way from 'A1A Interim' and 'Vegetation or Clearing', which masks out areas without vegetation.

Layer 'A1A Interim' is a composite layer producing 2 classes, generated from the sum of:

1 x '* High value water/groundwater resources'
1 x 'Protected Aboriginal Cultural Sites'

The result is classed into two zones:

Blue - areas without protection, and Red - areas that need protection.

It is clear from the map that the reference group did not see many places as requiring complete protection from plantations.

Figure 53: Component A1A: MCAS-S Output

A1B - Areas where detailed assessment of Carbon plantings is recommended

Layer 'A1B Interim' is a composite layer producing 3 classes

The composite function is generated from the maximum of:

3 x '* High quality agricultural land'

2 x '* High value water/groundwater resources'

1 x '* Protected Aboriginal Cultural Sites'

Using a maximum means that a high value in any one of the input layers will be maintained.

The result is classed according to a custom set of values, which provides a set of recommended plantation limits, similar to what some LGAs in the SCNRM region are doing:

- Areas where up to 50% of the cleared landscape should be planted to CFI plantations
- Areas where up to 30% of the cleared landscape should be planted to CFI plantations
- Areas where no more than 15% of the cleared landscape should be planted to CFI plantations

The final layer 'A1B Landscapes where detailed assessment of Carbon plantings is recommended' is generated with a Two Way from 'A1B Interim' and 'Vegetation or Clearing' which masks out areas without vegetation. The final map has four classes:

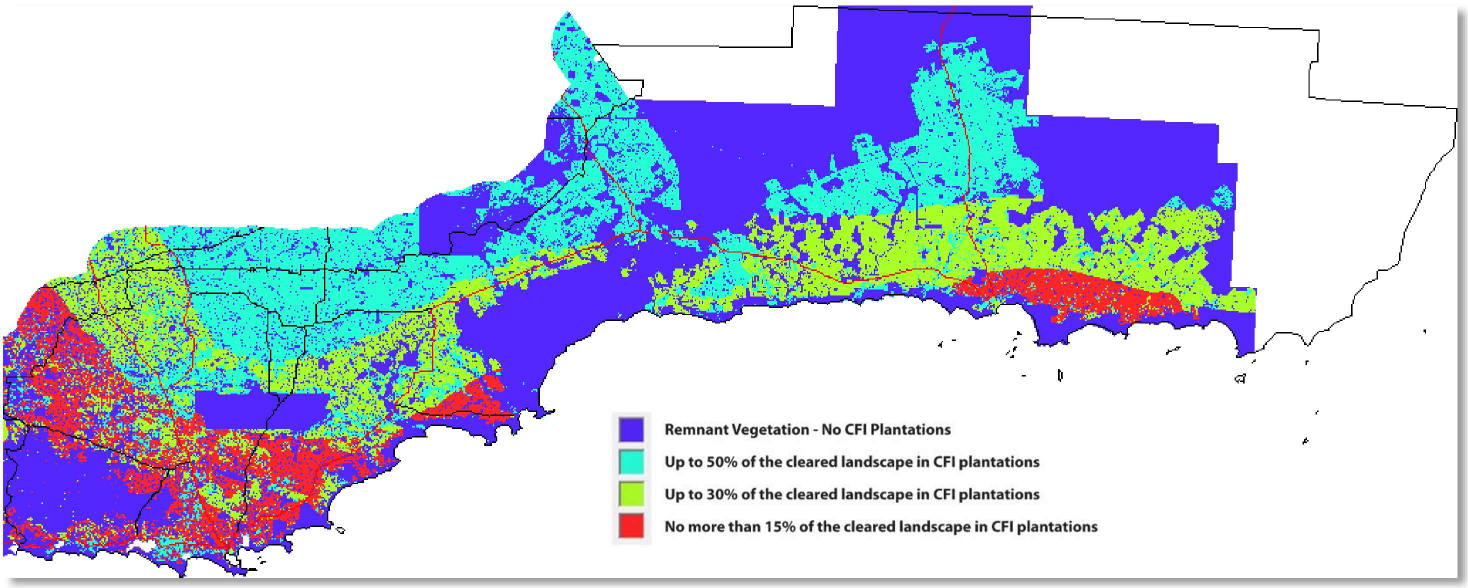


Figure 54: Component A1B: MCAS-S Output

4.1.2 A1C - Land Capability Value (Agriculture)

Agricultural land capability is a key dataset, as there is no desire to see the best agricultural land taken out of production for long term plantations. We did not have access to data on land values or agricultural productivity that was either fine scale or recent[3], and therefore looked to DAFWA to provide a surrogate. The chosen indicator of agricultural land value is agricultural land capability, which has been derived by DAFWA from their Soil-Landscape mapping datasets for 6 landuse types:

- Broadscale Agriculture – grazing, dryland cropping and dryland cropping with minimum tillage
- Intensive Agriculture – vines, perennial horticulture and annual horticulture.

In addition, we used projected annual rainfall (for 2020) as an indicator of where water availability would impact on the land capability values. This projection is from the CSIRO-Mk3.5 model under SRES marker scenario A2.

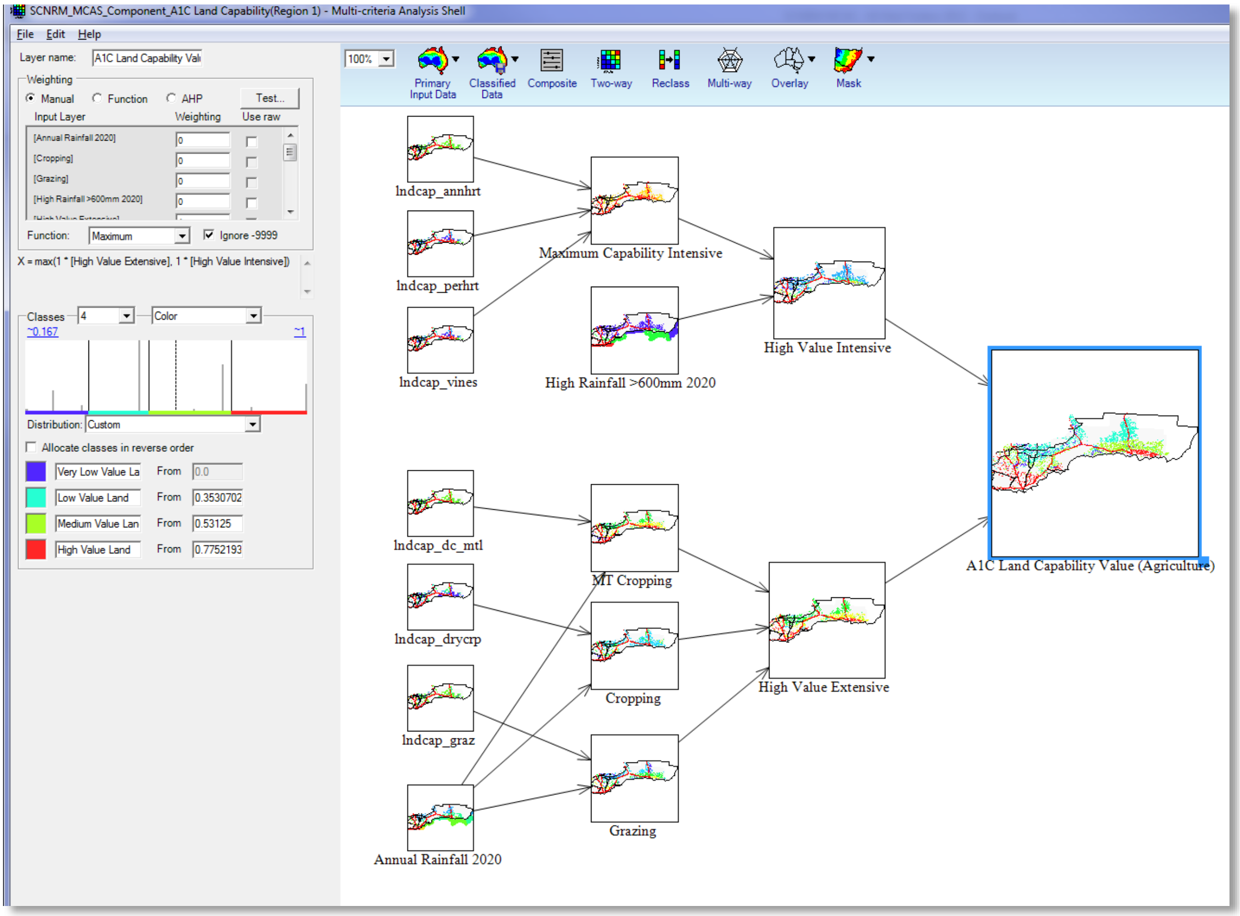


Figure 55: Component A1C MCAS-S Diagram

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[3] Data is available from ABARE, however it is based on previous census and surveys (at least 7 years old) and is at a very coarse scale.

Soils are classed for capability (classes 1 – 5; where 1 is best) and soil-landscape units coded based on proportion of capable soils:

Code	Legend
A1	>70% Class 1 or 2 (highest capability)
A2	50-70% Class 1 or 2
B1	>70% Class 1, 2 or 3
B2	50-70% Class 1, 2, 3
C1	50-70% Class 4 or 5
C2	>70% Class 4 or 5

These six landuse types were combined in MCAS as categorical layers, where A1 had the highest (~1.0) and C2 the lowest value (~0).

A discussion of values suggested that the actual value given to A1, A2, B1 etc. will not directly translate to the agricultural suitability of the land, which will depend on management and the cropping or grazing systems employed. This discussion is support by work from other NRM groups, where it is suggested that all the higher land capability classes (A1-B2) can support profitable agriculture (Rod Safstrom, DAFWA, pers. Com.) This aspect has been incorporated in the 2-way tables seen below, where high value can be ascribed to a number of land capability classes in a single rainfall band.

The model uses two separate sub-groups – Intensive Agriculture (vines, perennial horticulture and annual horticulture) and Extensive Agriculture (grazing, dryland cropping and dryland cropping with minimum tillage).

For intensive agriculture, rainfall was taken as being a moderating factor on value: the maximum land capability value for any of the intensive uses is maintained in areas with rainfall >600mm, but reduces 1 class interval in areas with 500-600mm rainfall. In areas below 500mm it reduces by 2 additional classes. This is shown in the figure below.

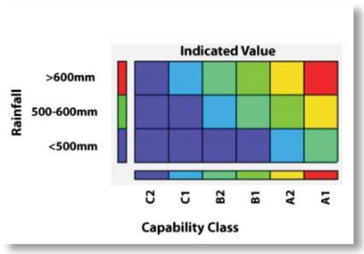


Figure 56: Rainfall & Capability Class 2-Way for High Value Intensive Agriculture

For the extensive agriculture land uses, rainfall is also taken as being a moderating factor on value, but varies by landuse type. For Dryland Cropping and Minimum Tillage Dryland Cropping, indicated values are focussed in the 300-600mm rainfall classes, reducing as the land capability values drop. For both land uses, maximum values are given to A1, A2 and A3 land capability in the 400-600mm rainfall bands. Areas with above 700mm or below 300mm have no indicated value.

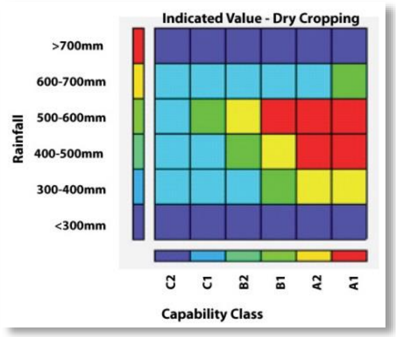


Figure 57: Rainfall & Capability Class 2-Way for Dryland Cropping

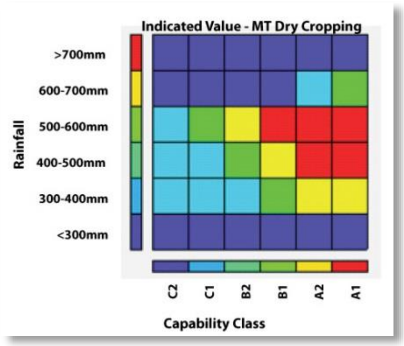


Figure 58: Rainfall & Capability Class 2-Way for Minimum Tillage Dryland Cropping

Indicated values are quite different for grazing – indicated value increases as both land capability and rainfall increase.

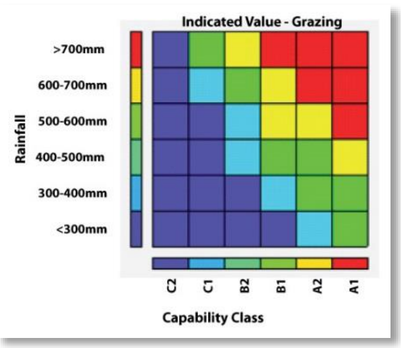


Figure 59: Rainfall & Capability Class 2-Way for Grazing

4.1.2.1 Component A1C Output

The final map produced - Layer 'A1C Land Capability Value (Agriculture)' is a composite layer producing 4 classes.

The composite function is generated from the maximum of:

1 x 'High Value Intensive'
1 x 'High Value Extensive'

The result is notionally classed according to this table:

1 - up to 0.3530702 [Very Low Value Land]
2 - up to 0.53125 [Low Value Land]

3 - up to 0.7752193 [Medium Value Land]
4 - above 0.7752193 [High Value Land]
This map has had native vegetation masked from view.

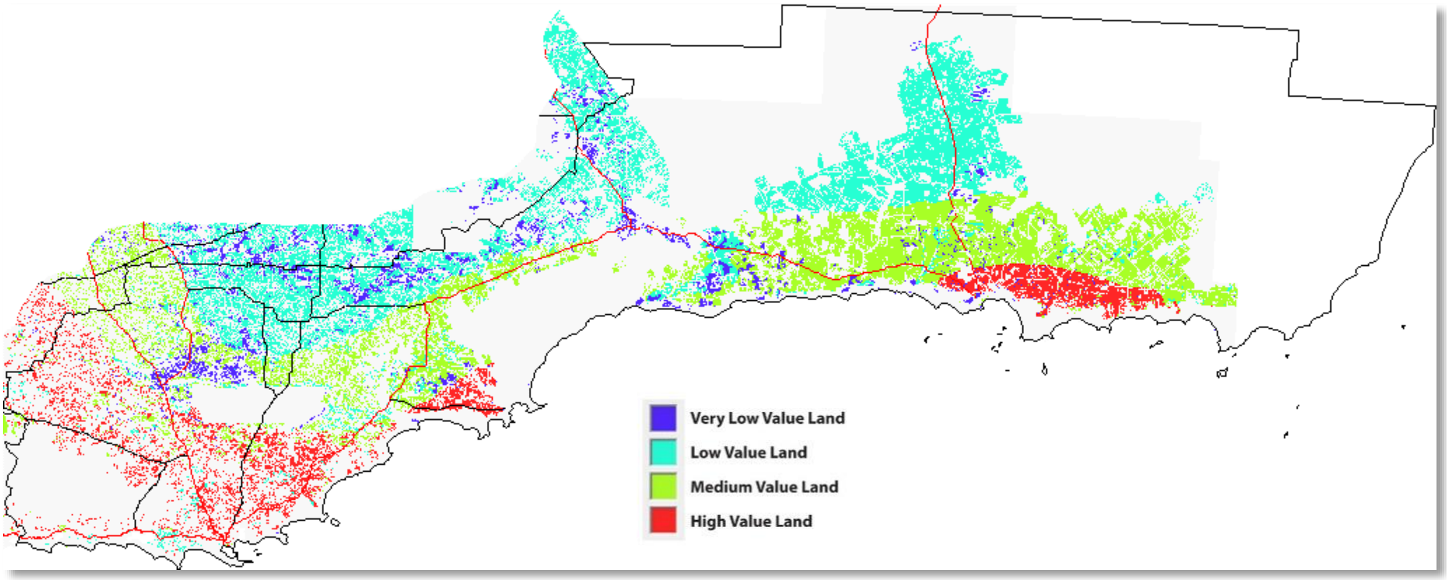


Figure 60: A1C – Land Capability Value

4.1.3 Component 2 – Commercial plantations (A2A) and Carbon plantings (A2B)

As outlined in the model logic, this component was split into 2 parts: A2A - Areas where SCNRM would encourage Commercial plantations, and A2B - Areas where SCNRM would encourage Carbon plantings. Because of a large amount of shared logic and datasets, the A2A and A2B analysis is carried out in a single MCAS model. This section will outline the criteria used for both parts of the model.

The MCAS-S diagram for component A2A & A2B is as follows:

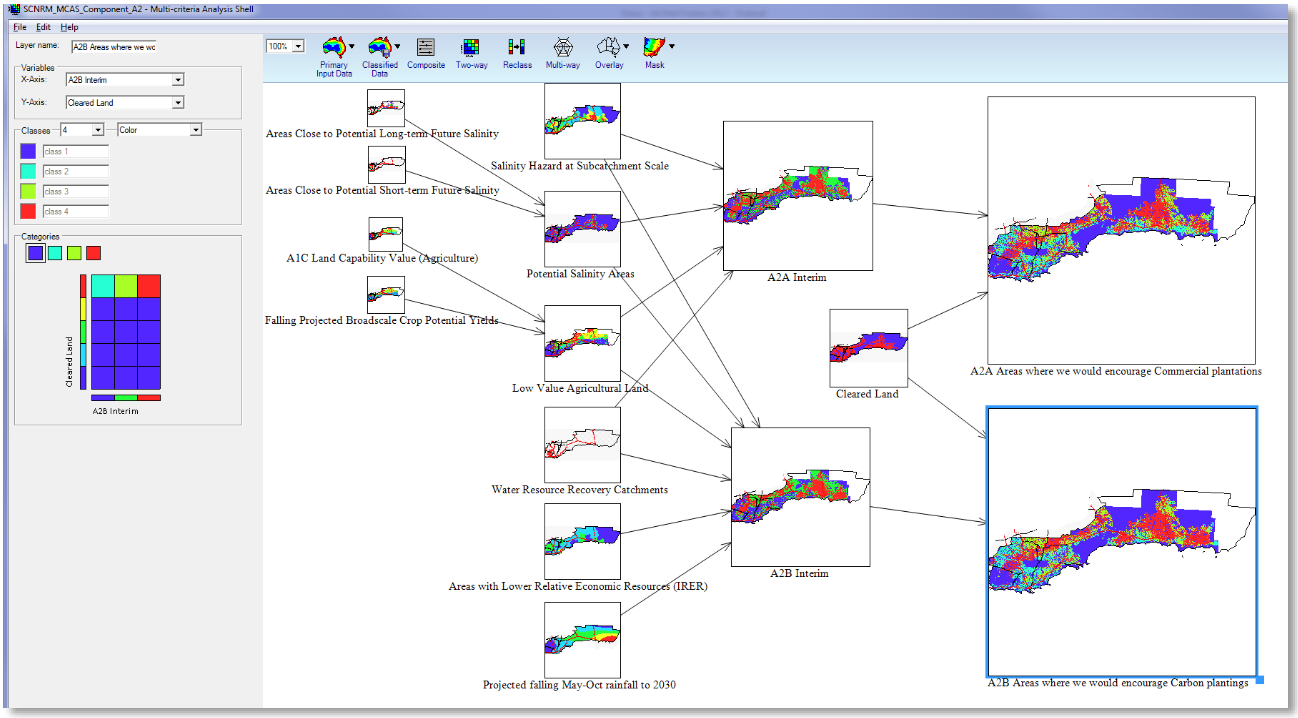


Figure 61: Component A2 MCAS-S Diagram

There criteria are outlined below.

4.1.3.1 Potential Salinity Areas

Planting of trees close to potential salinity areas is considered to be on effective measure to reduce the impact of salinization. This is a tactical approach – conducted at the local scale. The other approach is to provide for large-scale planting at the catchment scale to reduce water-table rise – a strategic approach – which is covered in the following criterion.

The short and long term future salinity layers are produced by a separate analysis. This analysis uses three criteria:

- Salinity Hazard (height above valley floor)
- Hydrozone salinity risk
- Salinity Extent

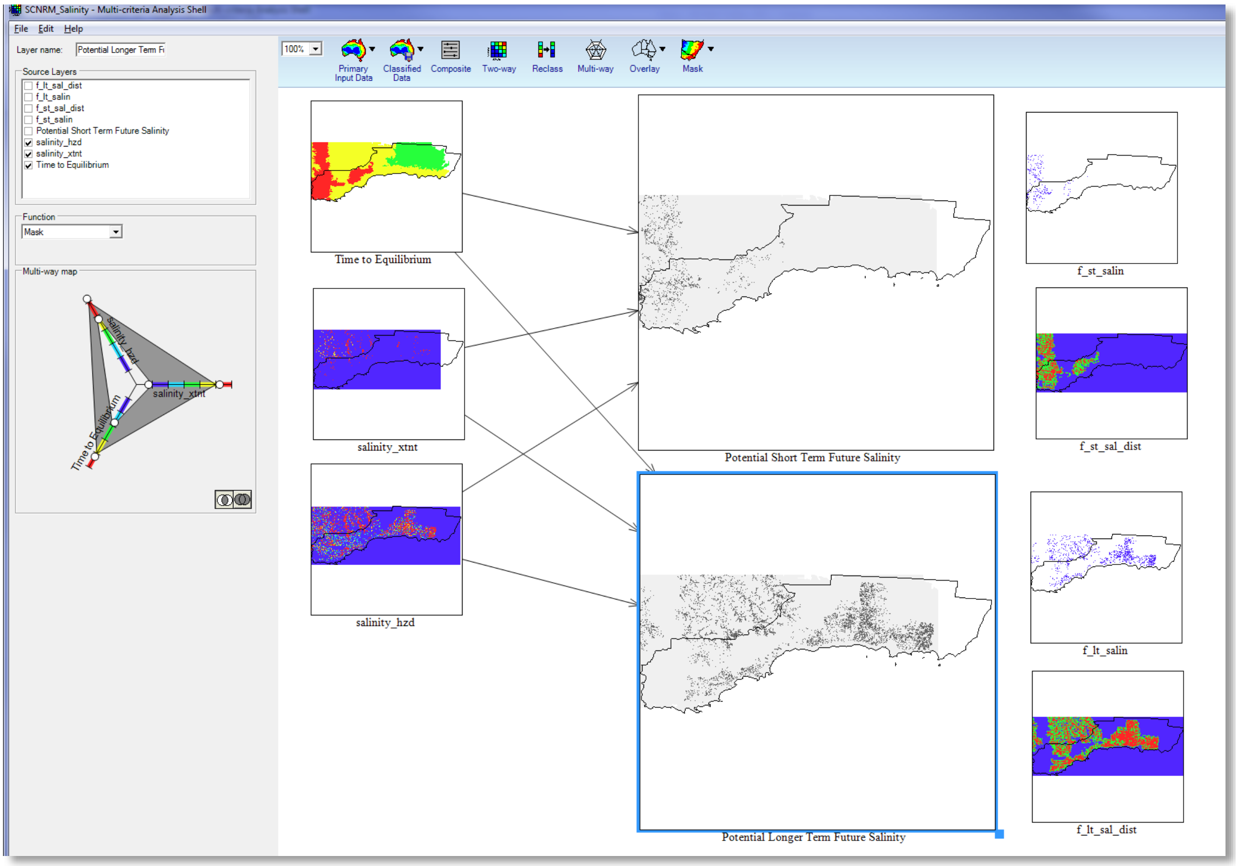


Figure 62: SCNRM Salinity Subcomponent – MCAS Diagram

Salinity Hazard (height above valley floor)

This dataset is calculated from Land Monitor digital elevation models (DEMs) 25m resolution, and identifies areas close to valley flow level as candidates for salinity dues to rising water tables. The original grid has been re-classified so that cell values referring to hazard areas (values 1, 2, 3) are converted to 1, all other values to 0. A process called 'block statistics' has been run at 8x8 cell scale to sum all the potential salinity hazard cells within an 8x8 grid (200mx200m area) - to represent coarser scale hazard (values 0 - 64). The summed values are charted below where blue = no hazard and red = highest hazard.

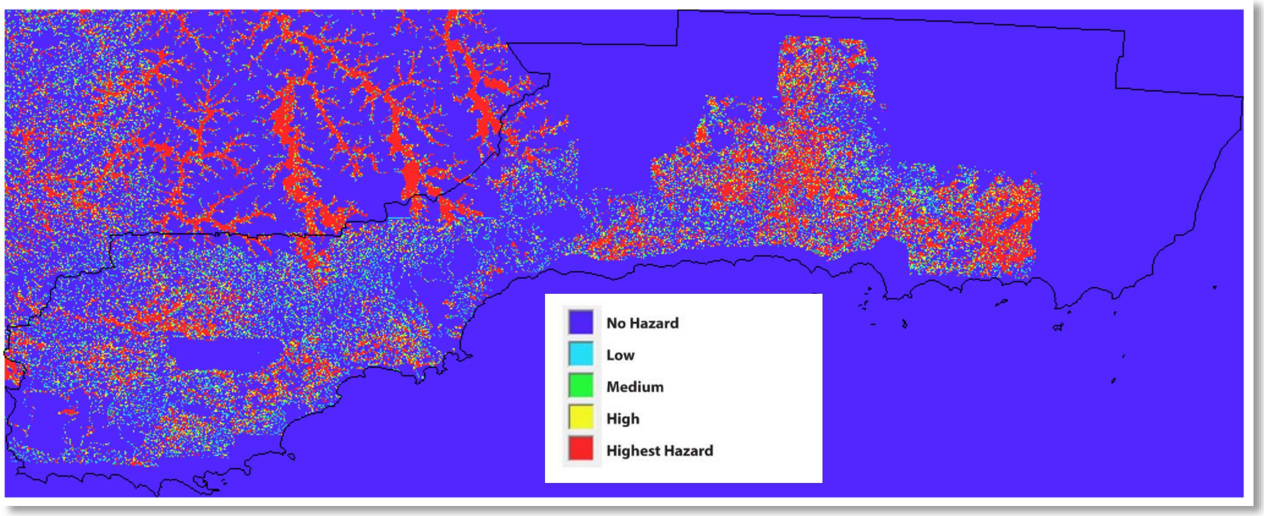


Figure 63: Salinity Hazard

Hydrozone salinity risk - time to equilibrium

This dataset represents the timescale of development of dryland salinity in each hydrozone, and has been produced as part of the DAFWA Report Card process. The risk assessment was based on the likelihood and consequence of dryland salinity developing further in each hydrozone.

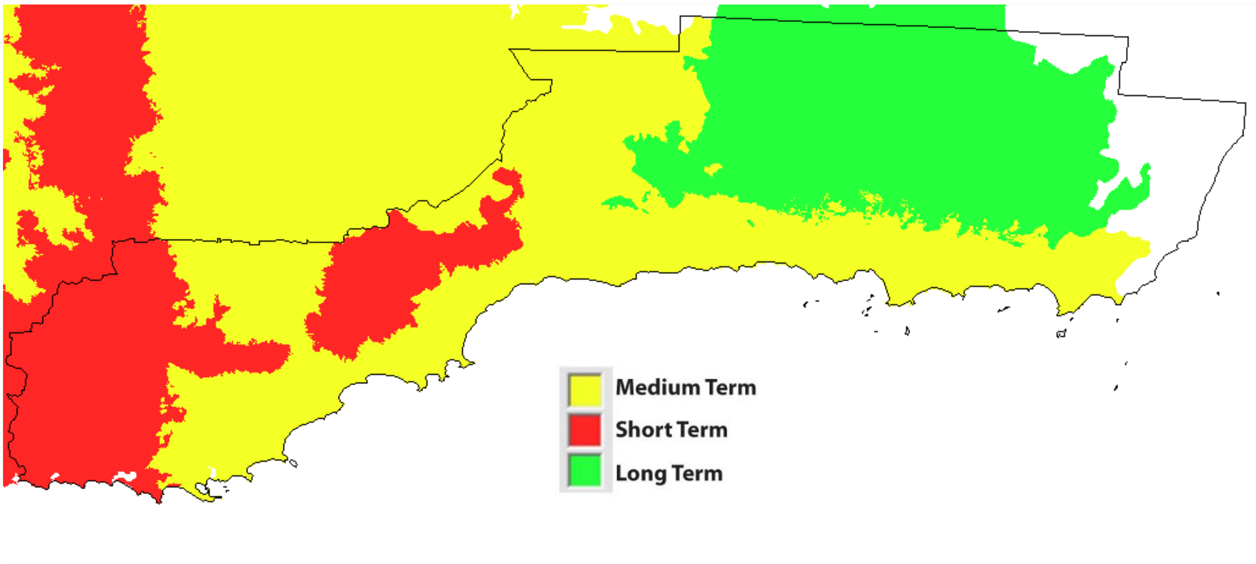


Figure 64: Hydrozone salinity risk

Salinity Extent

Salinity Extent data is sourced from the Landmonitor project and shows salt affected land, as well as land that is potentially salt-affected, but where vegetation makes classification uncertain. The salt affected classification represents areas affected by salt, not just surface expression (ie not just bare saltland). Mapping doesn't extend throughout the entire SCNRM area.

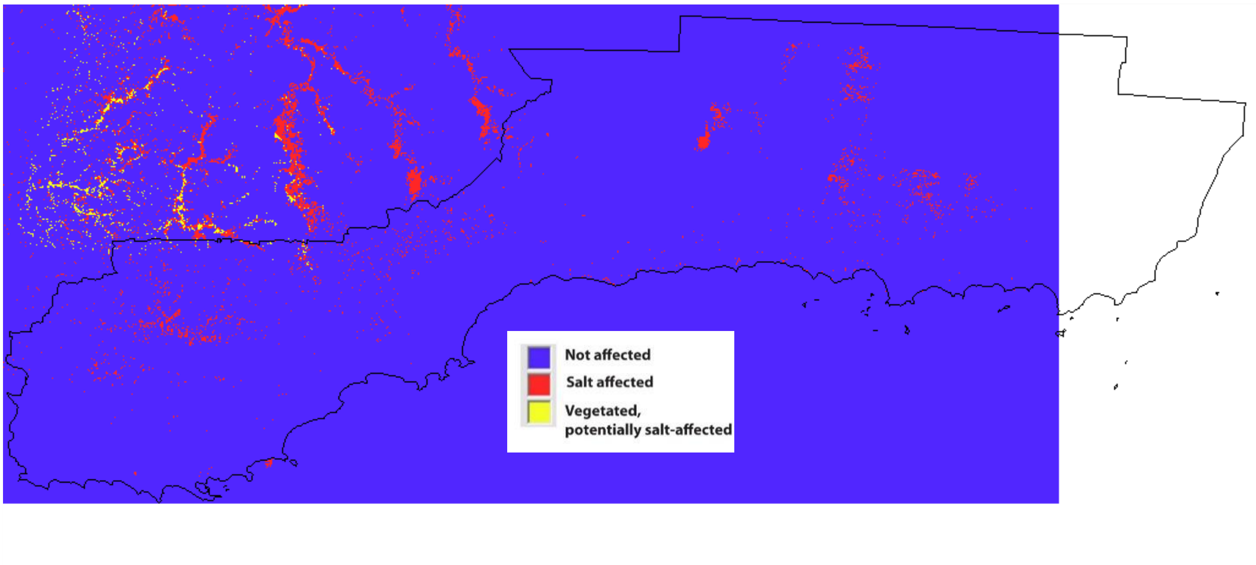


Figure 65: Salinity Extent

Distance from Potential Short Term Future Salinity

The layer 'Potential Short Term Future Salinity' is generated with a multi-way mask function in MCAS-S. The mask selects areas meeting the following criteria:

- Layer 'salinity_xtnt' having a classified value between 1 and 4: i.e. not yet affected by salinity
- Layer 'salinity_hzd' having a classified value of 5: i.e. high level hazard exists
- Layer 'Time to Equilibrium' having a classified value of 5: i.e. time to equilibrium is shorter term

These areas can be described as being at risk of developing salinity but not yet expressing any symptoms, and being in an area where such expressions will take place in the short term.

Layer 'salinity_xtnt' is a categorical layer built from 'salinity_xtnt'

Class 1 for Out of Area
Class 1 for Not Affected
Class 4 for Vegetated, potentially salt-affected
Class 5 for Salt Affected (highest value)

Layer 'salinity_hzd' is generated from primary data 'salinity_hzd'
Split into 5 classes
1 - from 0

2 - from 12.8
3 - from 25.6
4 - from 38.4
5 - from 51.2 (highest value)

Layer 'Time to Equilibrium' is a categorical layer built from ‘Time to equilibrium’.

Class 3 for Long Term
Class 4 for Medium Term
Class 5 for Short Term (highest value)

Figure 66: Potential Short Term Future Salinity

The dataset above had the operation Euclidean distance performed on it to identify the distance of every cell from these potential salinity areas. In the final component the distances used were very small – up to 200m from any potential salinity cell was given the highest value, and 200-400 the next highest. Distance above 600m had values discarded.

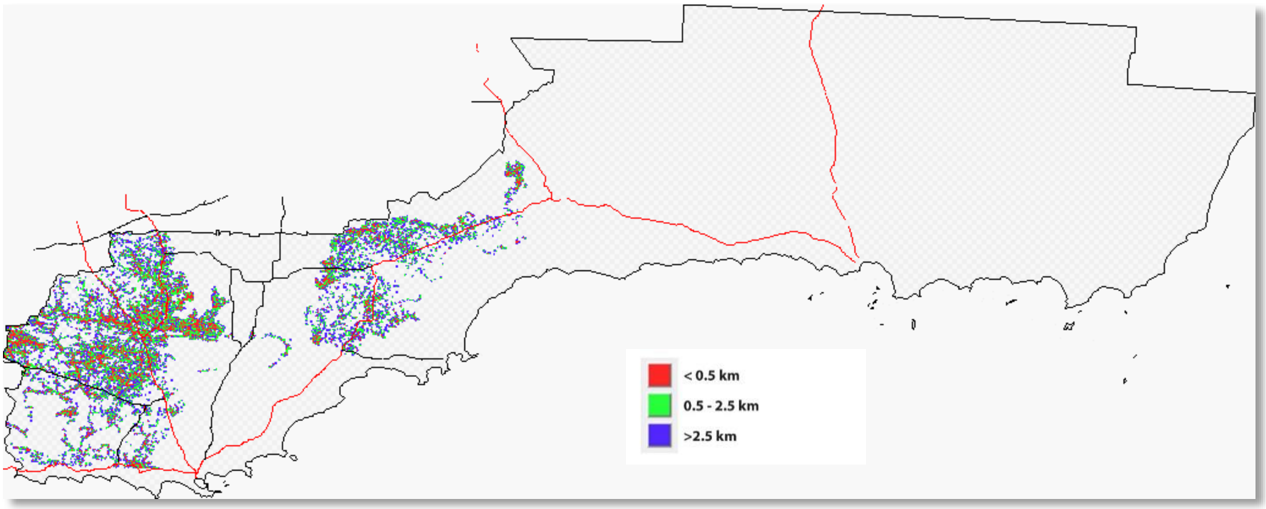


Figure 67: Distance from Potential Short Term Future Salinity

Distance from Potential Long Term Future Salinity

Layer 'Potential Longer Term Future Salinity' is generated with a multi-way mask function. The mask selects areas meeting the following criteria:

- Layer 'salinity_xtnt' having a classified value between 1 and 4: *Ie not yet affected by salinity*
- Layer 'salinity_hzd' having a classified value of 5: *high level hazard exists*
- Layer 'Time to Equilibrium' having a classified value between 3 and 4: *Time to Equilibrium is Medium term*

These areas can be described as being at risk of developing salinity but not yet expressing any symptoms, and being in an area where such expressions will take place in the longer (Medium) term.

Input datasets are the same as for Distance from Short-Term future Salinity, and the difference from Short Term salinity is in the classification of the Layer 'Time to Equilibrium' :

Class 5 for Long Term (highest value)
Class 4 for Medium Term
Class 3 for Short term

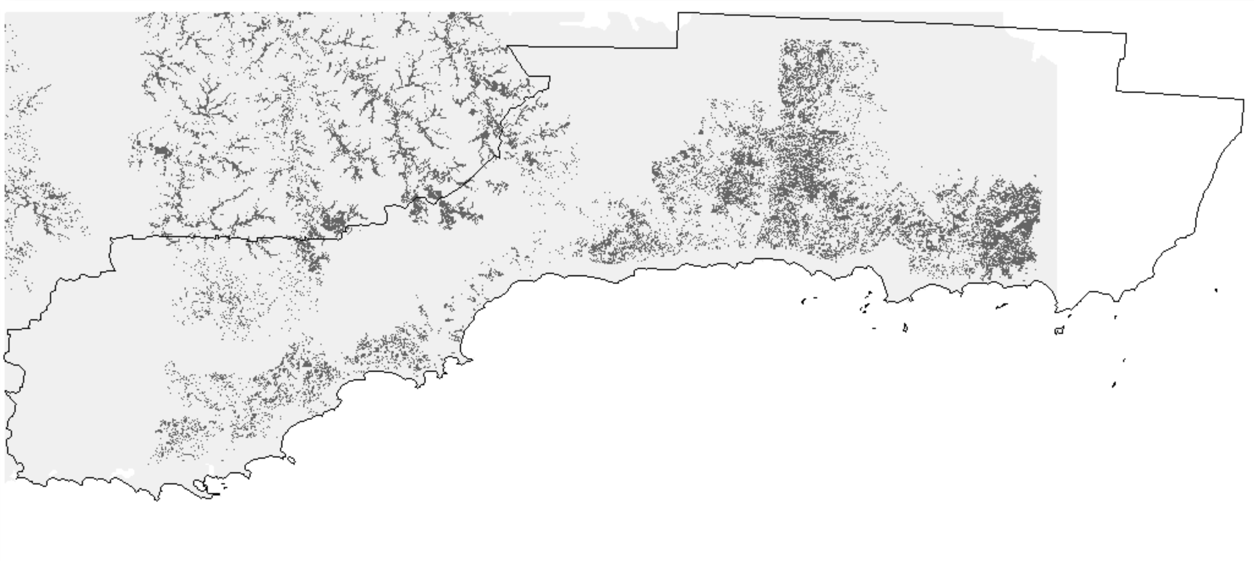


Figure 68: Potential Long Term Future Salinity

As for short-term potential salinity, this dataset above had the operation Euclidean distance performed on it to identify the distance of every cell from these potential salinity areas. In the final component the distances used were very small – up to 200m from any potential salinity cell was given the highest value, and 200-400 the next highest. Distance above 600m had values discarded.

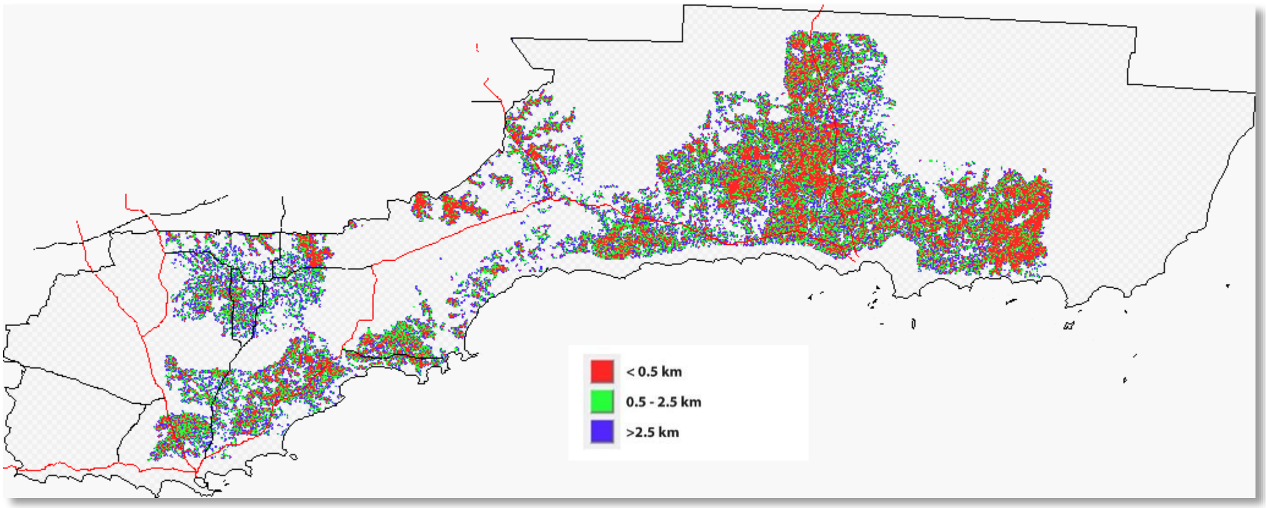


Figure 69: Distance from Potential Long Term Future Salinity

Potential Salinity Areas

Layer 'Potential Salinity Areas' is a composite layer producing 3 classes – low, medium and high.

The composite function is generated from the sum of:

1 x 'Distance from Potential Long Term Future Salinity'
2 x 'Distance from Potential Short Term Future Salinity'

Short term salinity is therefore weighted twice long.

The result is classed according to this table:
1 - up to 0.6666667
2 - up to 1.333333
3 - above 1.333333 (highest value)

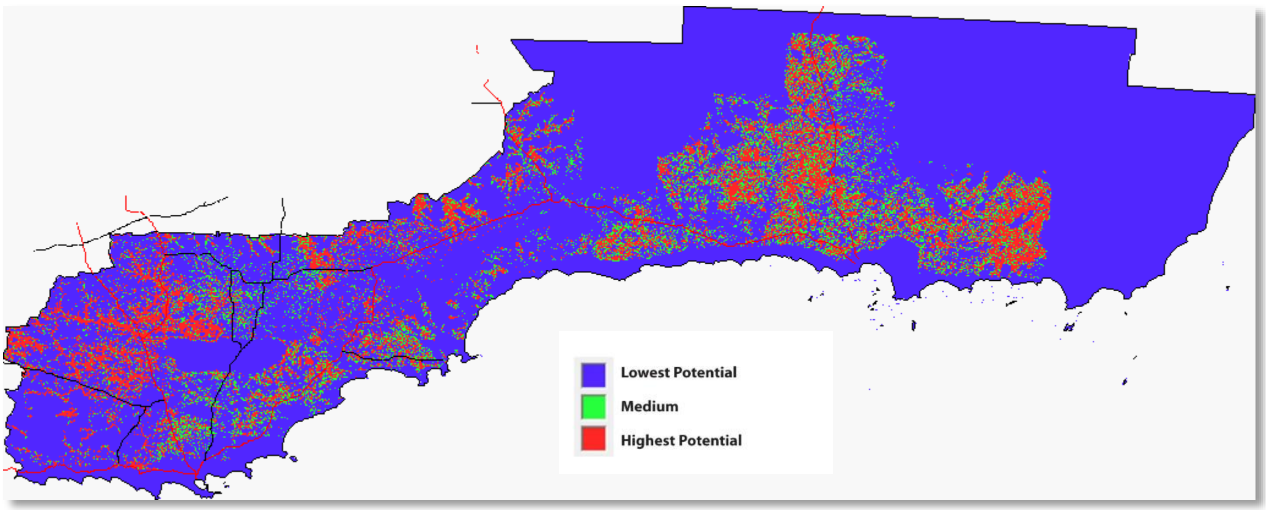


Figure 70: Potential Salinity Areas

4.1.3.2 Salinity Hazard at Subcatchment Scale

The other approach to salinity is to provide for large-scale planting at the catchment scale to reduce water-table rise – a strategic approach.

Salinity Hazard (height above valley floor) at 25m resolution was re-classified so that cell values referring to any hazard areas (values 1, 2, 3) are converted to 1, all other values to 0. The values were summarised at 8x8 cell scale to represent coarser scale hazard (values 0 - 64), and the result resampled to 50m cells.

These salinity hazard values were then summed at the subcatchment scale and the resulting salinity hazard normalised by area, to give a subcatchment-scale indication of salinity hazard.

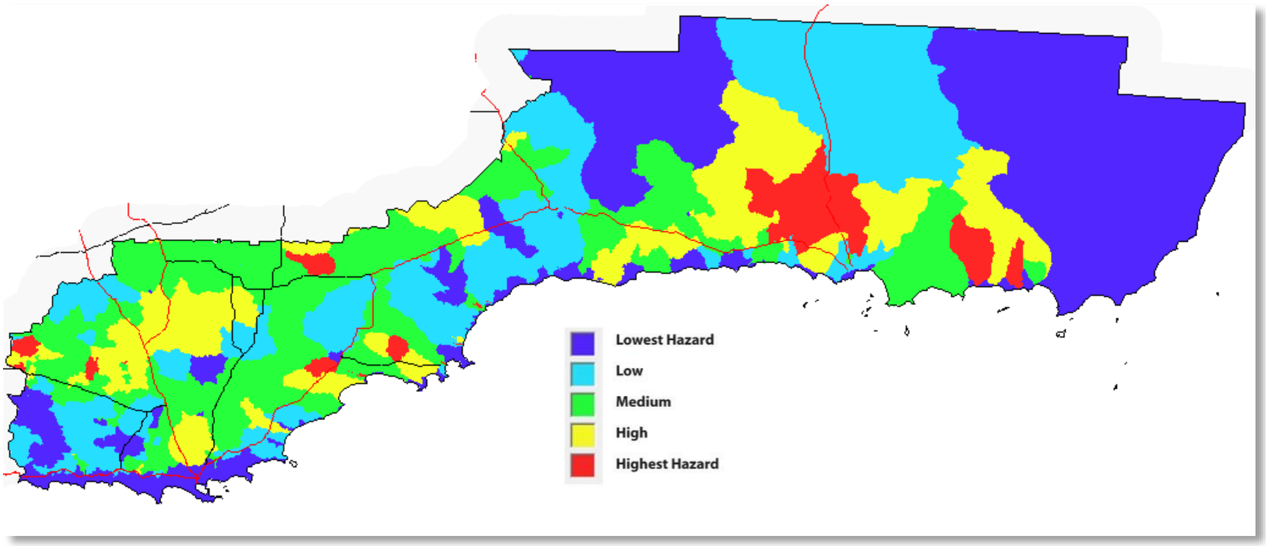


Figure 71: Salinity Hazard at Subcatchment Scale

4.1.3.3 Low Value Agricultural Land

A1C Land Capability Value (Agriculture)

As in the previous component, land capability has been derived by DAFWA from their Soil-Landscape mapping datasets for 6 landuse types. For this component the classes were allocated in reverse order: the cells with the lowest capability were classified as highest value, as these would be the areas that the group would direct plantations towards.

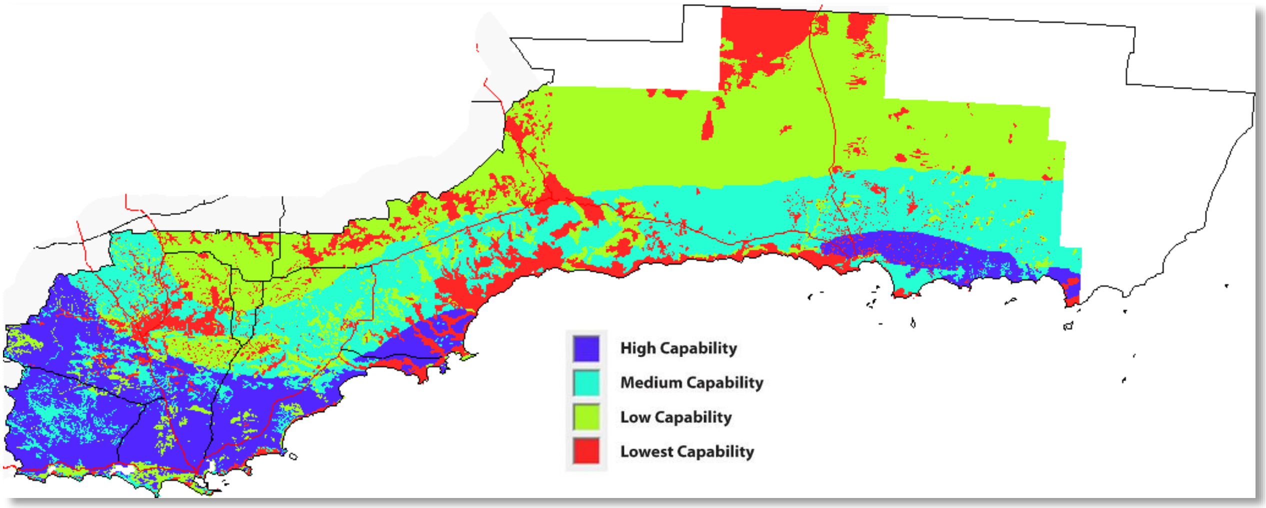


Figure 72: Low Capability Agricultural Land

4.1.3.4 Areas with Projected Yield Declines

This dataset comes from modelling conducted by DAFWA on Future Broadscale Crop Projected Potential Yields into the future under a moderate climate scenario. In this component however the classification system weights areas with high levels of decline as suitable targets for plantations.

Projected potential yield change estimates were generated by DAFWA in 2005 (Vernon and van Gool, 2006). Modelling was undertaken for major crops (wheat, oats, barley, lupins and canola) at 2050. The temperature change scenario used was SRES A2, and the GCM was CSIRO Mark II. The values used showed % change from 2005 yields (tonnes/ha). Projected yield declines are between 1.8 and 9.4%.

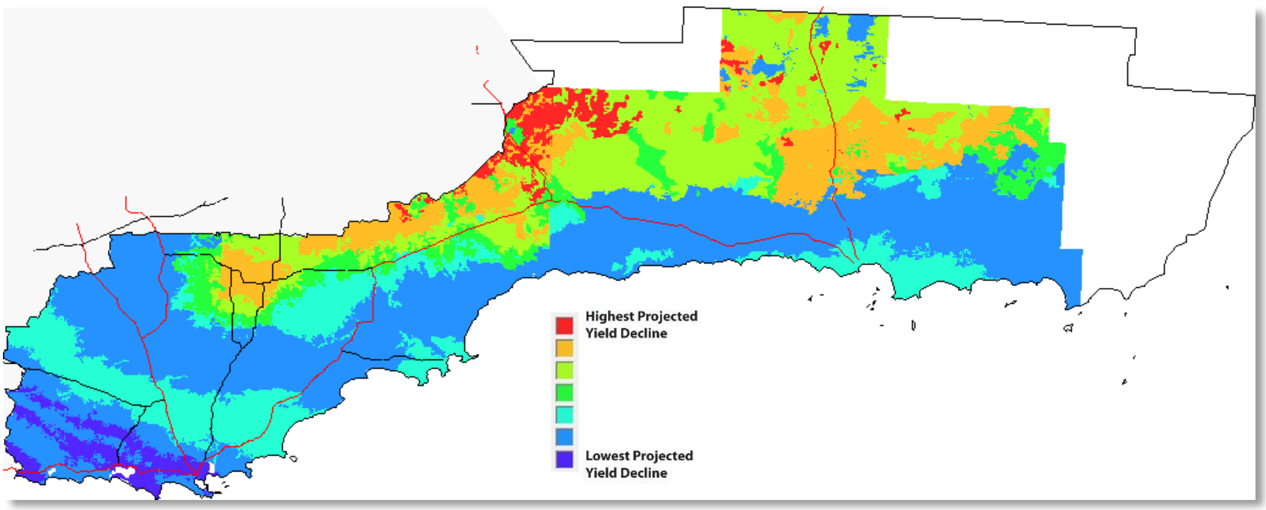


Figure 73: Areas with Projected Yield Declines

Low Value Agricultural Land

Layer 'Low Value Agricultural Land' is a composite layer producing 5 classes from 'High Value' (class 1) to 'Low Value' (class 5).

The composite function is generated from the sum of:

2 x ' Low Agricultural Capability'
1 x 'Areas with Projected Yield Declines'

The result is classed as equal interval according to this table:

1 - up to 0.5632499
2 - up to 1.1265
3 - up to 1.68975
4 - up to 2.253
5 - above 2.253 (highest value)

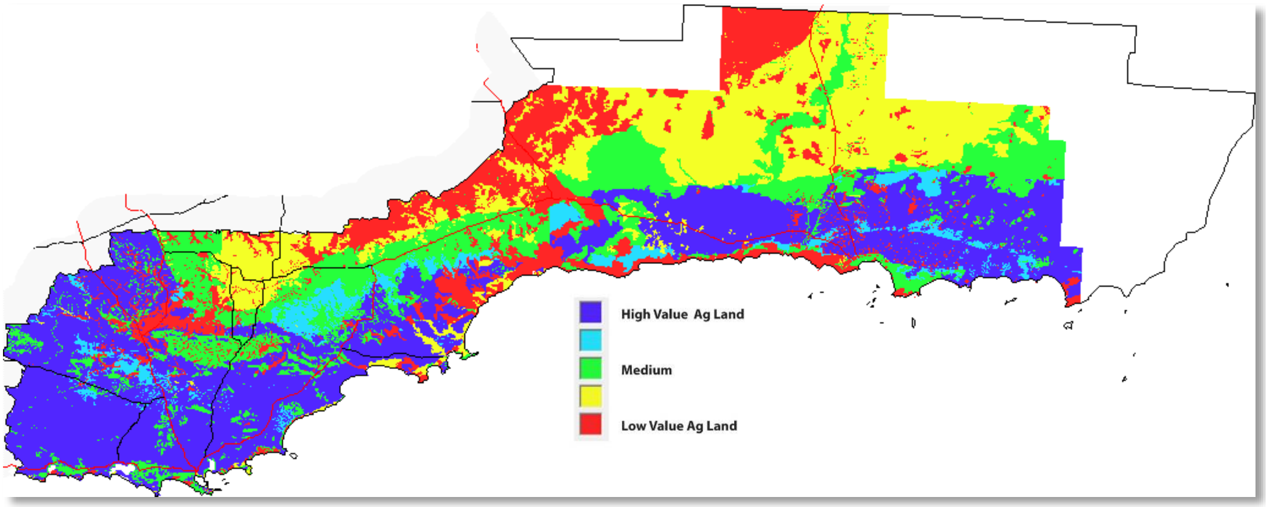


Figure 74: Low Value Agricultural Land

4.1.3.5 Water Resource Recovery Catchments

Water Resource Recovery Catchments are important targets for revegetation, and so are included in both A2A (Commercial) and A2B (CFI) plantings.

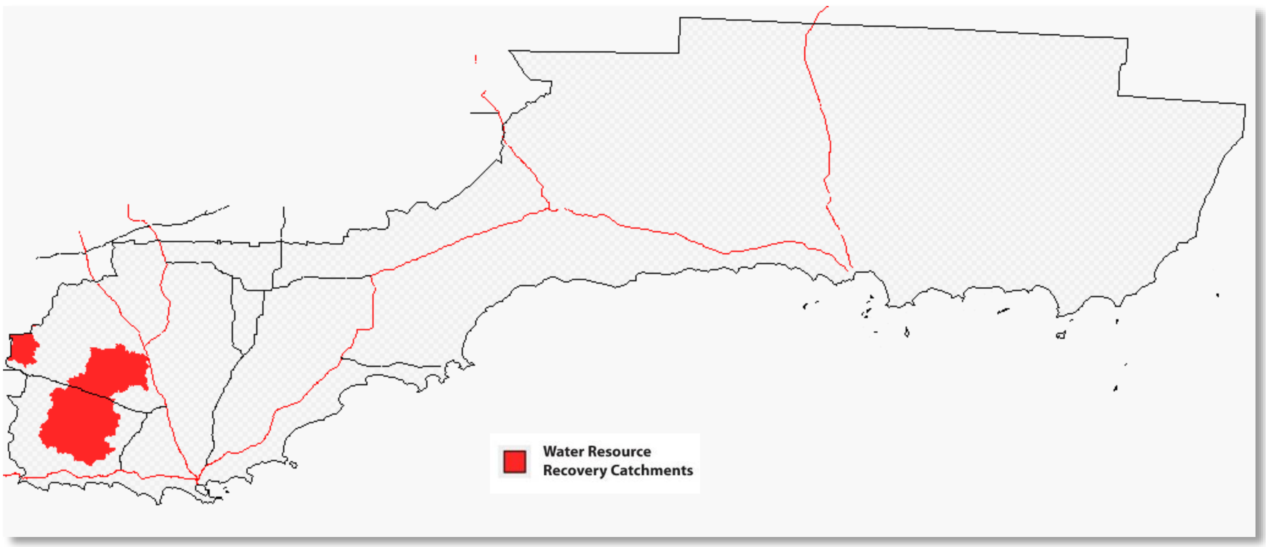


Figure 75: Water Resource Recovery Catchments

4.1.3.6 Areas with Lower Relative Economic Resources (IRER)

The Index of Relative Economic Resources (IRER) is an ABS dataset that focuses on the financial aspects of relative socio-economic advantage and disadvantage, by summarising variables related to income and wealth. This index excludes education and occupation variables because they are not direct measures of economic resources. It is used as a locator for areas that would benefit from the investment associated with CFI plantations, but there was significant discussion about its usefulness. Note that urban areas generally rank lowest in this index.

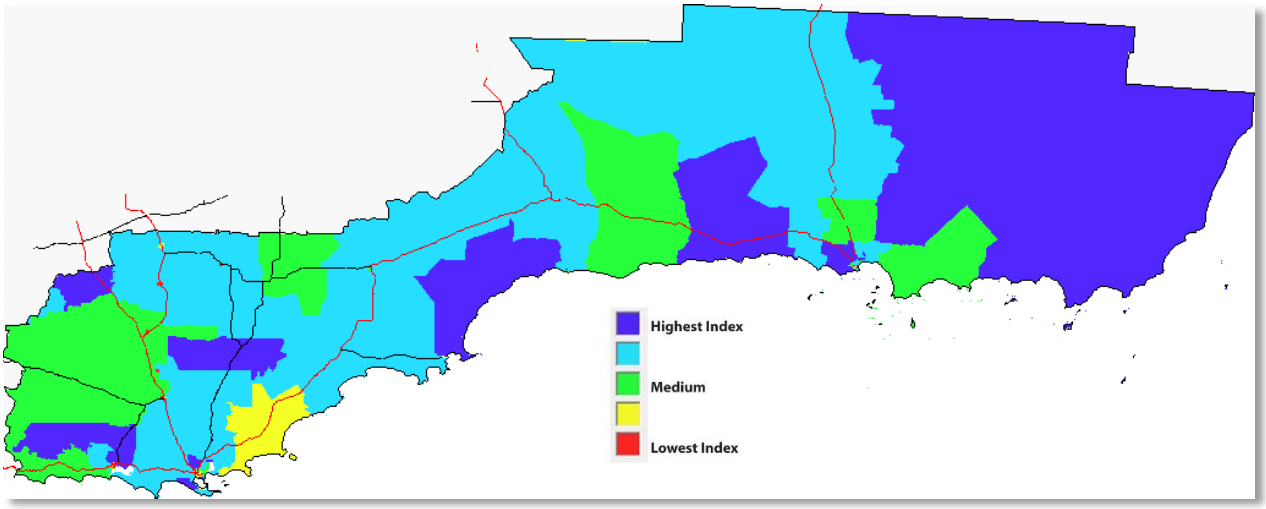


Figure 76: Areas with Lower Relative Economic Resources

4.1.3.7 Projected Rainfall Decline (to 2030)

Project rainfall decline in the near term (2030) was used as an indicator of areas where carbon (CFI) plantations would be useful to offset falling agricultural viability. The layer is split into 5 classes using an equal interval classification:

5 - 9.6 – 8.5% decline
4 – 8.5 – 7.5% decline
3 – 7.5 – 6.4% deline
2 – 6.4 – 5.4% decline
1 - < 5.4% decline

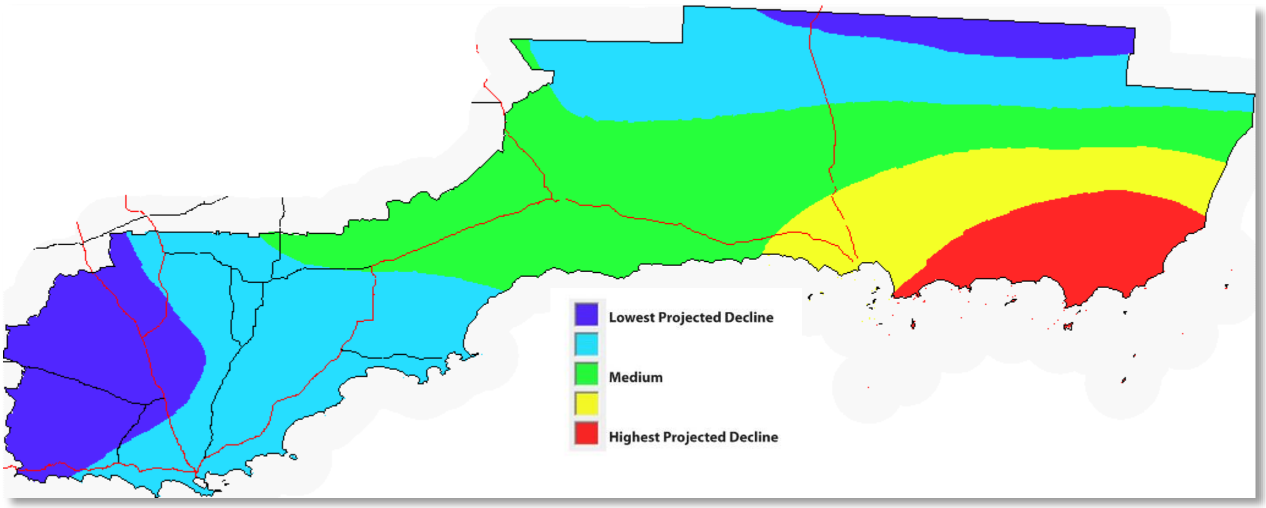


Figure 77: Projected May-Oct rainfall decline to 2030

4.1.3.8 Remnant Vegetation

Remnant vegetation is again included as an exclusion for both A2A and A2B – no planting will occur on areas still vegetated.

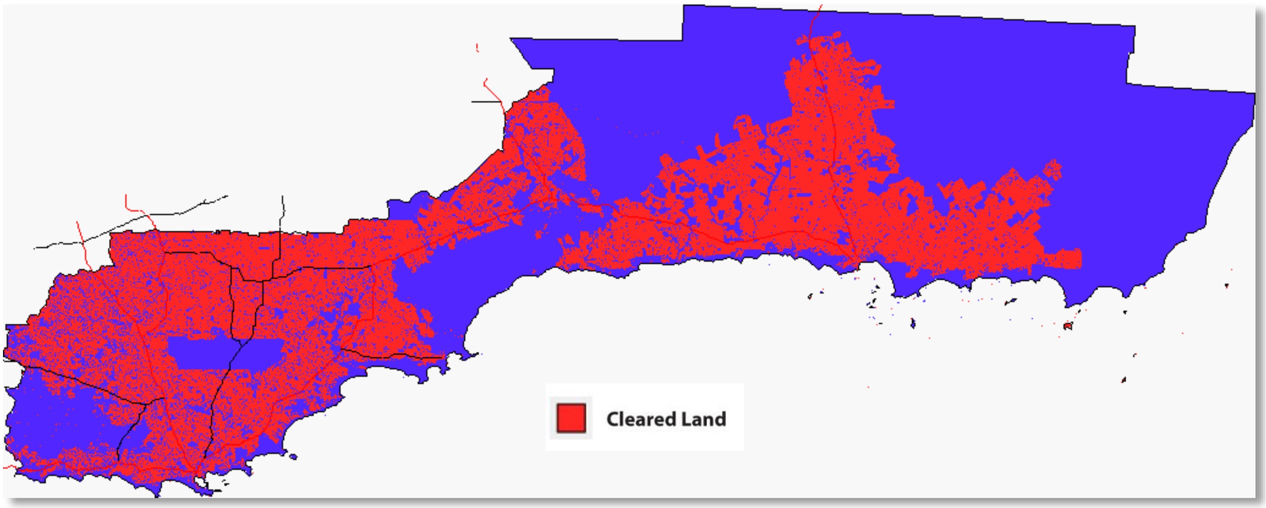


Figure 78: Cleared Land – Potentially available for plantations

4.1.3.9 Component A2 Outputs

A2A - Areas where SCNRM would encourage Commercial plantations

Commercial plantations would be encouraged on areas that have salinity hazards, are low value agricultural land or are Water Resource Recovery catchments. The final map uses an interim layer which combines these inputs in a composite layer generated from the sum of:

1 x 'Low Value Agricultural Land'
1 x 'Potential Salinity Areas'
1 x 'Salinity Hazard at Subcatchment Scale'
1 x 'Water Resource Recovery Catchments'

No specific weighting was applied to these layers in the workshops. Future work may provide a different set of input weights. This interim map is then combined with the cleared land layers in a Two Way from 'A2A Interim' and 'Cleared Land' to mask out all areas where vegetation has not been cleared.

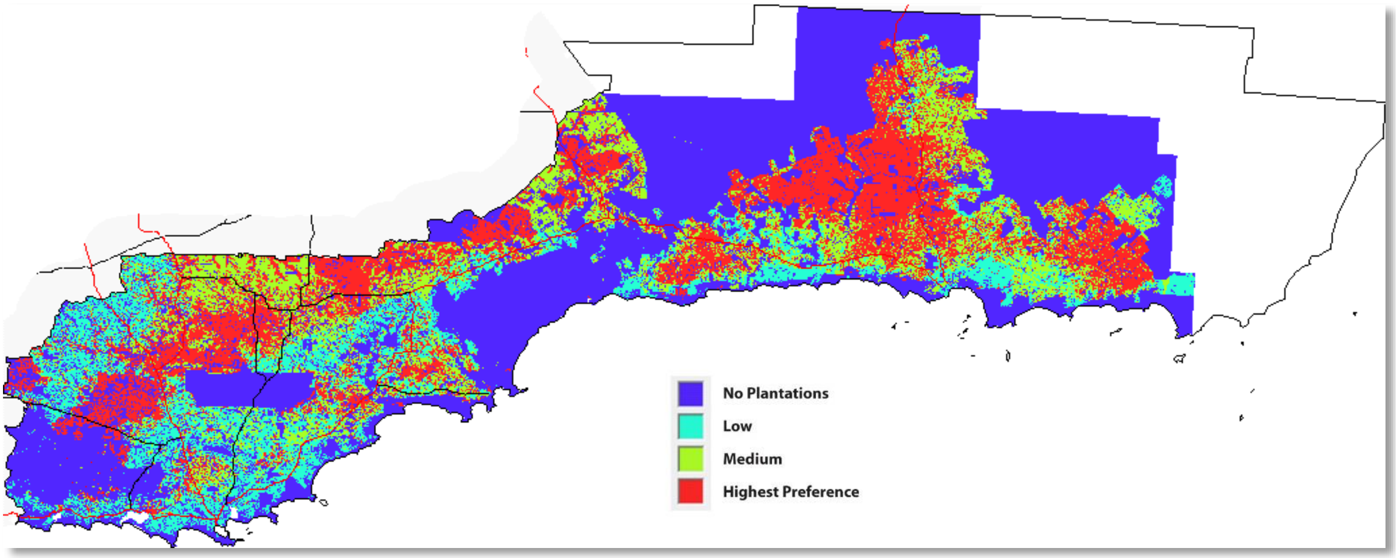


Figure 79: Component A2A Output - Areas where SCNRM would encourage commercial plantations

A2B - Areas where SCNRM would encourage carbon plantings

Even with the addition of a socio-economic index (the IRER) and the May-October rainfall projection (2030), the map of the areas where carbon plantings would be encouraged is similar to A2A.

Layer 'A2B Interim' is a composite layer generated from the sum of:

1 x 'Low Value Agricultural Land'
1 x 'Potential Salinity Areas'
1 x 'Areas with Lower Relative Economic Resources (IRER) '
1 x 'Projected falling May-Oct rainfall to 2030'
1 x 'Salinity Hazard at Subcatchment Scale'
1 x 'Water Resource Recovery Catchments'

Note that the map below was the result of the workshop, but that no specific weighting has been applied to these layers, as a result of running out of time in the workshops. Future investment may provide a different set of input weights. The result is classed according to equal areas, and then combined with the cleared areas mask to create the final map.

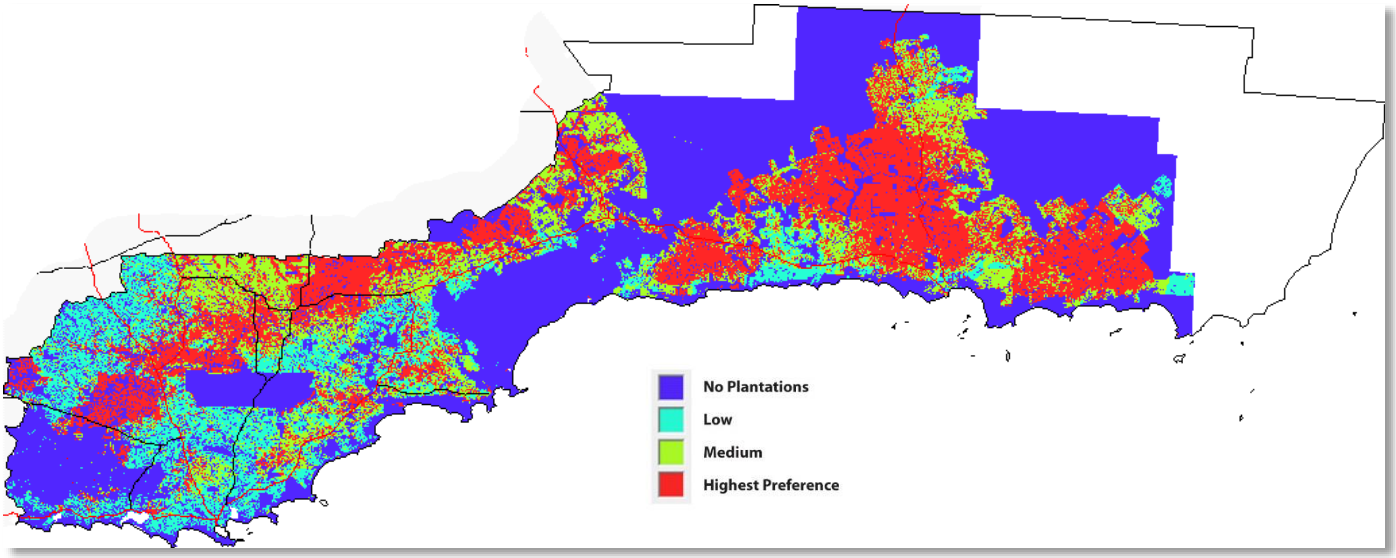


Figure 80: Component A2B Output - Areas where SCNRM would encourage carbon plantings

A comparison of the outputs of A2A and A2B indicates that these produce similar results, differing most in the vicinity of Esperance.

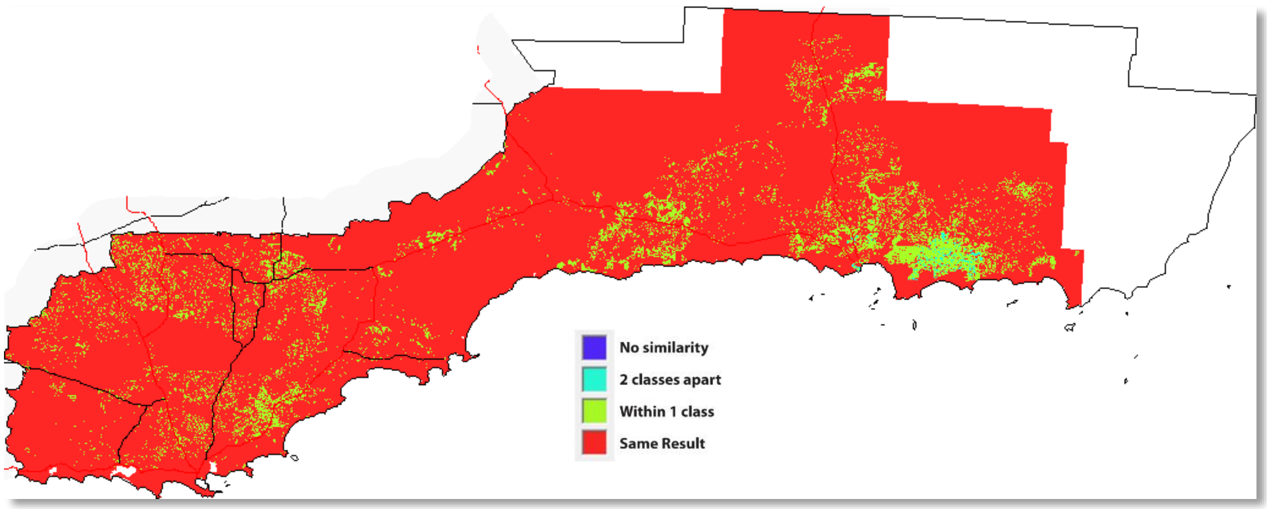


Figure 81: Comparison of A2A and A2B outputs.

4.1.4 Component A3 – Carbon plantings for conservation/biodiversity enhancement

The component contains four major sub-components shown in the MCAS_S diagram below:

- Proximity to High Biodiversity values [Component B1A]
- Proximity to Linkages/Corridors [B3]
- Proximity to known biodiversity assets; and
- Projected climate refugia status

Two of these sub-components are purely locational – indicating identified assets or locations that are considered important to plant near. As in the case of components 1 & 2, it removes remnant vegetation from consideration.

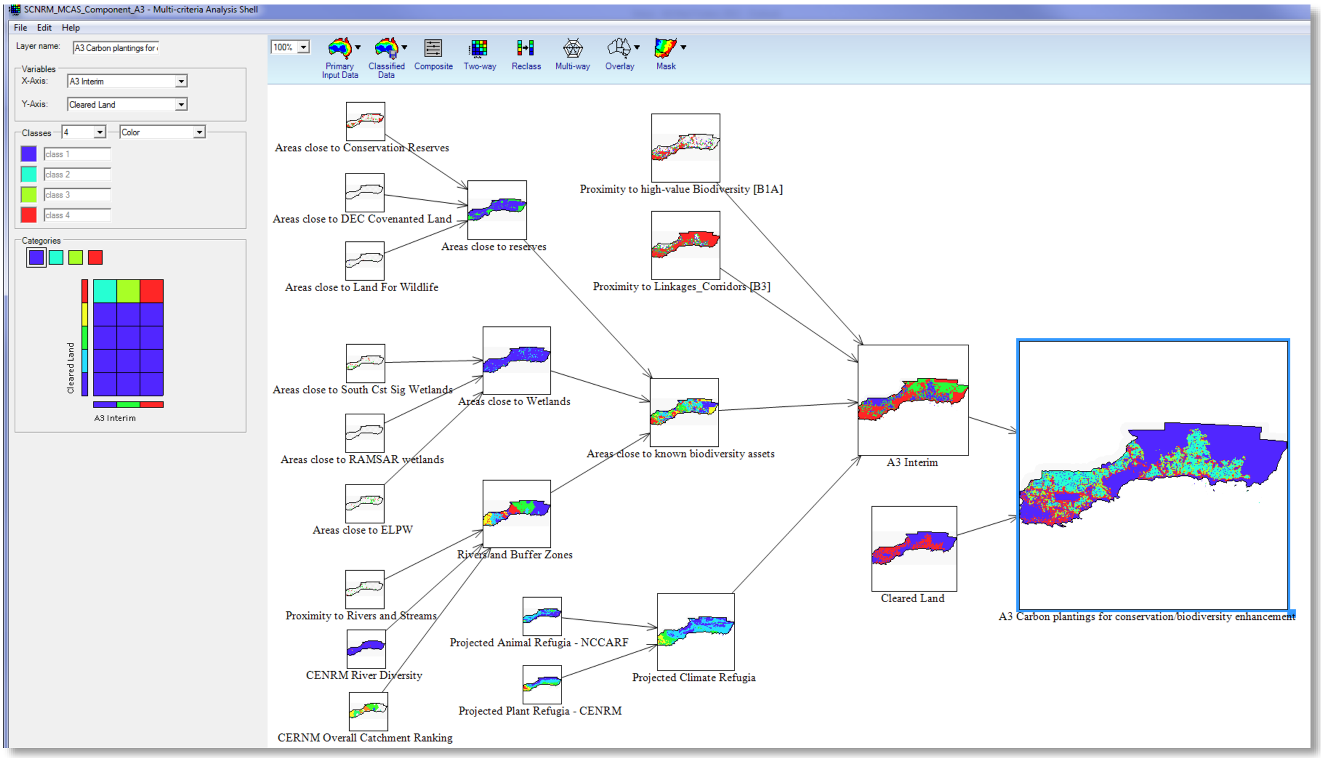


Figure 82: Component A3 - MCAS-S Diagram

4.1.4.1 Proximity to high biodiversity values [Component B1A]

The result from Component A2A has been split into two classes – high and low – using a classification that identifies the highest 16% of all remaining vegetated areas. This area has been buffered to identify close proximity to these highest value areas and the buffer values are used here.

The classes used identify areas within 1km and 2km of High Value Biodiversity/Conservation vegetation as being areas where these is a preference to undertake biodiversity plantings.

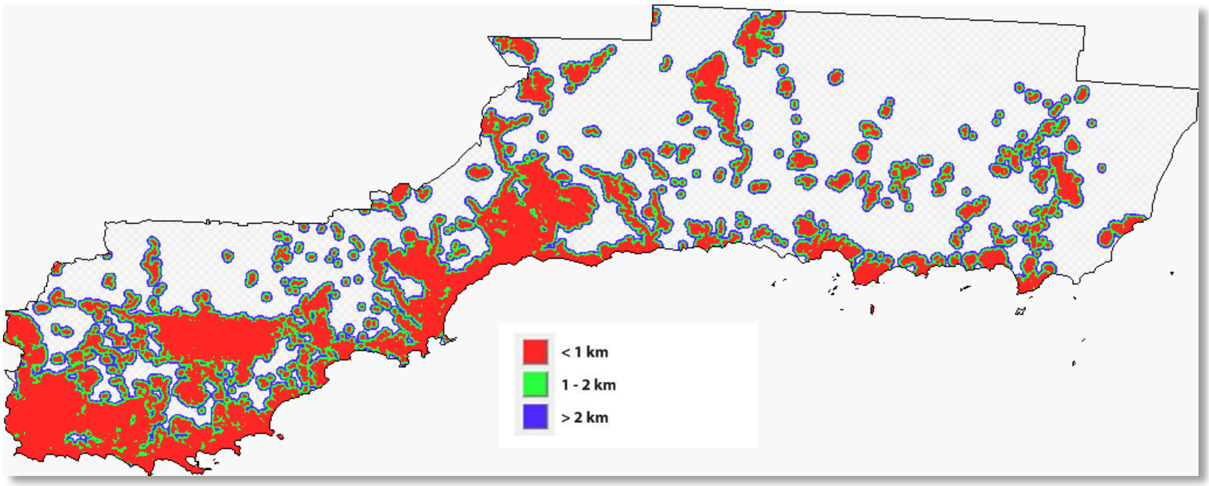


Figure 83: Proximity to High Biodiversity/Conservation values

4.1.4.2 Proximity to Linkages/Corridors [B3]

A key aim of conservation planting is to assist in reconnecting conservation assets in the landscape. The result from Component B3 was been split into three classes – low, med & high, and the highest class exported as a single layer, This has been buffered to identify proximity to these highest value areas and the buffer values are used here.

The classes used identify areas within 1km and 3km of the linkages /corridors as being areas where these is a preference to undertake biodiversity plantings.

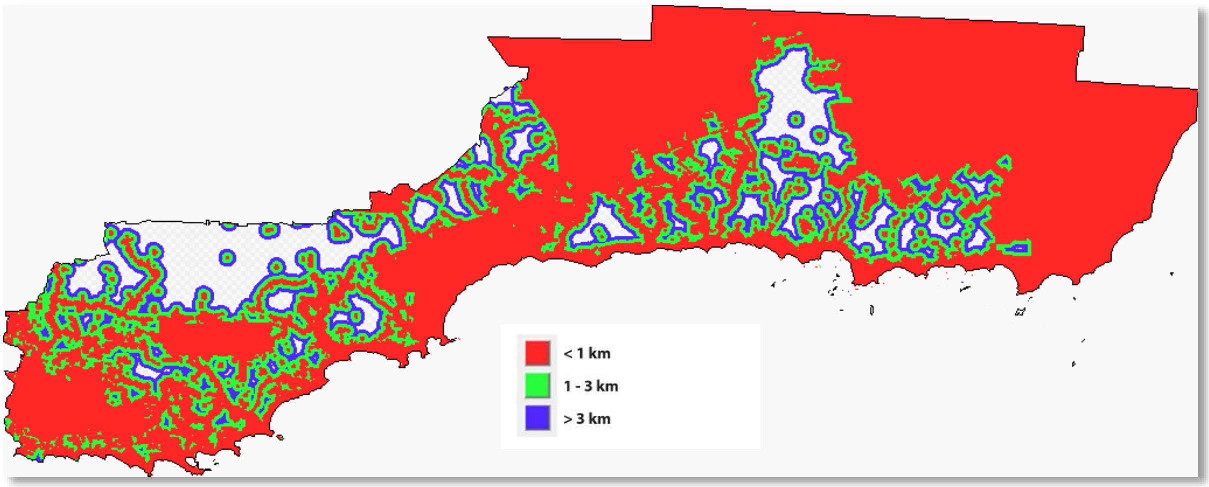


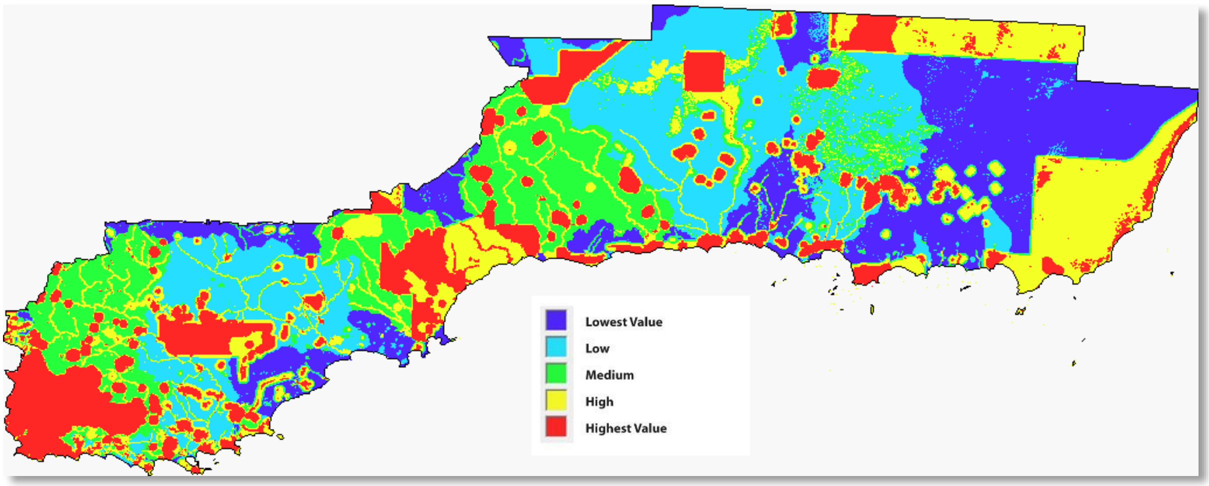
Figure 84: Proximity to Linkages/Corridors [B3]

4.1.4.3 Proximity to known biodiversity assets

Layer 'Areas close to known biodiversity assets' is a composite layer is generated from the sum of:

2 x 'Areas close to reserves'
1 x 'Areas close to Wetlands'
1 x 'Rivers and Buffer Zones'

This criterion combines a wide range of existing biodiversity assets, emphasising reserves over other areas.



Areas close to reserves

Layer 'Areas close to reserves' is a composite layer generated from the sum of:

2 x 'Areas close to Conservation Reserves'
1 x 'Areas close to DEC Covenanted Land'
1 x 'Areas close to Land for Wildlife'

This weighting emphasises existing conservation reserves.

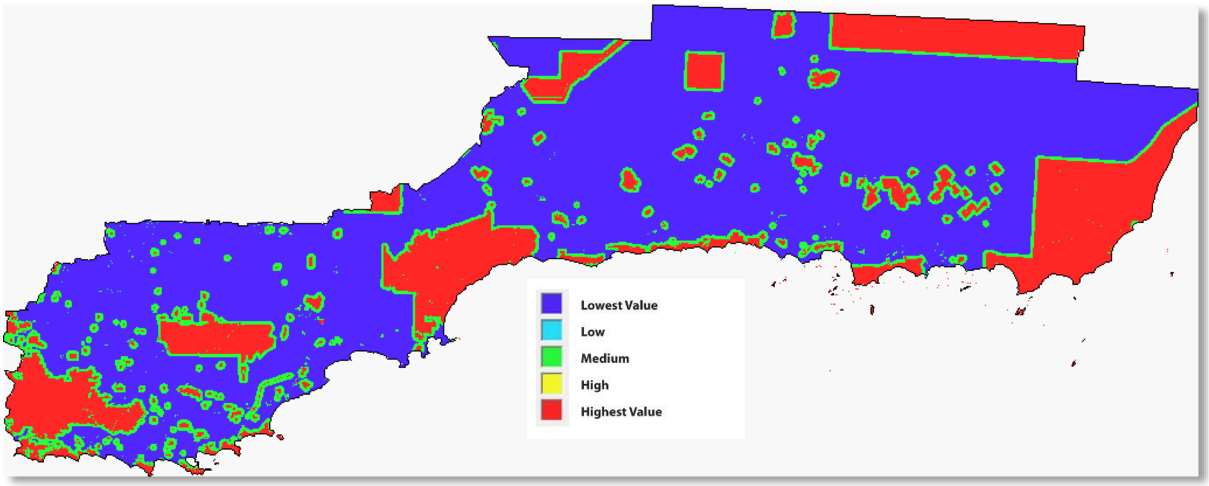


Figure 85: Areas close to reserves

Areas close to Conservation Reserves

This criterion specifies areas in close proximity to all Crown Reserves specifically vested for conservation purposes. It will have the effect of providing for planting around existing reserves.

Split into 3 classes:

3 - from 0 – 1000m (Highest Value)

2 - from 1km – 2.5km
No value is given to areas further than 2.5km.

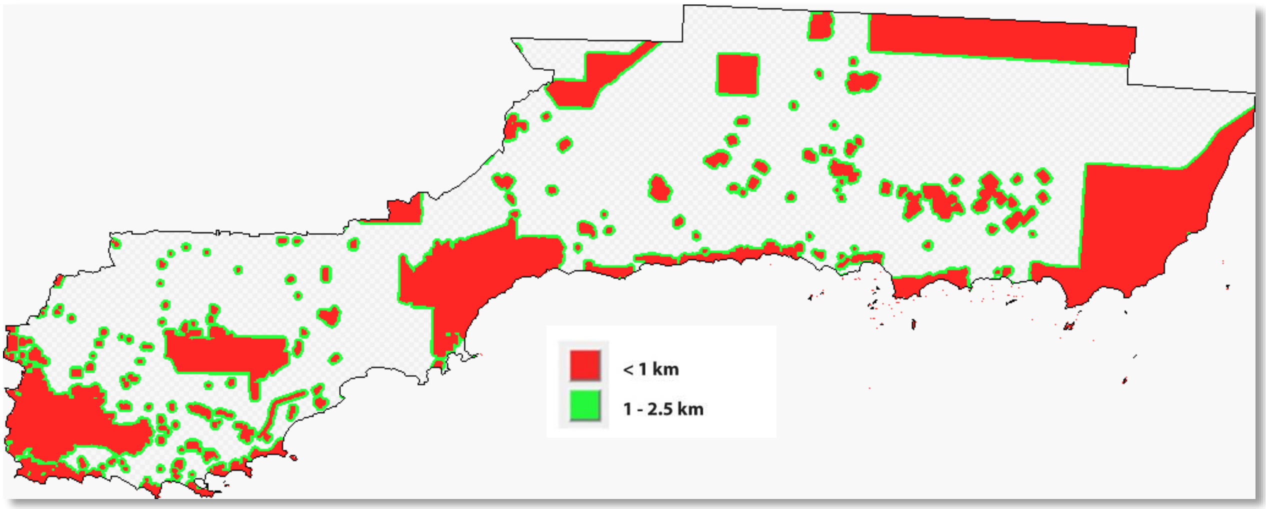


Figure 86: Areas close to Conservation Reserve

Areas close to DEC Covenanted Land

This criterion specifies areas in close proximity to all Land Covenanted by DEC for conservation purposes. It will have the effect of favouring planting around these areas of private conservation land. It is split into 2 classes: from 0 – 200 m (Highest Value); 200 – 400 m (Lowest value)

Areas further than 400m from a covenanted area do not receive a value.

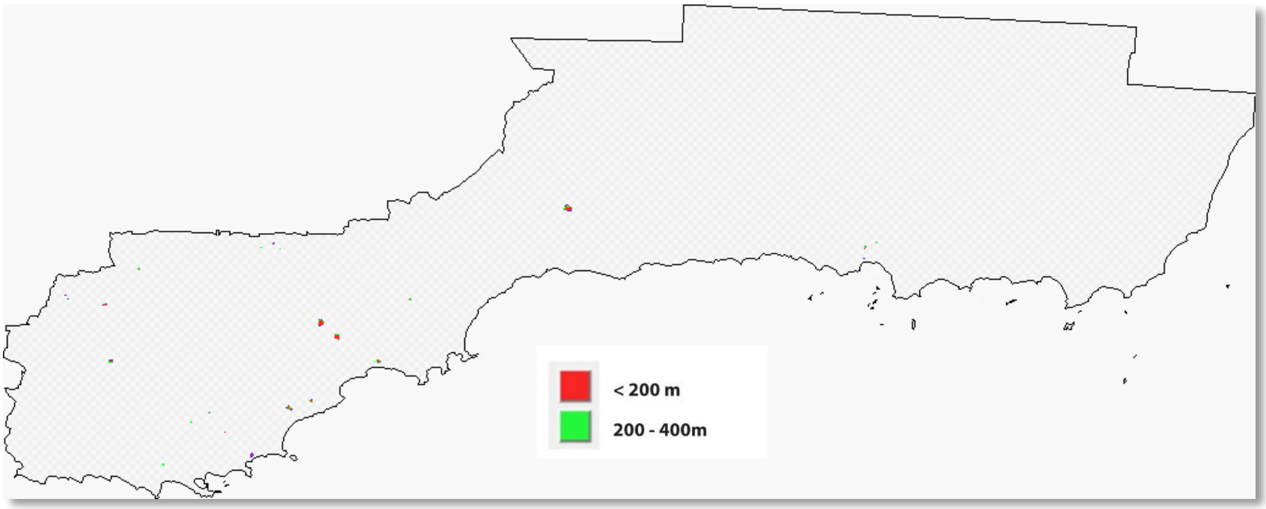


Figure 87: Areas close to DEC Covenanted Land

Areas close to Land for Wildlife Land

This criterion specifies areas in close proximity to all Land for Wildlife areas. It will have the effect of favouring planting around these areas of private conservation land.

The data was split into 2 classes

- from 0 – 200 m (Highest Value)
- from 200 – 400 m (Lowest value)

Areas further than 400m from a Land for Wildlife area do not receive a value.

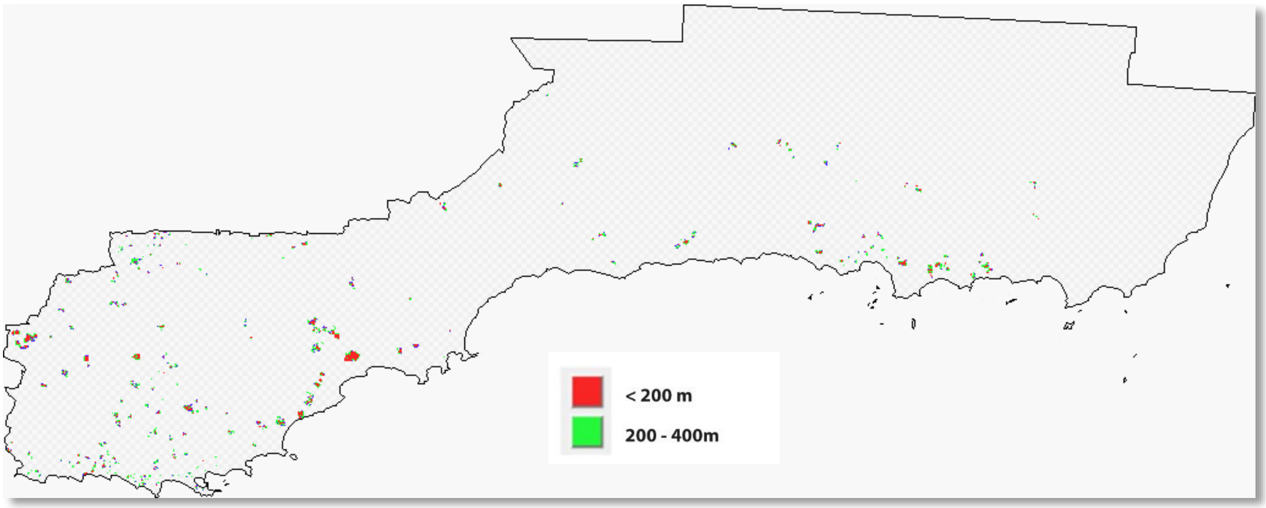


Figure 88: Areas close to Land for Wildlife Areas

Areas close to Wetlands

Layer 'Areas close to Wetlands' is a composite layer is generated from the sum of:

1 x 'Areas close to estuaries, lakes, pool & watercourses
1 x 'Areas close to RAMSAR wetlands'
1 x 'Areas close to South Coast Significant Wetlands'

Summing means that if a wetland is indicated in more than one of these datasets it will be more highly valued.

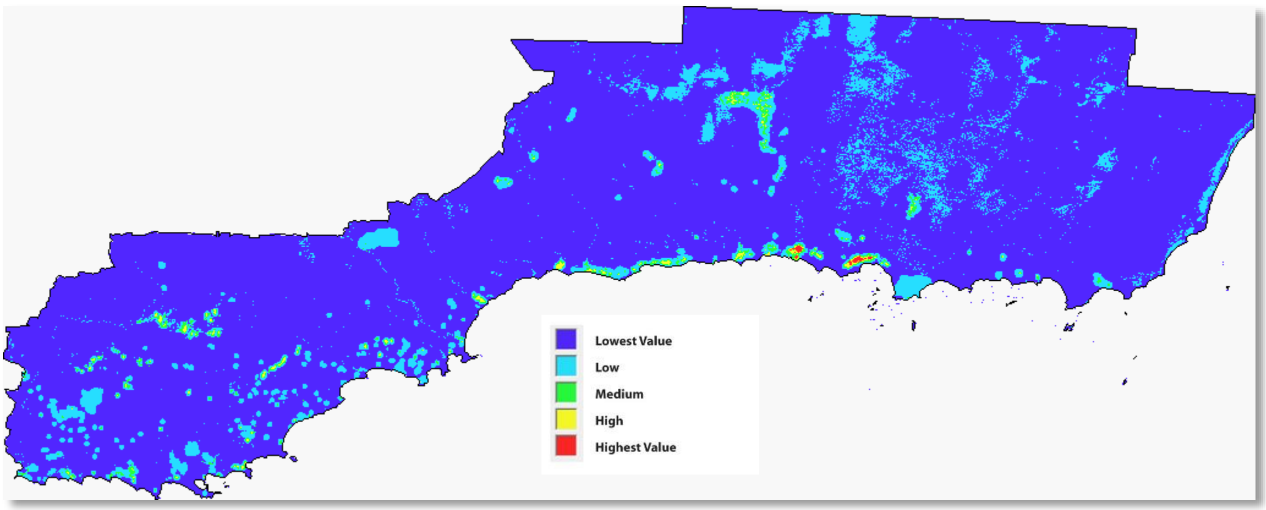


Figure 89: Areas close to Wetlands

South Coast Significant Wetlands (Proximity)

This criterion specifies areas in close proximity to all EPP Wetlands. It will have the effect of providing for planting around these wetlands and providing additional protection to them. Distances in m.

Split into 3 classes

3 - from 0 – 1000m (Highest Value)
2 - from 1km – 2.5km

No value is given to areas further than 2.5km.

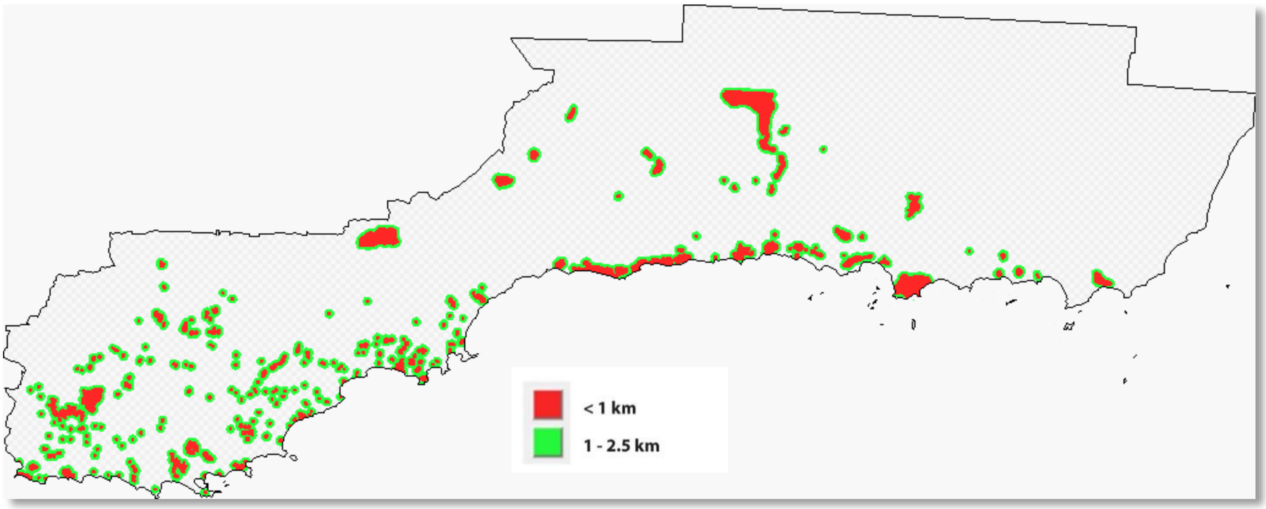


Figure 90: Distance to South Coast Significant Wetlands

Ramsar Wetlands (Proximity)

This criterion specifies areas in close proximity to all RAMSAR wetlands. It will have the effect of providing for planting around these wetlands and providing additional protection to them. Distances in m.

Split into 3 classes

- from 0 – 1000m (Highest Value)
- from 1km – 2.5km

No value is given to areas further than 2.5km.

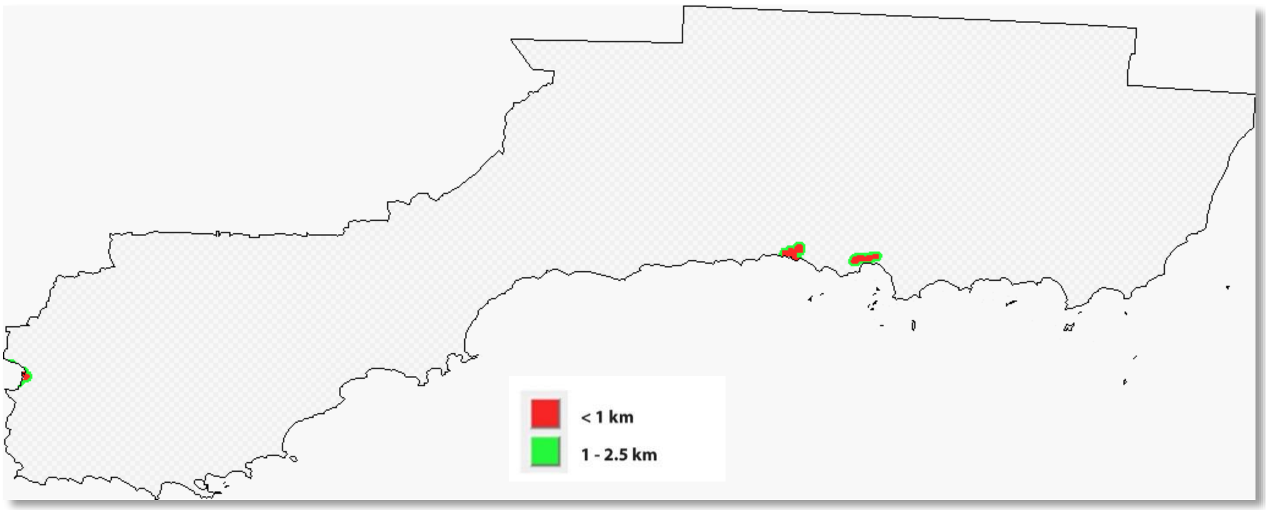


Figure 91: Distance to Ramsar Wetlands

Distance from Water features (Topographic estuaries, lakes, pool & watercourses)

This criterion specifies areas in close proximity to all water features - estuaries, lakes, pool and identified watercourses. It will have the effect of enhancing planting around these wetlands and providing additional protection to them. Distances in m. Split into 3 classes

3 - from 0 – 200m (Highest Values)
2 - from 200 – 500m
1 - Over 500

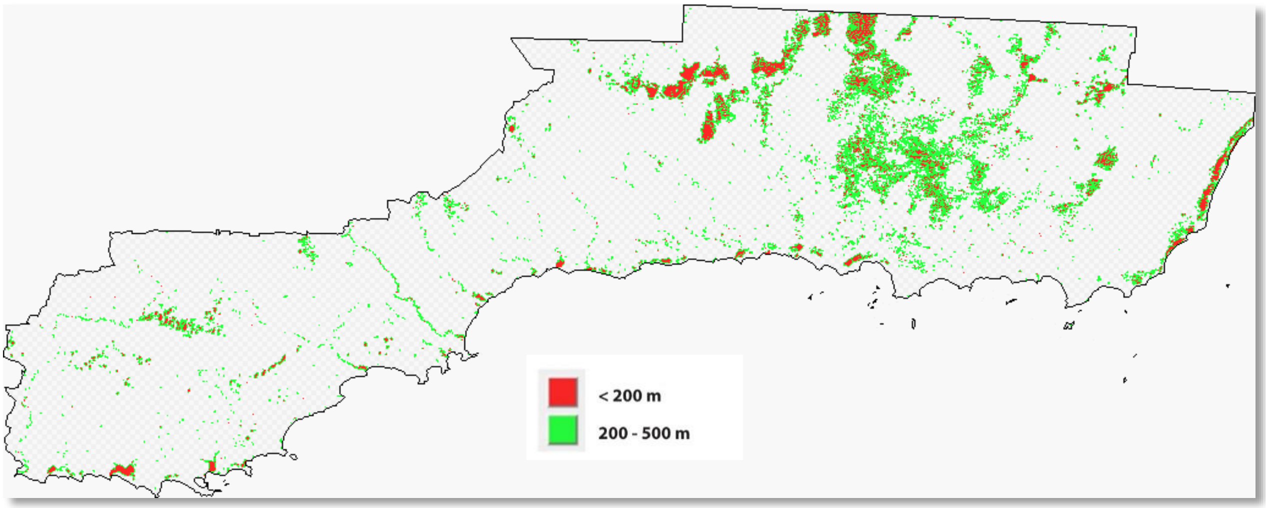


Figure 92: Distance from Water features (Topographic estuaries, lakes, pool & watercourses)

Rivers and buffer zones

The sub-component identifies areas in close proximity to major rivers and streams, as well as catchments that have been ranked highly on the basis of diversity or overall from a conservation perspective through CENRM research. Major rivers in these catchment score highest.

The layer 'Rivers and Buffer Zones' is a composite layer generated from the sum of:

1 x 'CENRM River Diversity'
1 x 'CERNM Overall Catchment Ranking'
1 x 'Proximity to Rivers and Streams'.

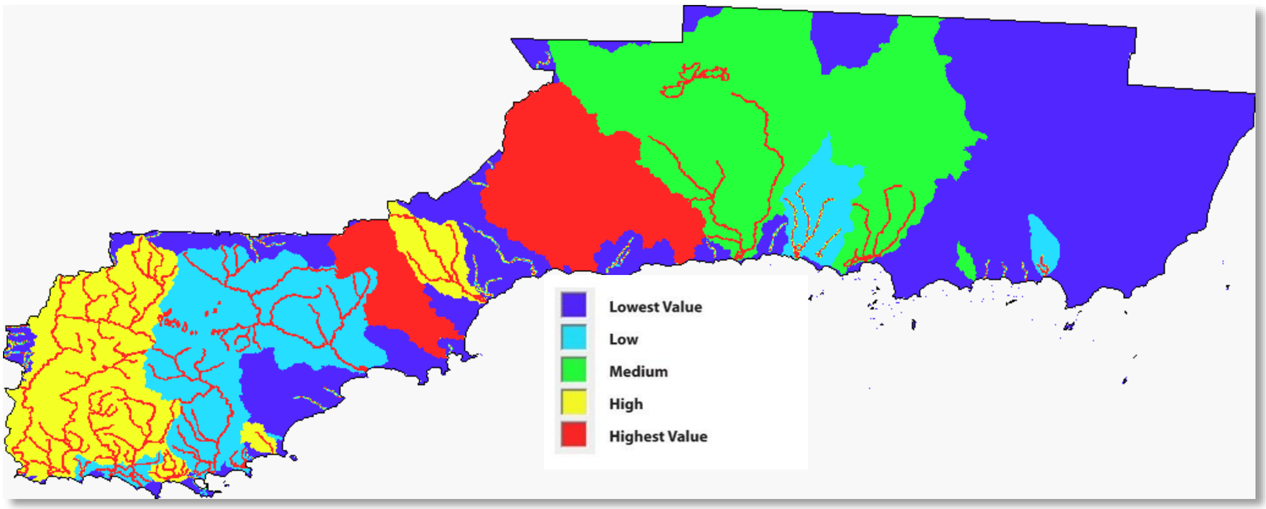


Figure 93: Rivers and buffer zones

Proximity to rivers and streams

Proximity to rivers and streams is considered an important criterion – not only does fringing vegetation play an important role in improving water quality, but the provision of riverine vegetation provides for corridors and greatly improves in-stream habitat quality.

Rivers and streams are the lines classified as Mainstream, Major river, Minor river & Significant Stream in the topographic dataset Hydrography_Linear dataset from DoW. The classification limits the influence of the criterion to less than 600m from the watercourse.

Split into 3 classes

3 - from 0 – 200m (Highest Values)
2 - from 200 – 500m

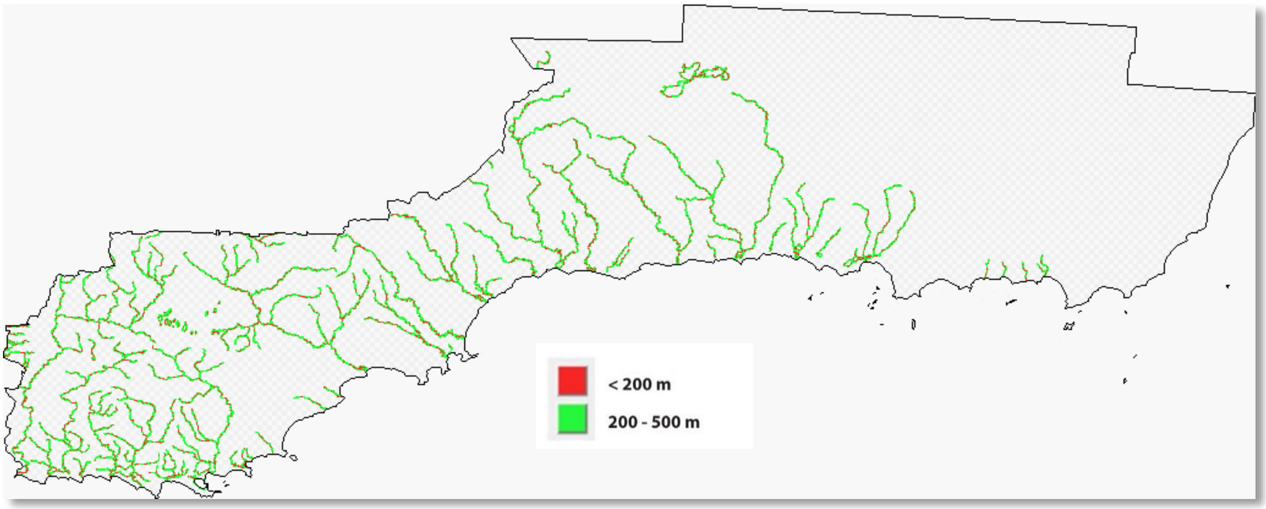


Figure 94: Proximity to rivers and streams

CENRM River Diversity

CENRM Catchment assessment provided a diversity assessment from surveys of aquatic fauna and habitats - this value is given to a 200m grid of the major rivers and streams in each subcatchment.

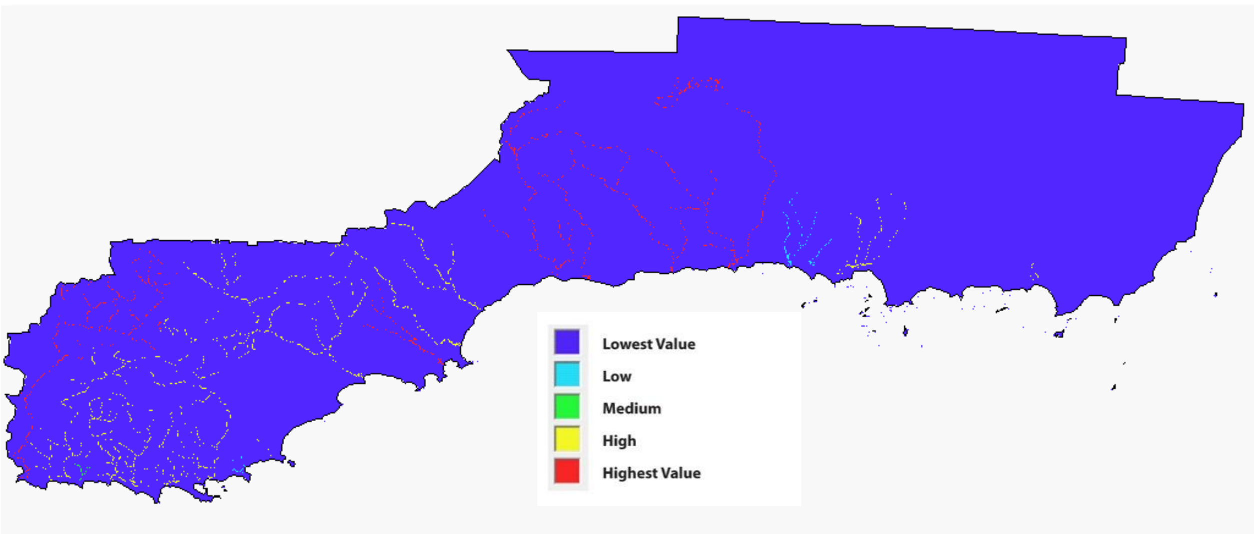


Figure 95: CENRM River Diversity

CENRM Overall Catchment Ranking

CENRM Catchment assessment provides an Overall Catchment Ranking based on Naturalness, Diversity and Rarity, which is applied to the entire catchment, indicating that the whole catchment contributes to these values. This has been classified to allow un-surveyed catchments - where no value is given - to be included in the layer without removing them from the analysis (given -9999 value).

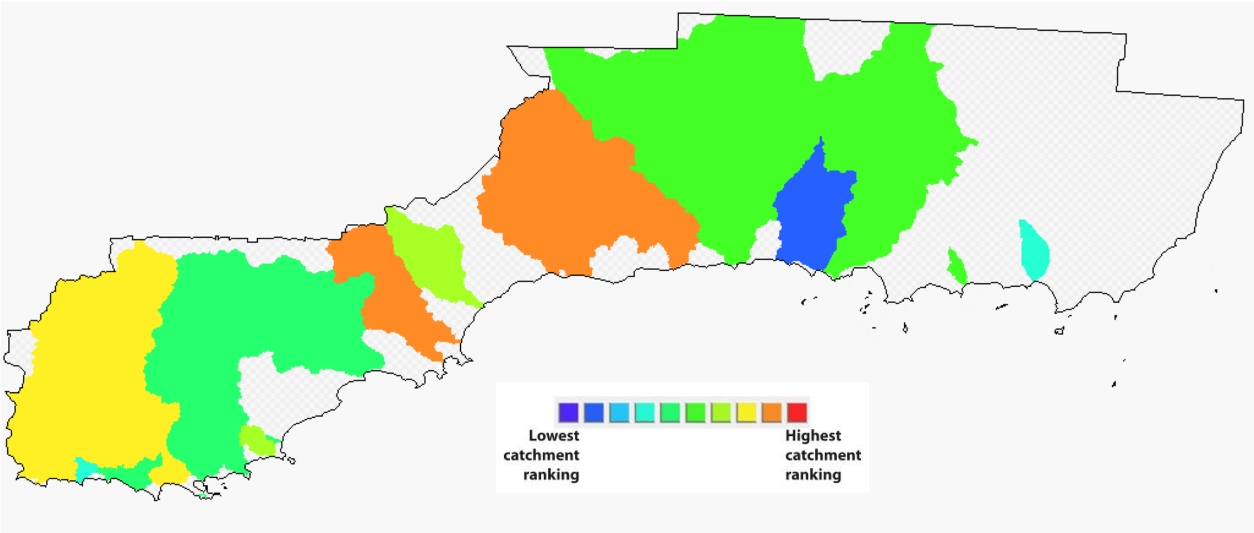


Figure 96: CENRM Overall Catchment Ranking

4.1.4.4 Projected Climate Refugia

SCNRM is currently engaged in introducing climate change into its planning, and this criterion is the best available to identify potential climate impacts on species (ie biodiversity). For the current context these areas represent the best places to invest in revegetation based on likely survivability.. The layer 'Projected Refugia' is a composite layer generated from the sum of:

1 x Projected Animal Refugia - NCCARF
1 x Projected Plant Refugia - CENRM

The result is classed using an equal interval scale.

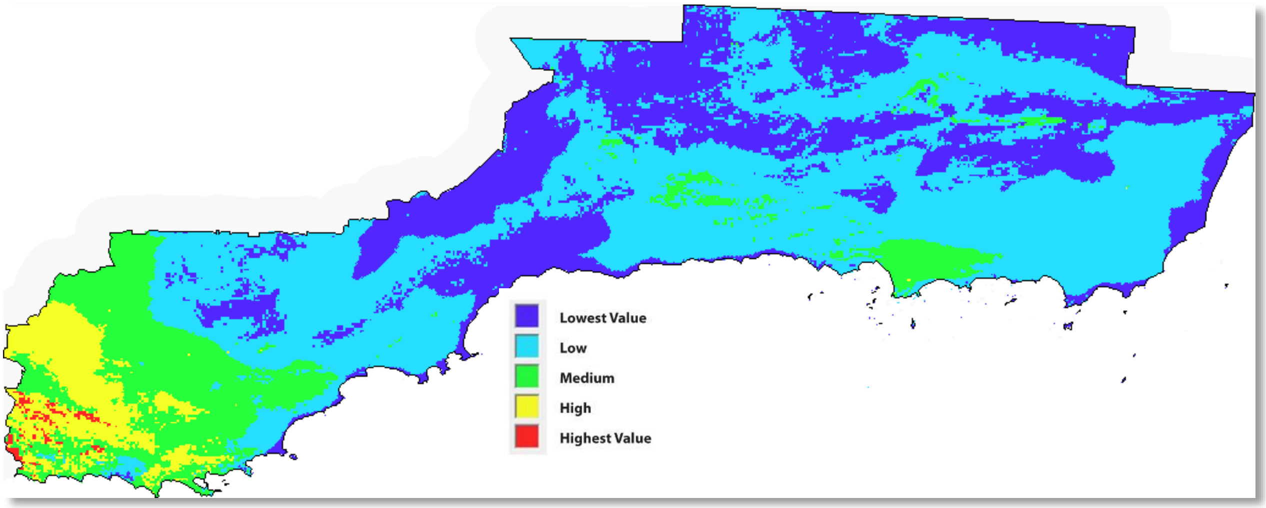


Figure 97: Project Climate Refugia

Projected Animal Refugia – NCCARF (Reside)

The Biological Refugia under Climate Change criterion is one output of a large project (see Reside, et al 2013) funded by NCCARF, modelling potential distributions of species into the future. This dataset shows projected refugia areas in 2085, being areas with the smallest loss, and greatest gain, of species in four major taxonomic groups – mammals, birds, reptiles and amphibians - a total of 1400 species.

The areas with high values (Class Five) are projected to be refugia in the sense of providing the best chance for the retention of existing biodiversity, and the potential to provide possibilities for species displaced by changing climate.

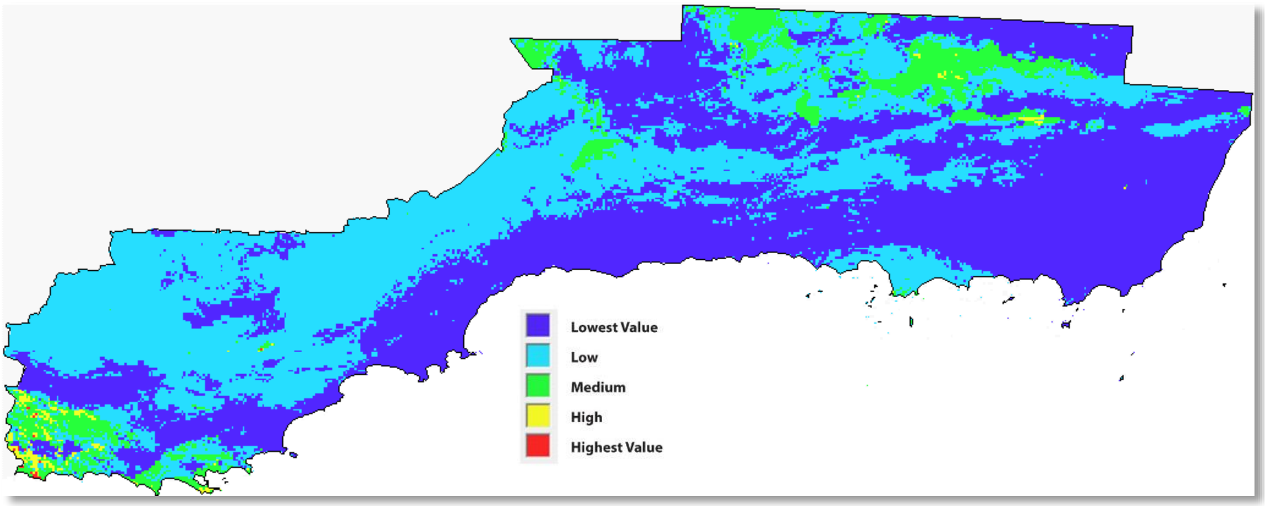


Figure 98: Projected Climate Refugia for Animals (NCCARF - 2085)

Projected Plant Refugia - CENRM

Through 2014 the Centre for Excellence in NRM in Albany has been modelling bioclimatic distributions for plant species. This map uses a similar method as NCCARF for identifying "refugia". Here the groups are based on climate drivers (such maximum summer temperature, mean summer temperature) that plants are most sensitive to. Total species numbers ~130.

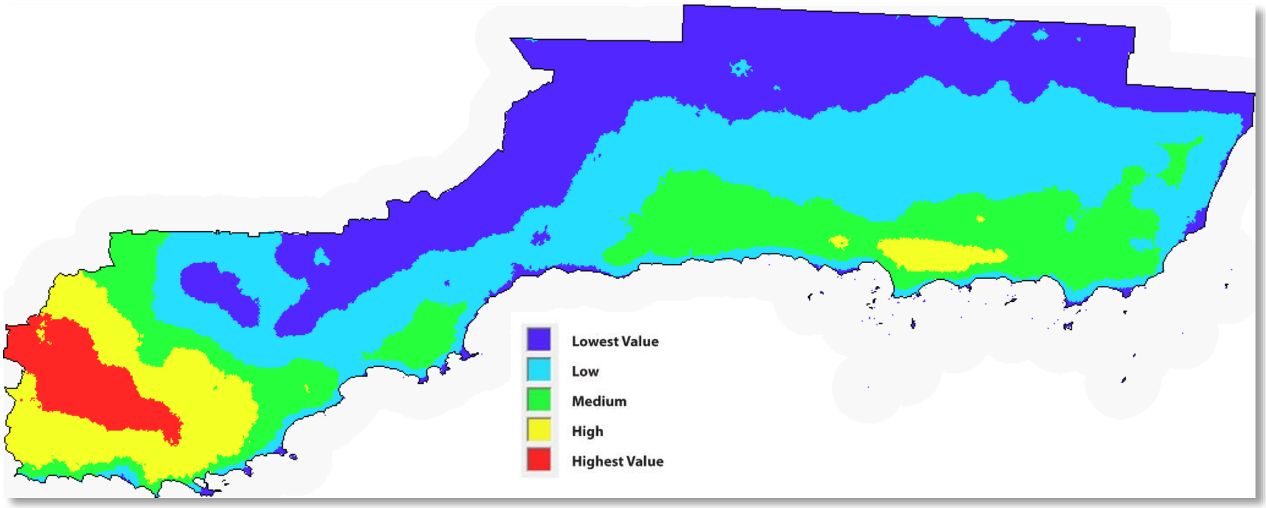


Figure 99: Projected Climate Refugia for Plants (CENRM - 2080)

4.1.4.5 Component A3 Output - Carbon plantings for conservation/biodiversity enhancement

The final output indicates areas that would be most suitable for carbon plantings (and other plantings) for biodiversity/conservation enhancement.

The initial layer 'A3 Interim' is a composite layer producing 3 classes from the sum of:

1 x 'Areas close to known biodiversity assets'
2 x 'Proximity to high-value Biodiversity [B1A] V2'
2 x 'Proximity to Linkages/Corridors [B3] v2'
0.5 x 'Projected Climate Refugia'

The weightings indicate that the most significant factors in this map are high value biodiversity [B1A] and linkages/corridors [B3]. The result is classed using a custom set of class values as decided by the workshop, and then combined with the cleared areas mask to create the final map.

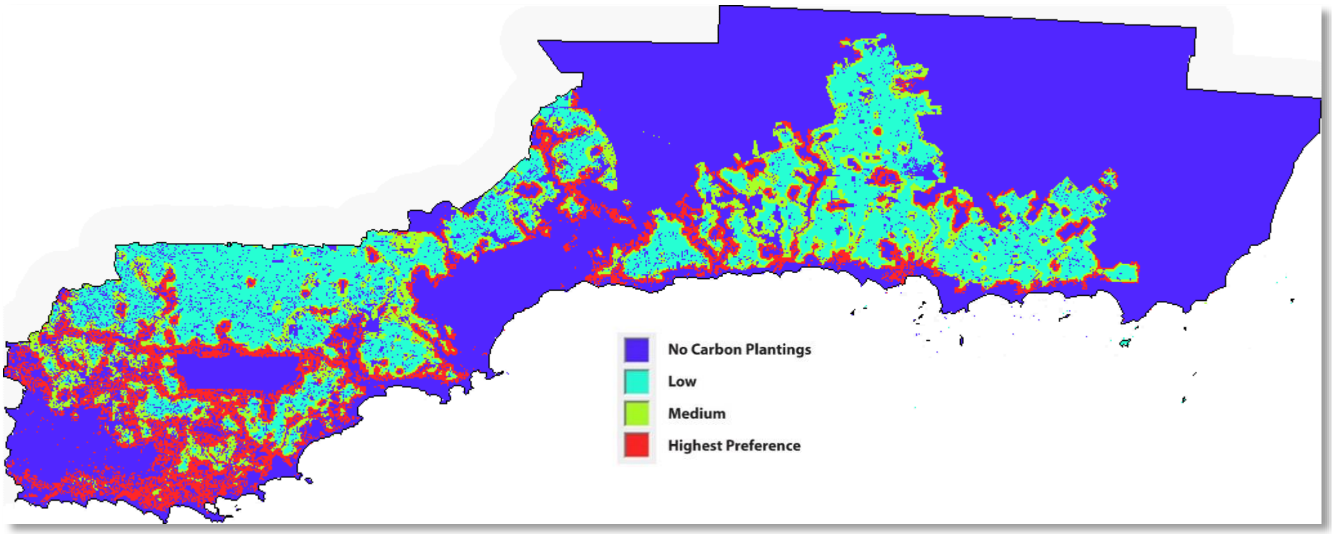


Figure 100: MCAS-S Final Output – Component A3

4.2 Theme B

4.2.1 Component B1A – Identifying Areas of High Biodiversity Value

Component B1A is complex, and includes a number of intermediate sub-components which feed into the three major criteria – rarity or uniqueness, naturalness, and diversity. The complex set of criteria is shown below in the component diagram.

Layer 'Areas of High Value Biodiversity' is a composite layer producing 5 classes, and is generated from the sum of:

4 x 'Diversity'
3 x 'Naturalness'
3 x 'Rarity/ Uniqueness'

The result is classed with a custom set of boundaries. It is used as an input to Components A3 and B1B but is also a standalone indicator of biodiversity value.

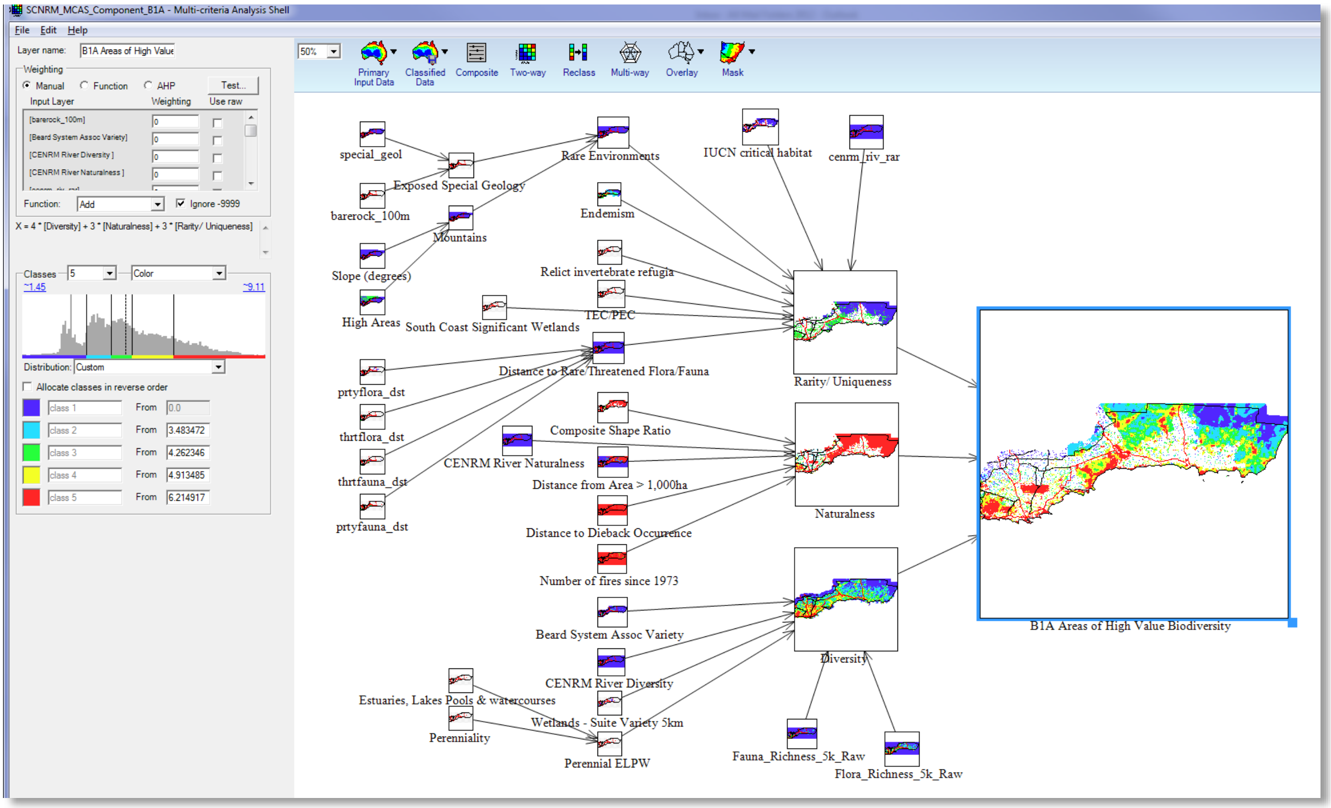


Figure 101: MCAS-S Diagram for Component B1A

4.2.1.1 Rarity/Uniqueness

One of the three major criteria in High Value Biodiversity, this is a composite layer generated from the sum of a range of criteria:

1 x CENRM River Rarity
2 x 'Distance to Rare/Threatened Flora/Fauna'
0.2 x 'Endemism'

1 x 'IUCN critical habitat'
2 x 'Rare Environments'
1 x 'Relict invertebrate refugia'
1 x 'South Coast Significant Wetlands'
1 x 'TEC/PEC'

The result is custom classified to the satisfaction of the workshop participants using a simple 3 class scale.

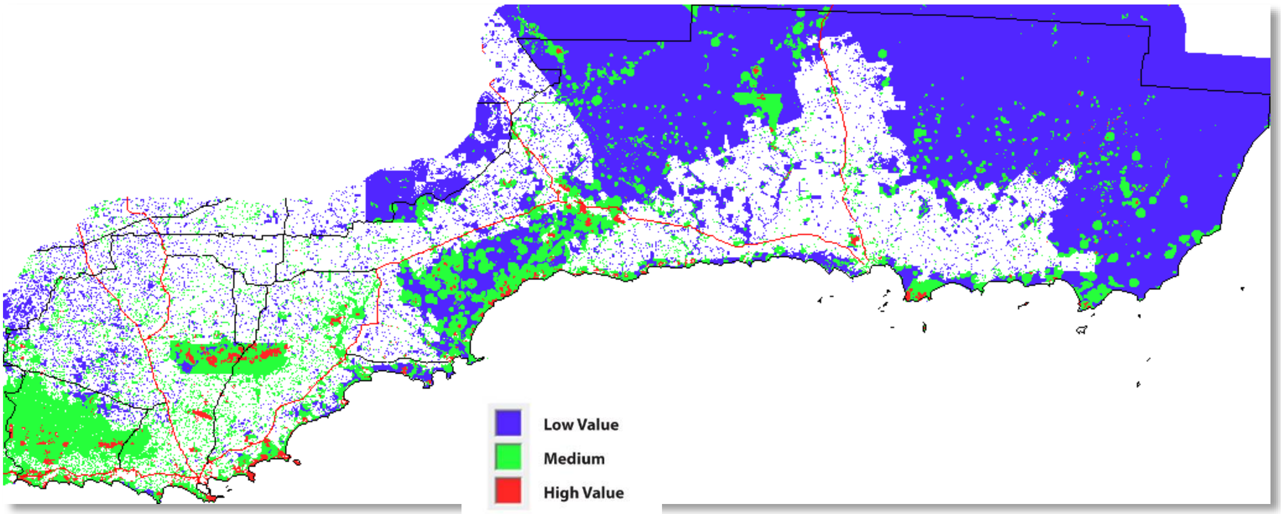


Figure 102: Rarity/ Uniqueness

IUCN Critical Habitat

This is an IUCN criterion, where community types of very small extent are identified as critical habitat. It uses System Association remaining derived from remnant vegetation and Beard datasets (DAFWA/DEC). The critical areas are <1500ha, or 1500 – 3000 ha.

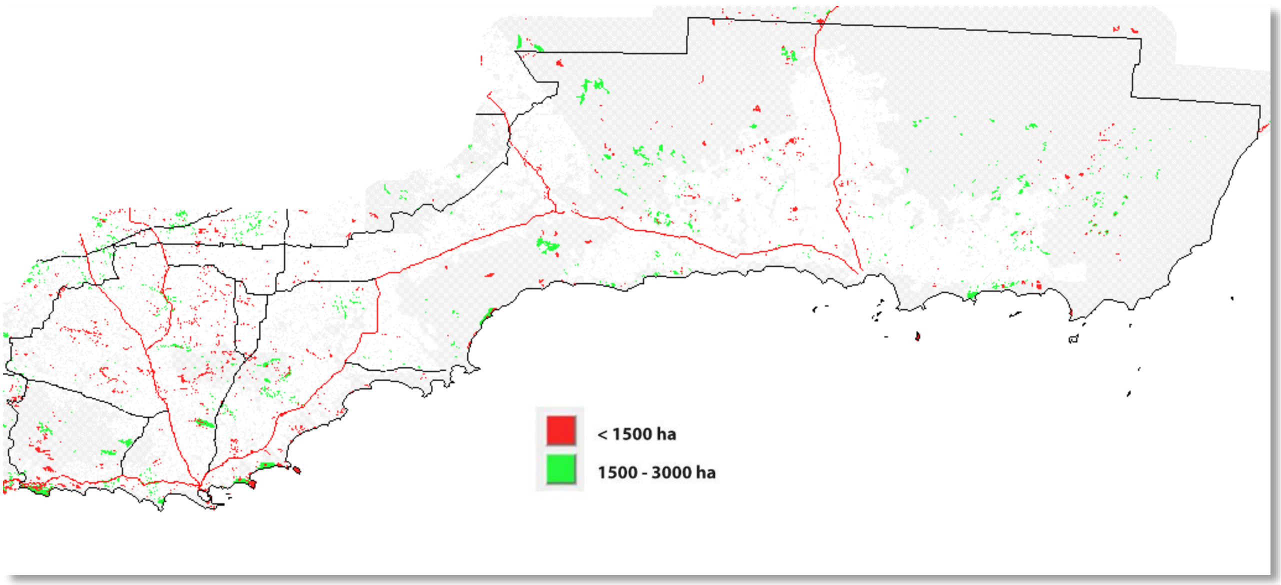


Figure 103: IUCN Critical Habitat

CENRM River Rarity

CENRM Catchment assessment provided a rarity assessment from surveys of aquatic fauna and habitats - this value is given to a 200m grid of the major rivers and streams in each subcatchment. Using this helps recognise the biodiversity values of rivers and streams.

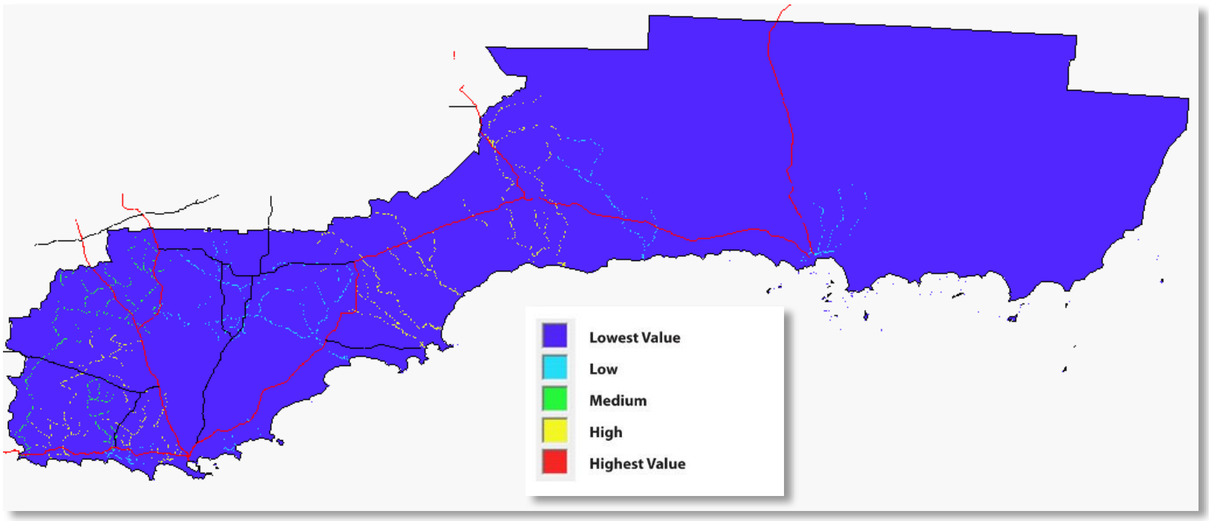


Figure 104: CENRM River Rarity

Rare Environments

This sub-component is made up of two criteria:

- Exposed special geology
- Mountains

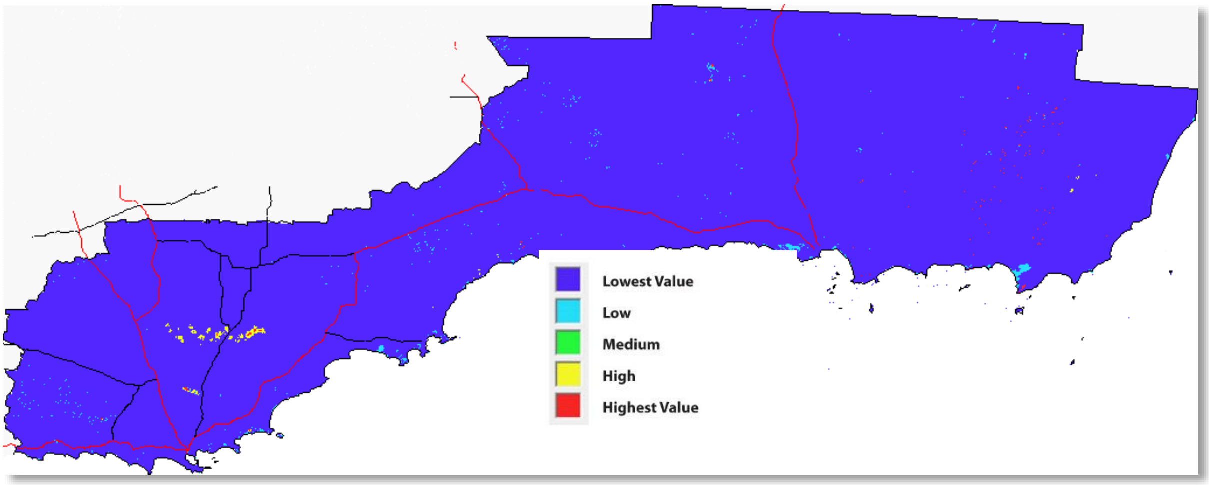


Figure 105: Rare Environments

Exposed special geology

A range of unusual rock types provide unique environments, particularly in inland locations where vegetation communities surrounding the bare surfaces are watered from runoff in locally restricted micro-climates. This factor combines the following geology types (from Surface Geology of Australia, 1:1 000 000 scale, 2012 edition) with bare rock areas (gridded at 100m cell size to pick up smaller areas).

2 Siltstone, sandstone, bryz. carbonates, spongolite
3 Quartzite
4 Mafic to Ultramafic
5 Ultramafic
6 Banded Iron
7 Granite
8 Spongolite, sandstone, siltstone

The selected environments are shown in Red below:

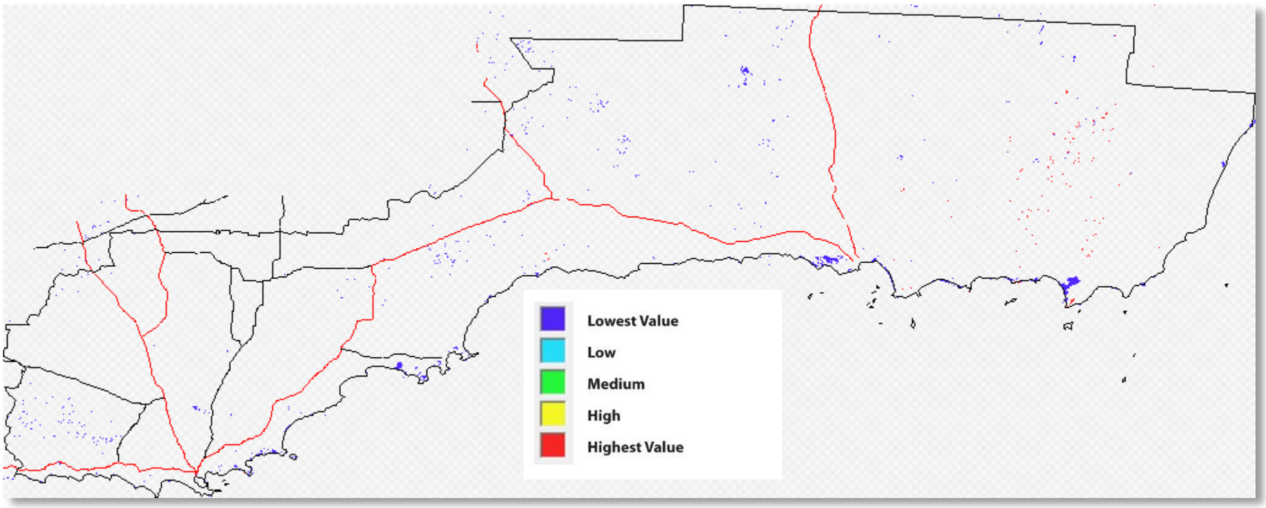


Figure 106: Exposed special geology

Mountains

Layer 'Mountains' is generated with a Two Way from 'High Areas' and 'Slope (degrees)' – all areas above 700m classed as mountains, and areas 300-700m with slope above 10 degrees.

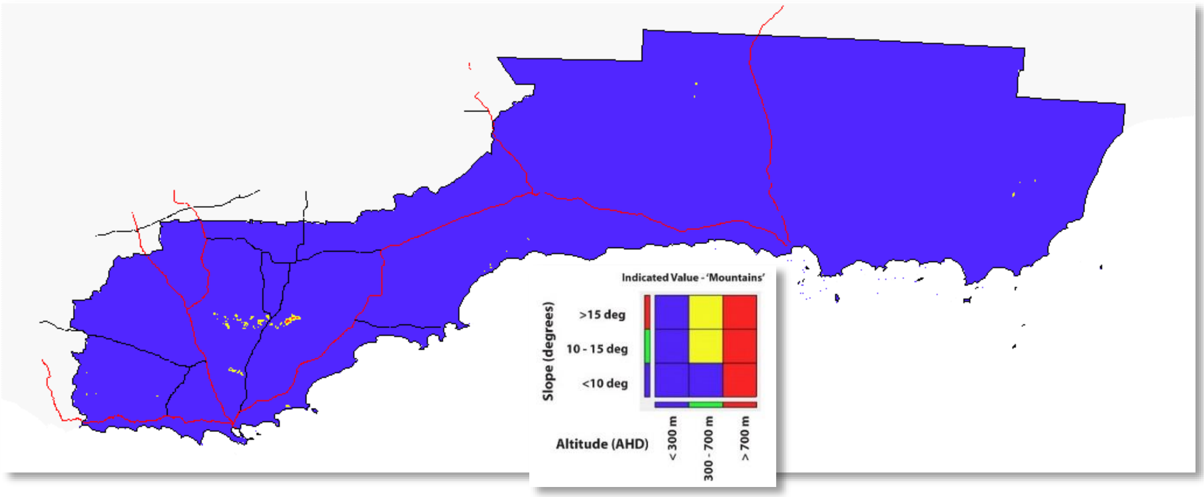


Figure 107: Mountains

High Areas

Layer 'High Areas' is generated from a 1 second SRTM Derived Smoothed Digital Elevation Model (DEM-S) version 1.0 from Geoscience Australia, resampled to 200m cells and smoothed with low pass filter.

It is split into 3 classes

1 - from 0m, 2 - from 300m, 3 - from 750m

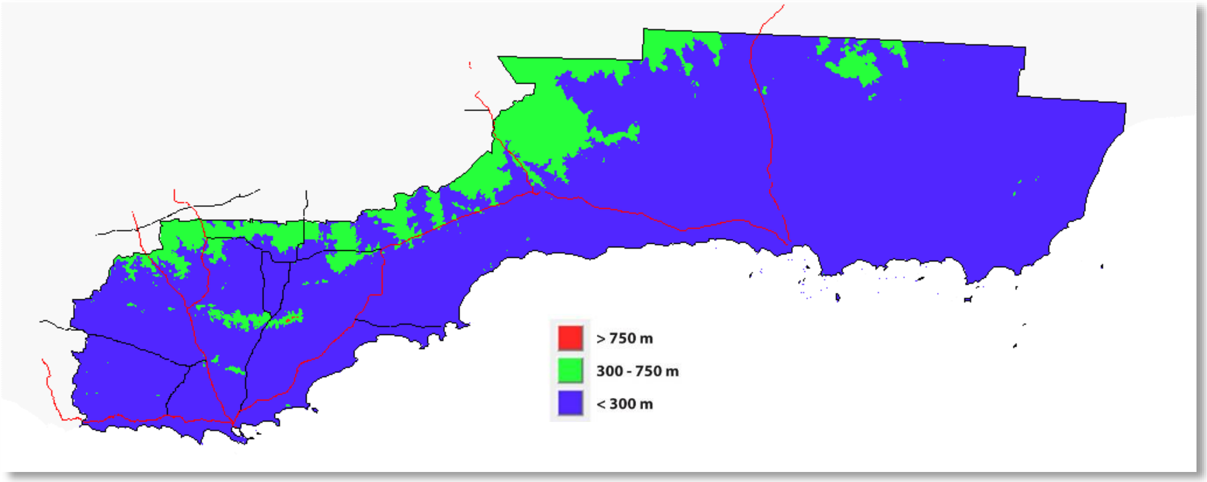


Figure 108: High Areas

Slope (degrees).

Slope (degrees) is split into 3 classes.

1 - from 0 degrees, 2 - from 10 degrees, 3 - from 15 degrees

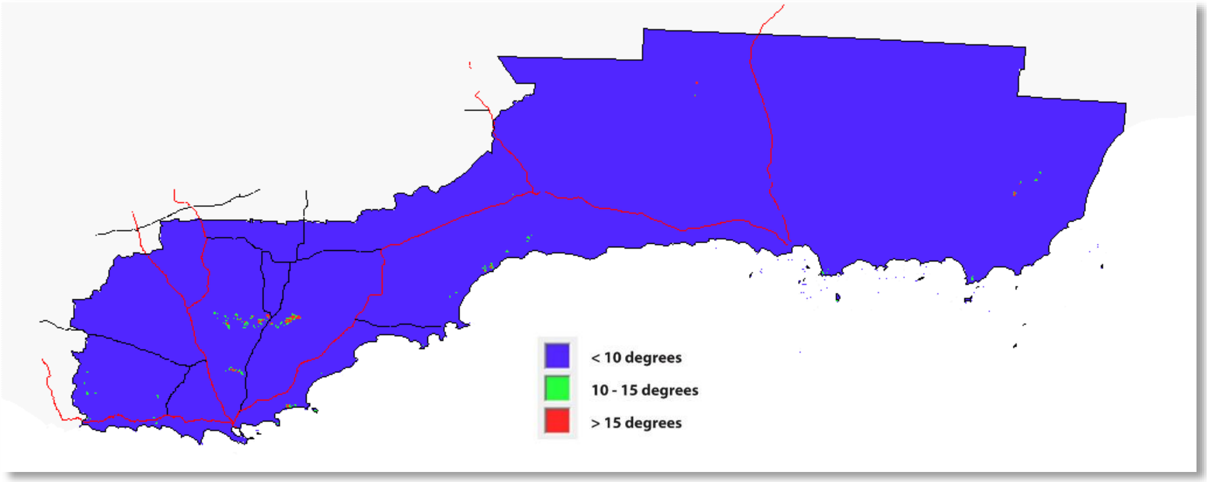


Figure 109: Slope (degrees).

Species Endemism

This layer represents the concentration of taxa with distributions < 10,000 sq. km. It is based on subsampled data, using quarter degree cells. Up to 500 records within each cell were randomly sampled 5 times and endemism calculated. The final value is an average, and is then indexed. It represents one aspect of the uniqueness of an area. Classification is with an equal interval scale.

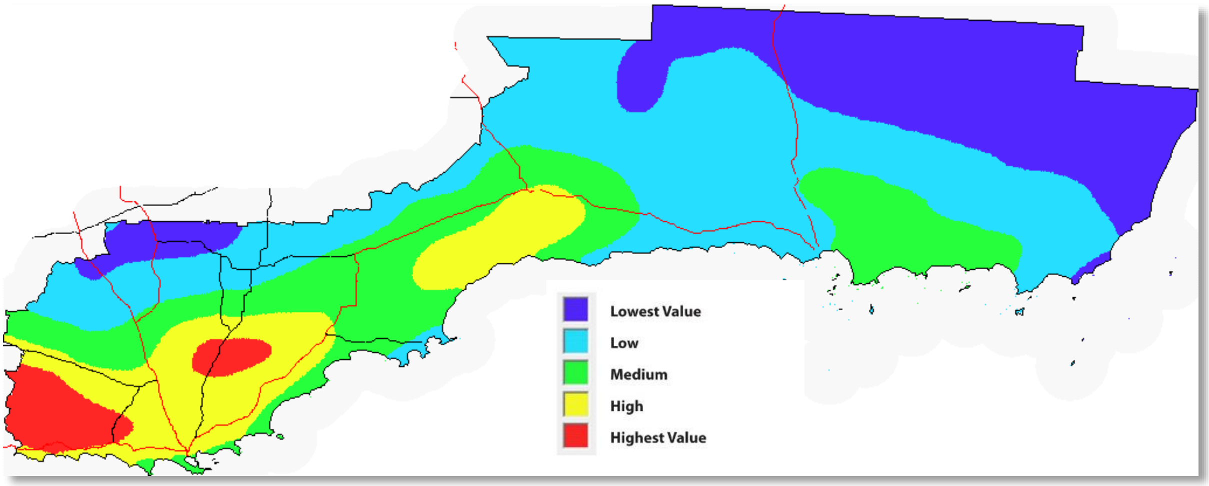


Figure 110: Species Endemism (smoothed)

Threatened & Priority ecological communities

Threatened and Priority Ecological Community (TecPecs) are ecological communities throughout WA that have been classified as "Critically Endangered", "Endangered", "Vulnerable", or as "Priority".

Note that this dataset covers a very restricted set of communities which can benefit from buffering and additional protection. The classification values the Critically Endangered & Endangered communities highest, with Vulnerable and Priority 1, 2 & 3 just below. Note that this does NOT include the new TEC "Kwongan Heath", which is considered to be too poorly mapped and not suitable for use in this context.

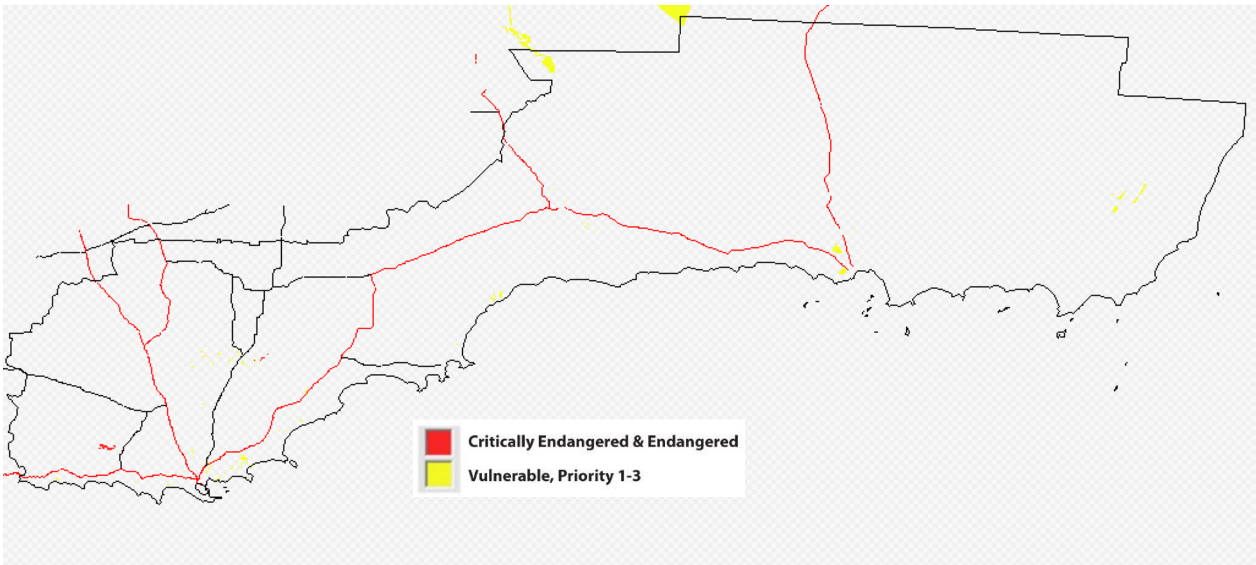


Figure 111: Threatened ecological communities (TECs)

Relict invertebrate refugia

This dataset is the result of a model run to identify likely relict invertebrate refugia. It represents another aspect of uniqueness, as the identified sites are both rare and are known habitat for relict species. Value classes are direct from the source model.

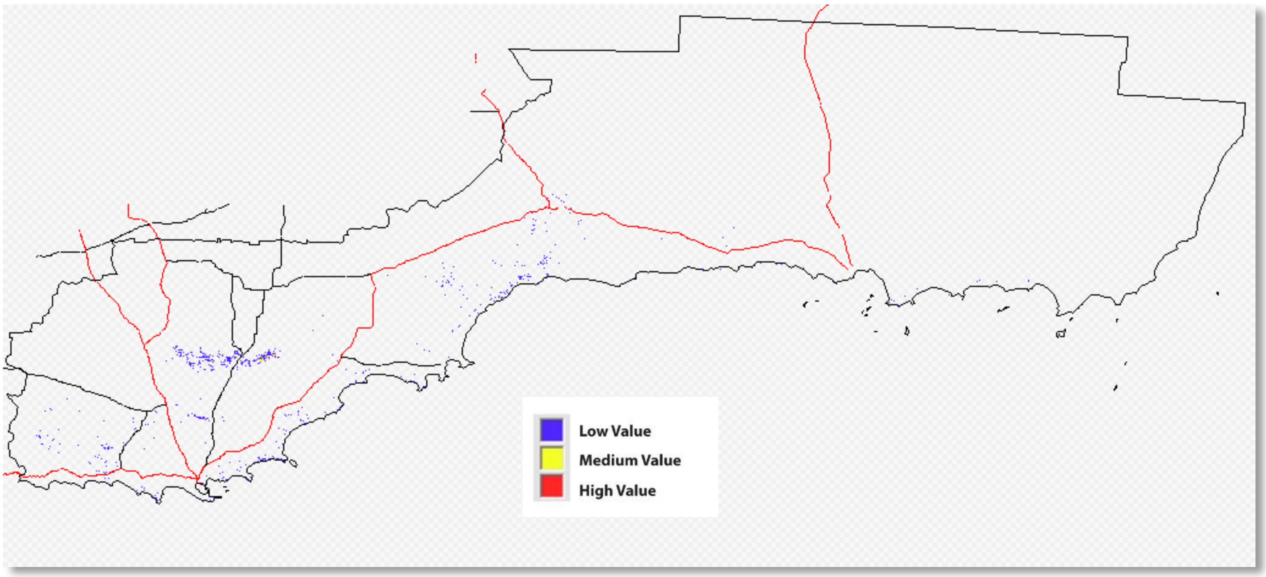


Figure 112: Relict Invertebrate Refugia

South Coast Significant Wetlands

South Coast Significant Wetlands comprise all major wetlands, including RAMSAR, ANCA, National Estate registered and unclassified.

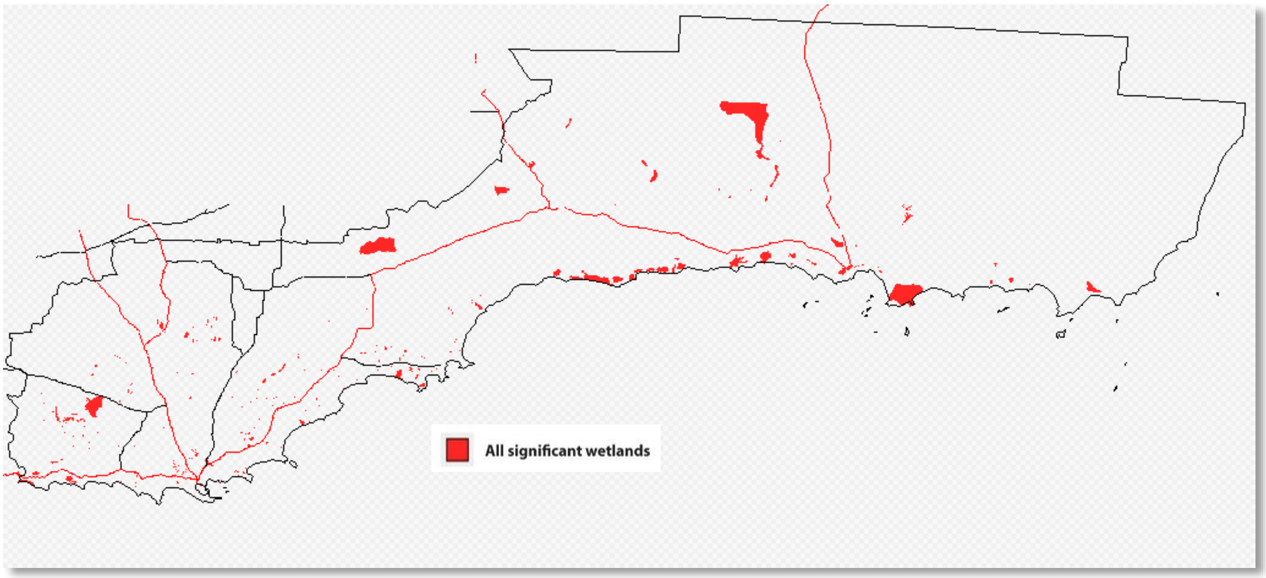


Figure 113: South Coast Significant Wetlands

Distance to Rare/Threatened Flora/Fauna

Layer 'Distance to Rare/Threatened Flora/Fauna' is a composite layer producing 5 classes generated from the sum of:

1 x 'prtyfauna_dst'
1 x 'prtyflora_dst'
1.5 x 'thrtfauna_dst'
1.5 x 'thrtflora_dst'

Threatened species distributions are weighted at 1.5x the priority species. The result is classed according to custom boundaries that maintain the distance values from the inputs. Note that it is understood by the workshop groups that there are significant issues with these data due to sampling effort inconsistency.

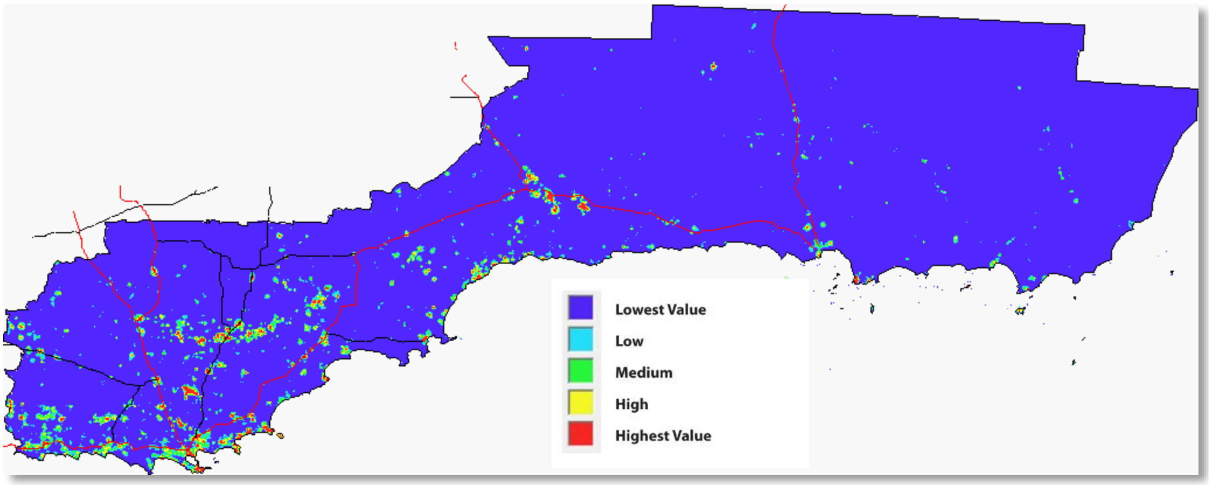


Figure 114: Distance to Rare/Threatened Flora/Fauna

Distance from Priority Flora

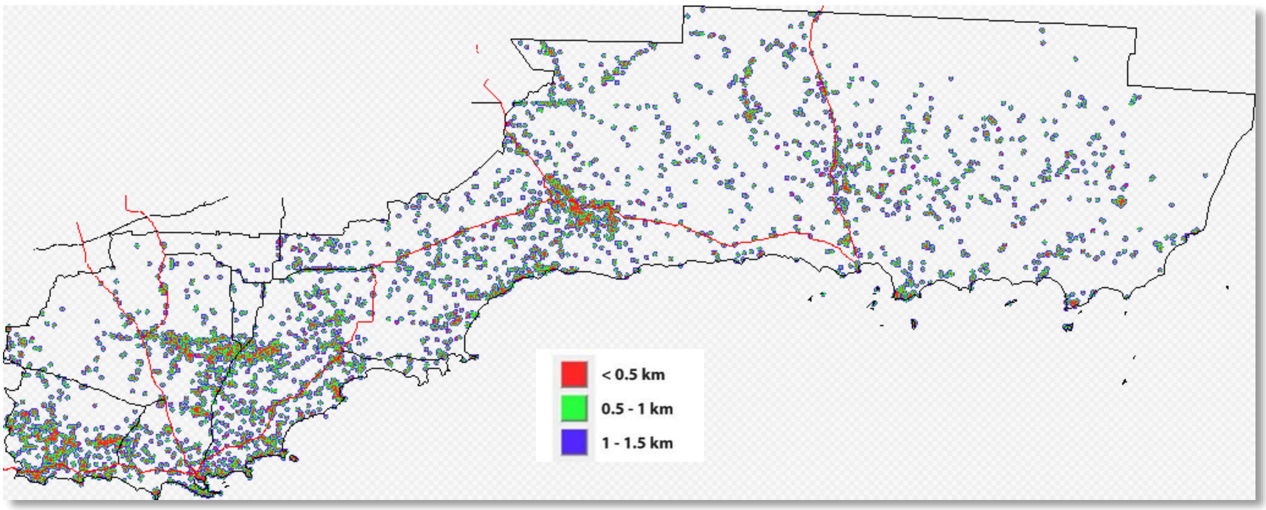


Figure 115: Distance from Priority Flora

Distance from Threatened Flora

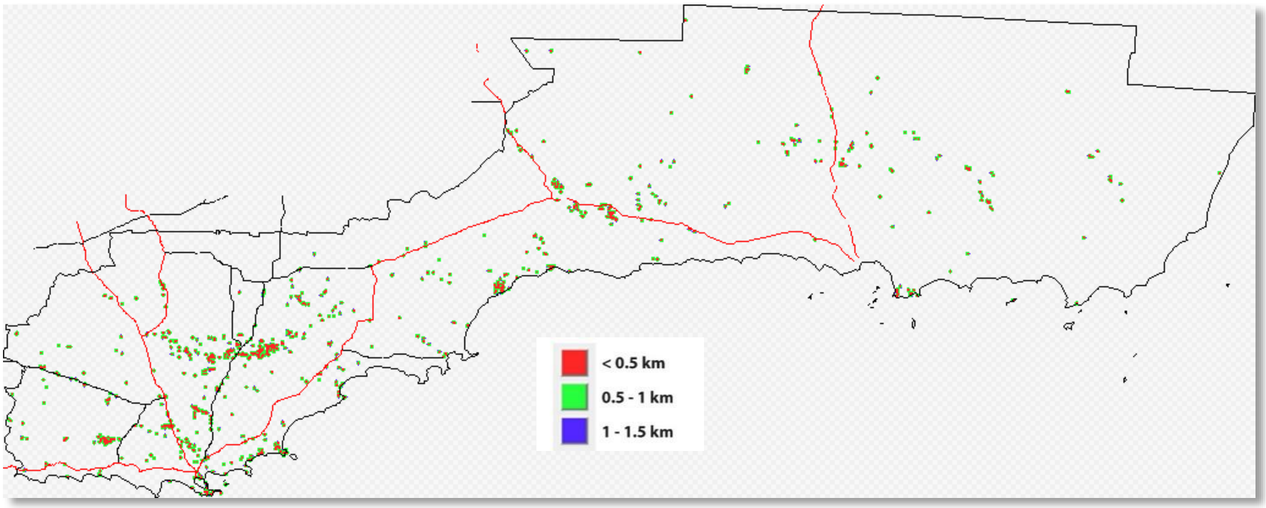


Figure 116: Distance from Threatened Flora

Distance from Priority Fauna

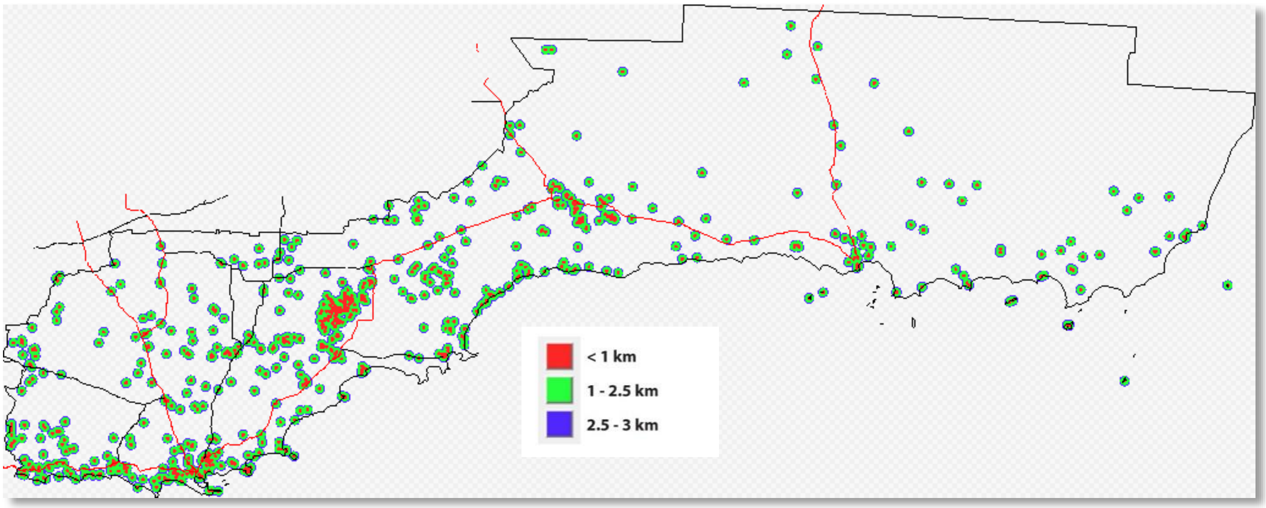


Figure 117: Distance from Priority Fauna

Distance from Threatened Fauna

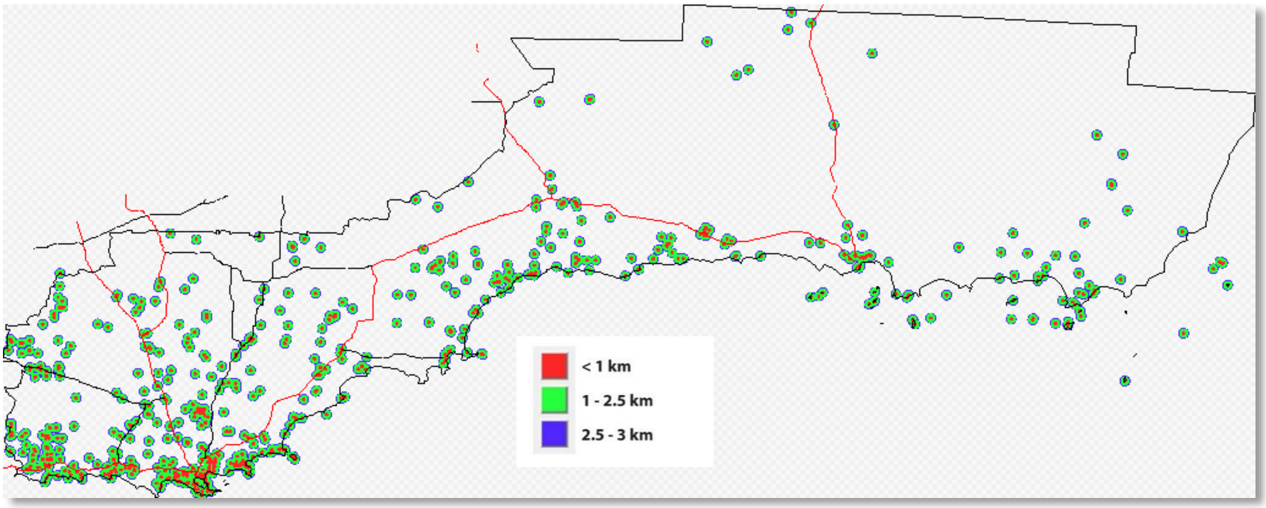


Figure 118: Distance from Threatened Fauna

4.2.1.2 Naturalness

Naturalness is based on five sub-criteria with the following weights:

1 x CENRM River Naturalness
3 x Composite Shape Ratio
1 x Distance to Dieback Occurrence
1 x Number of fires since 1973
1 x Distance from Area > 1,000ha

The result is classed according to a custom system that provided ensure that areas of reasonable naturalness were given a top score.

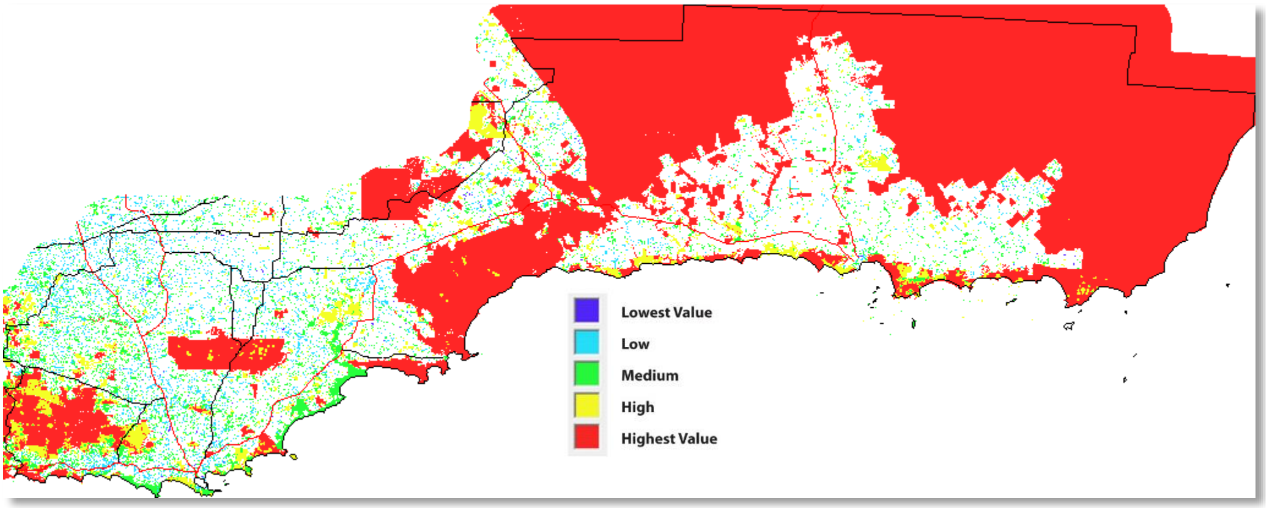


Figure 119: Naturalness

CENRM River Naturalness

CENRM Catchment assessment provided a naturalness assessment from surveys of aquatic fauna and habitats - this value is given to a 200m grid of the major rivers and streams in each subcatchment.

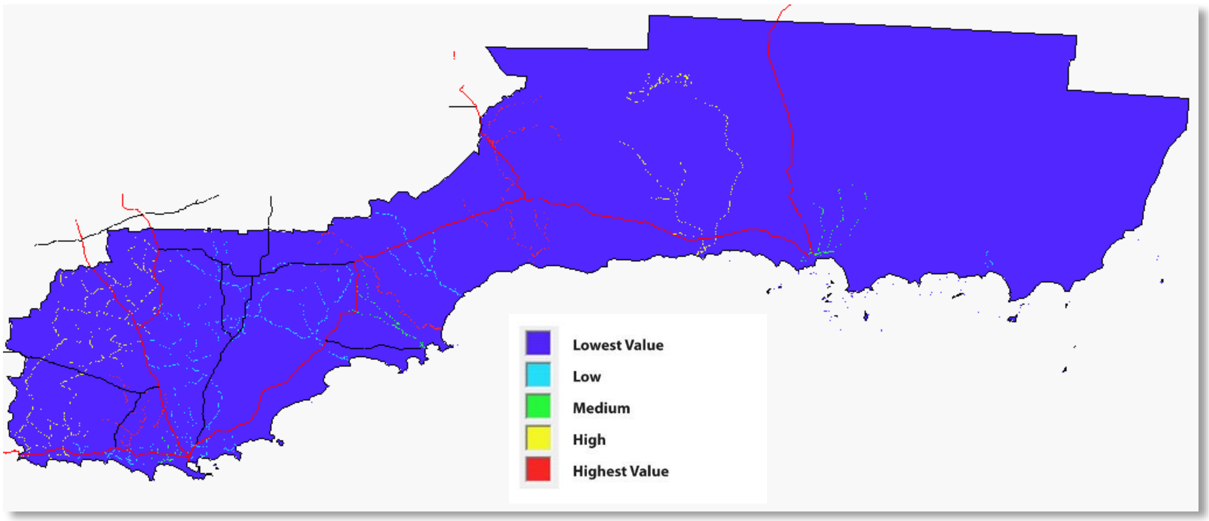


Figure 120: CENRM River Naturalness

Composite Shape Ratio

Based on the Native Vegetation Contiguous Area 2014 data from DAFWA, this in index combines shape and size. (Area to Boundary (squared) Ratio x (Area to Boundary Ratio). It ranks areas of contiguous vegetation high if they small with a good shape (close to round or square), moderate sized with reasonable shape, or they are very large irrespective of shape. It is an important indicator both of existing naturalness value and potential to maintain values over time.

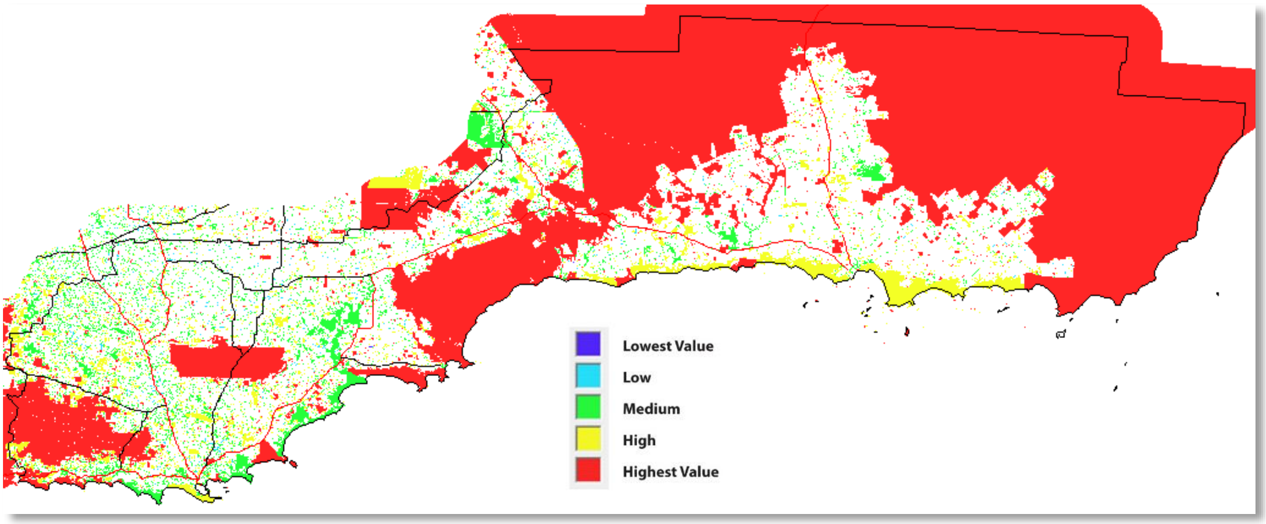


Figure 121: Composite Shape Ratio

Distance from Area > 1,000ha

This criterion indicate proximity to significant biodiversity reservoirs. The value of 1000ha was chosen as being significant in the local context. Contiguous area is from the DAFWA remnant vegetation data for 2014 – note that roads cut forest polygons into smaller contiguous blocks. Value decreases rapidly with distance up until 3km.

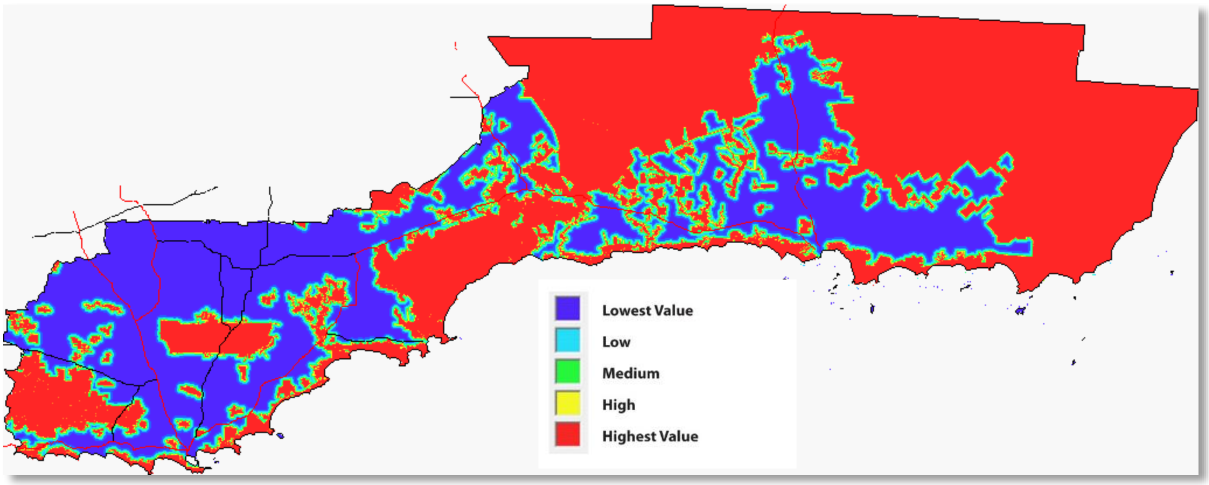


Figure 122: Distance from Areas > 1000ha

Distance to Dieback Occurrence

Point data for P. cinnamomi extracted from the Vegetation Health database is considered more accurate and up to date that area risk indicators. Any areas more than 1000m from a recorded infestation are considered of equal (high) value.

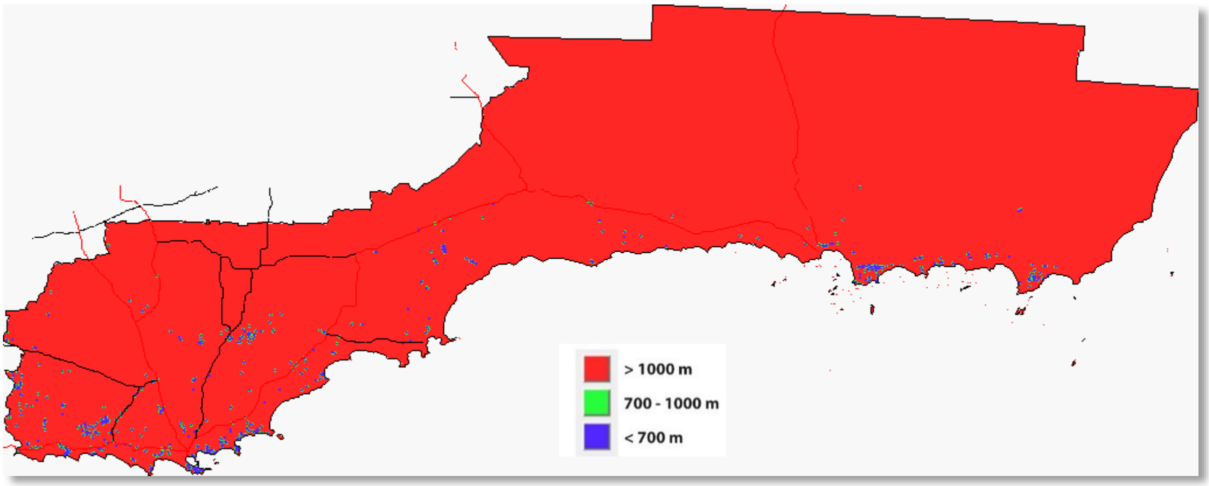


Figure 123: Distance to Dieback Occurrence

Number of fires since 1973

Fire history is considered a reasonable indicator of naturalness although there are a range of ways in which it will impact on communities. Fires since 1973 (last 40 years) was a compromise indicator. It is based on data collated from DPAW records. All fire boundaries were collated and unique fire histories developed for unique polygons (DPAW).

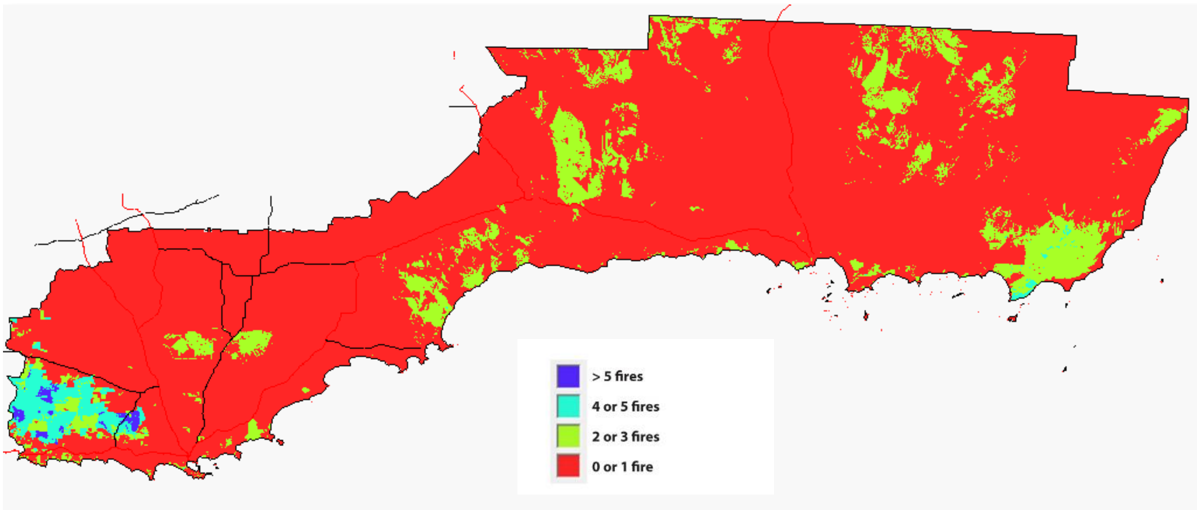


Figure 124: Number of fires since 1973

4.2.1.3 Diversity

Layer 'Diversity' is a composite layer producing 5 classes, generated from the sum of:

2 x 'Beard System Assoc Var5k2'
1 x 'cenrm_riv_div'
3 x 'Fauna_Richness_5k_Raw'
3 x 'Flora_Richness_5k_Raw'
0.5 x 'Perennial ELPW'
1 x 'Wetlands - Suite Variety 5km'

The datasets used combine a range of diversity measures (diversity of vegetation communities, wetlands & river diversity) with flora & fauna richness datasets. The result is classed according with natural breaks classification, which produced a suitable range of values.

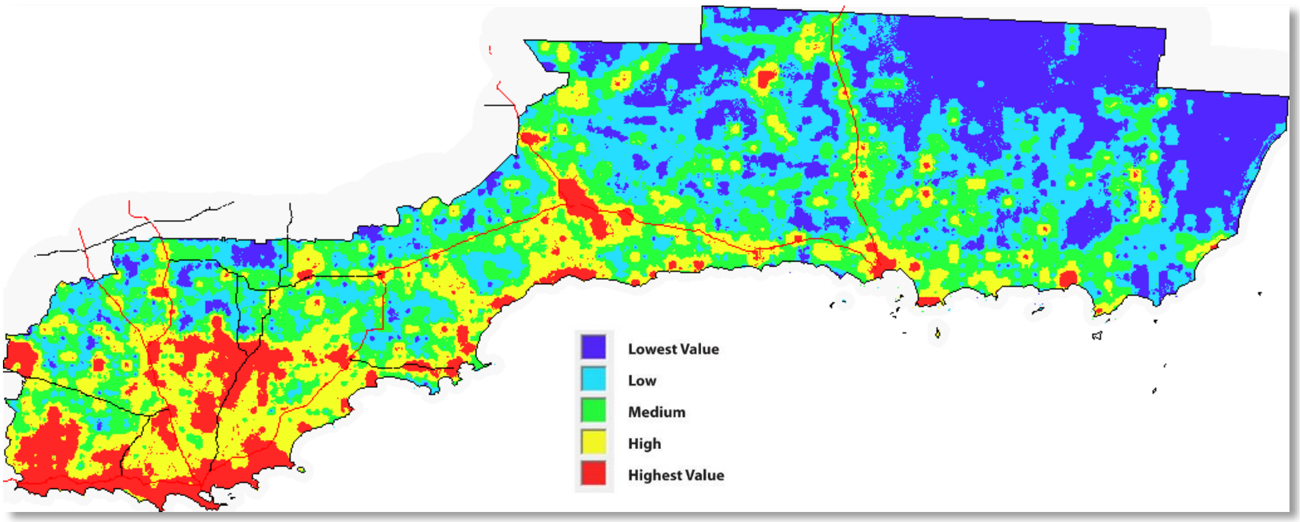


Figure 125: Diversity Criterion

Variety of Vegetation Associations (Beard)

Community diversity is a standard indicator of conservation value on the grounds that more diverse areas contain greater opportunities for species richness and complexity. The index used here is the variety of Vegetation Associations within 5km (2014), derived from Beard Datasets (DAFWA/DEC)

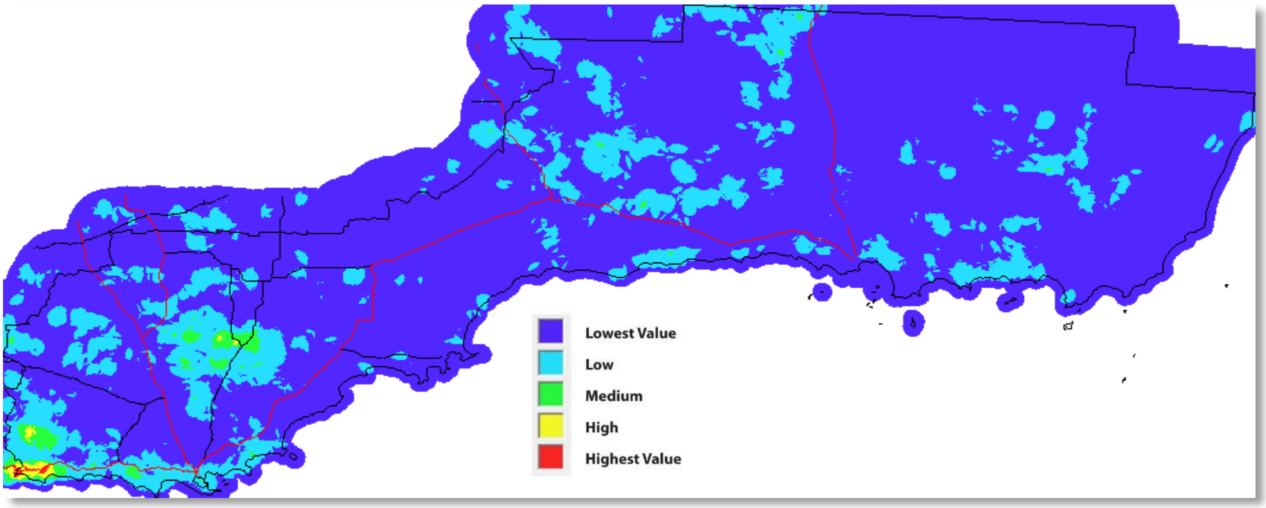


Figure 126: Community Diversity – number of vegetation associations within 5km

CENRM River Diversity

CENRM Catchment assessment provided a diversity assessment from surveys of aquatic fauna and habitats - this value is given to a 200m grid of the major rivers and streams in each subcatchment.

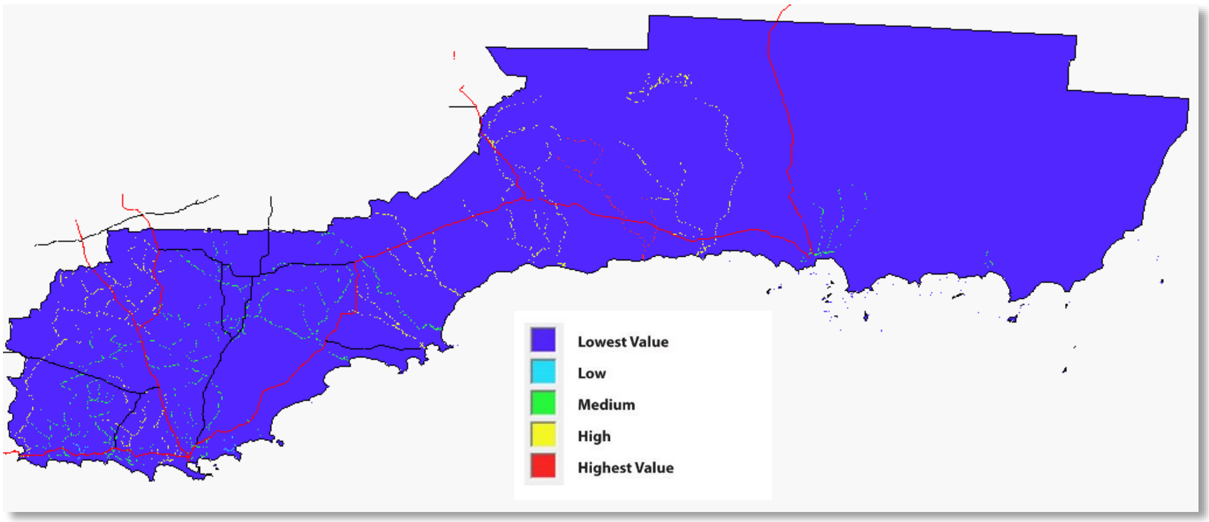


Figure 127: CENRM River Diversity

Wetlands - Suite Variety 5km

Using the South Coast Significant Wetlands dataset (which includes RAMSAR, ANCA, National Estate registered and unclassified wetlands), the suite ID was gridded and we counted the variety of different suite IDs within a 5km radius. This is a measure of surface water feature diversity, using a equal interval class system.

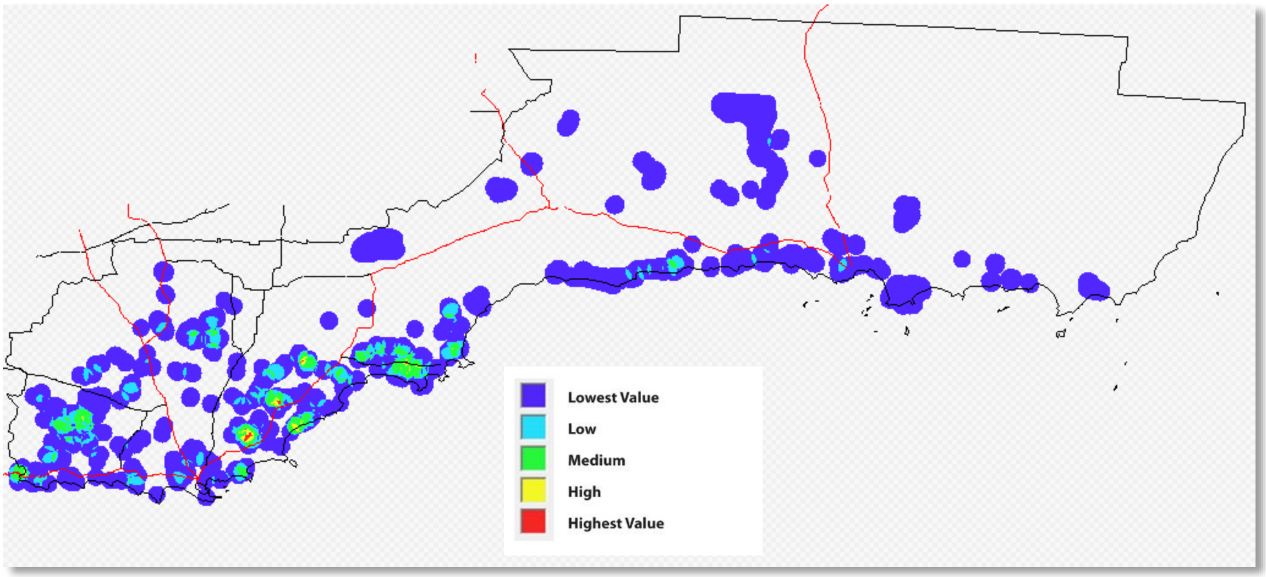
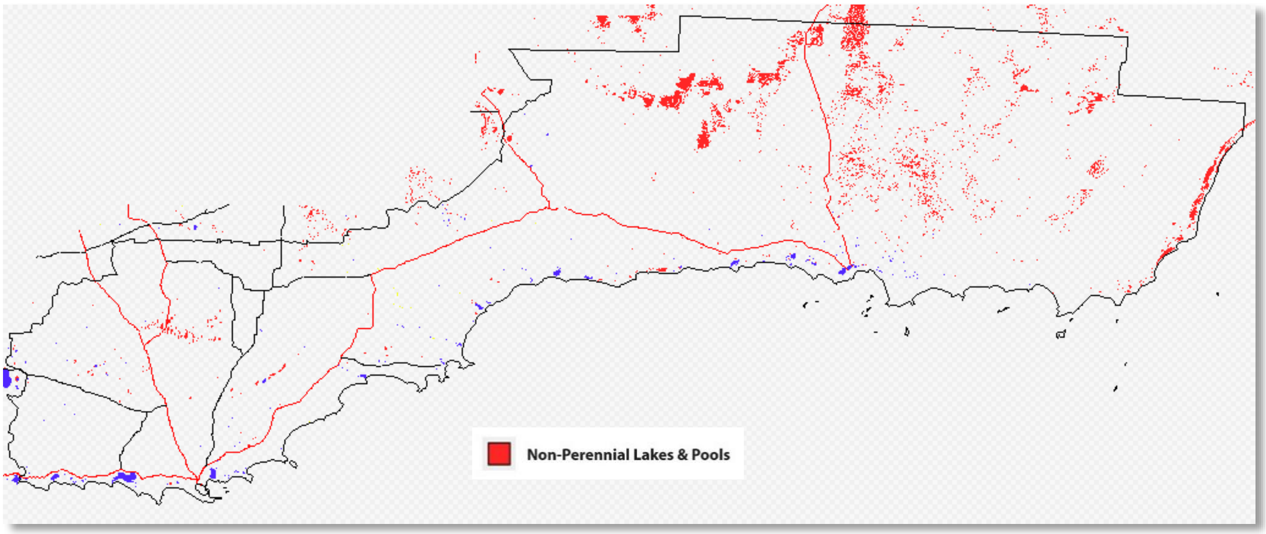


Figure 128: Wetlands - Suite Variety 5km

Perennial ELPW (Estuaries, Lakes Pools & watercourses)

Estuaries, Lakes Pools & watercourses were obtained from the topographic Database, and overlayed with Perenniality from the same dataset. Values highlight non-perennial (ephemeral) lakes & pools.



Fauna Richness (5km, raw)

This is a critical dataset in terms of diversity, but is still not available in its final form. The data used here is a raw count and has not been re-sampled or sub-sampled to account for sampling bias. It also is on a fine grid and shows other errors. Future work should wait for similar products to be produced by DPaW (see Paul Gioia).

All fauna records from DEC's Naturebase species records database were provided by Paul Giopia (DPaW).

A 5km grid was created with a unique ID for each cell, and intersected with the Naturebase dataset. The variety of species numbers (unique ID) in each cell was calculated using pivot table in Excel, and transferred back to ArcGIS.

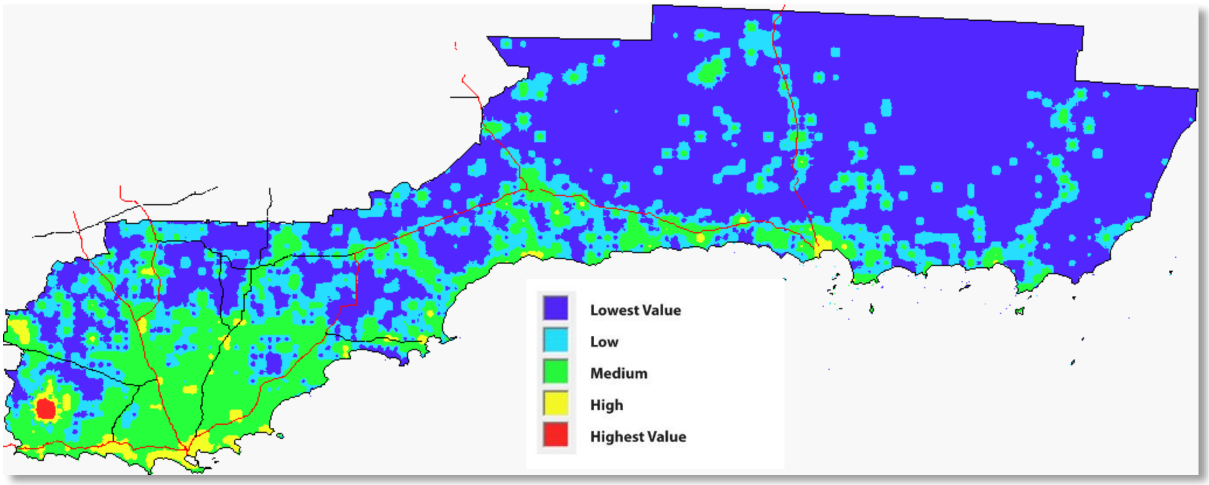


Figure 129: Fauna Richness

Flora Richness (5km, raw)

Comments and derivation as for Fauna Richness.

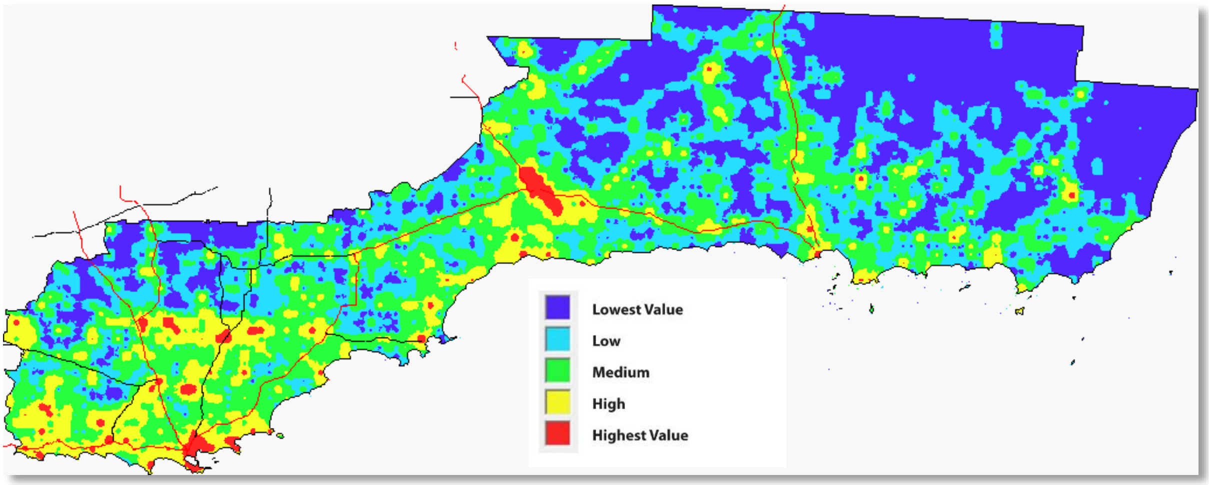


Figure 130: Flora Richness

4.2.1.4 Component B1A Output – Areas with High Biodiversity Value

Layer 'Areas of High Value Biodiversity' is a composite layer producing 5 classes

The composite function is generated from the sum of:

4 x 'Diversity'
3 x 'Naturalness'
3 x 'Rarity/ Uniqueness'

The result is classed according to workshop preference in a 5 class custom scale. The scale was designed to identify a total of approximately 15% of remaining vegetation as "High Value", which would be used below. (Due to classification limitations the actual figure is 16.08%).

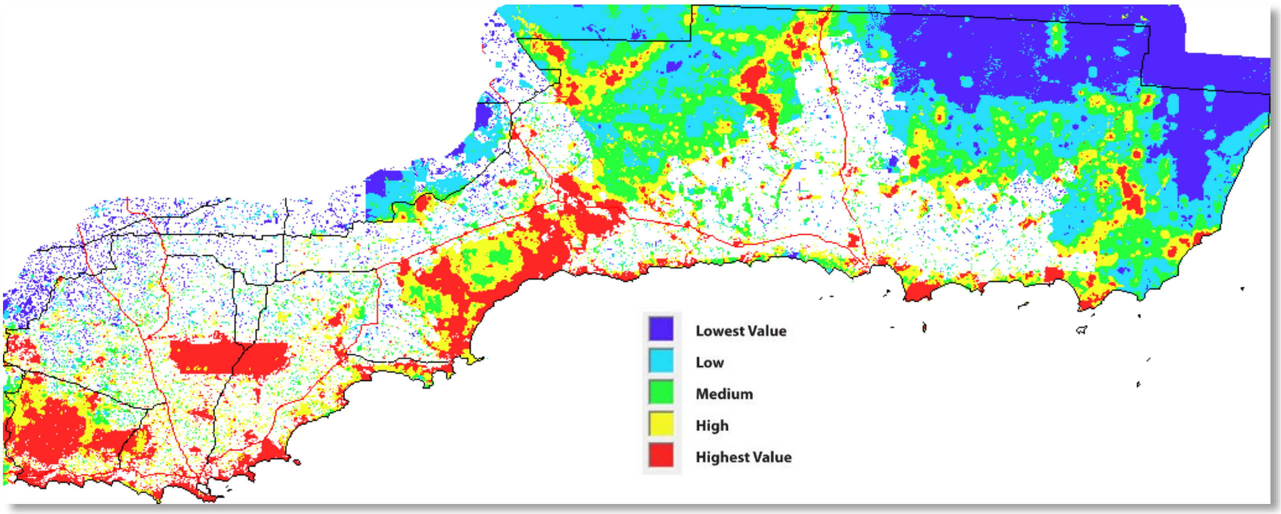


Figure 131: Component B1A Output –Areas with High Value Biodiversity

The areas of highest value biodiversity are shown in red in the following figure.

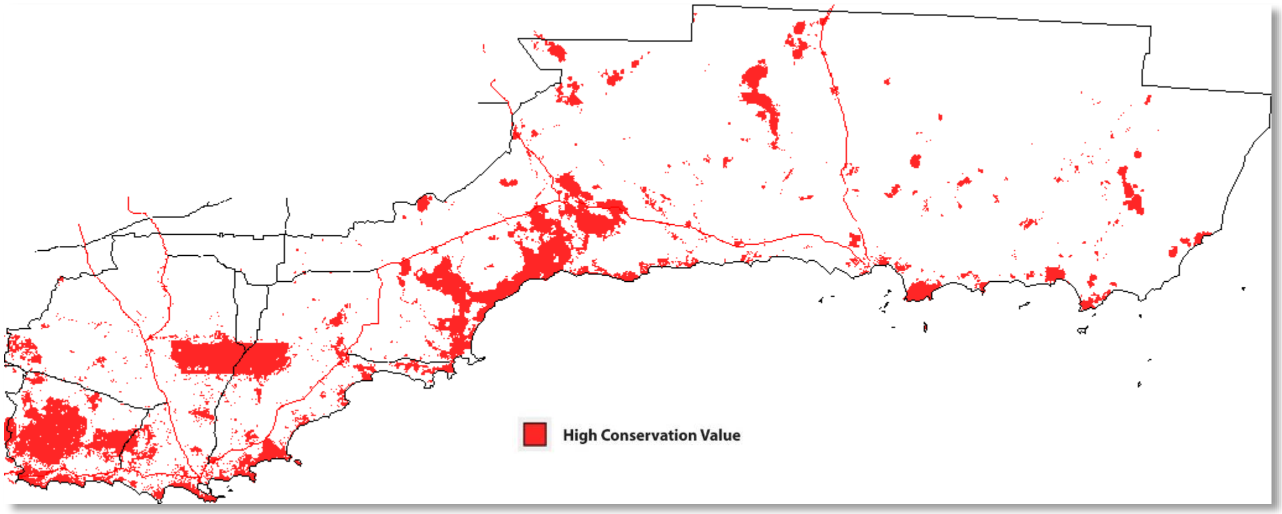


Figure 132: Areas defined as High Conservation Value using the ~15% threshold.

4.2.2 Component B1B – Areas with High Conservation Value

Component B1B is another complex model, and includes a number of intermediate sub-components which feed into the three major criteria – Representativeness, Management Potential, and Climate Resilience. The complex set of criteria is shown below in the component diagram.

Layer 'Areas of High Value Biodiversity' is a composite layer producing 5 classes, and is generated from the sum of:

3 x B1A Areas of High Value Biodiversity
2 x B3 Where are the Landscape Corridors
4 x Representativeness
1 x Climate Resilience
2 x Management Potential

The result is classed with a custom set of boundaries. Its main purpose is as a standalone indicator of conservation value.

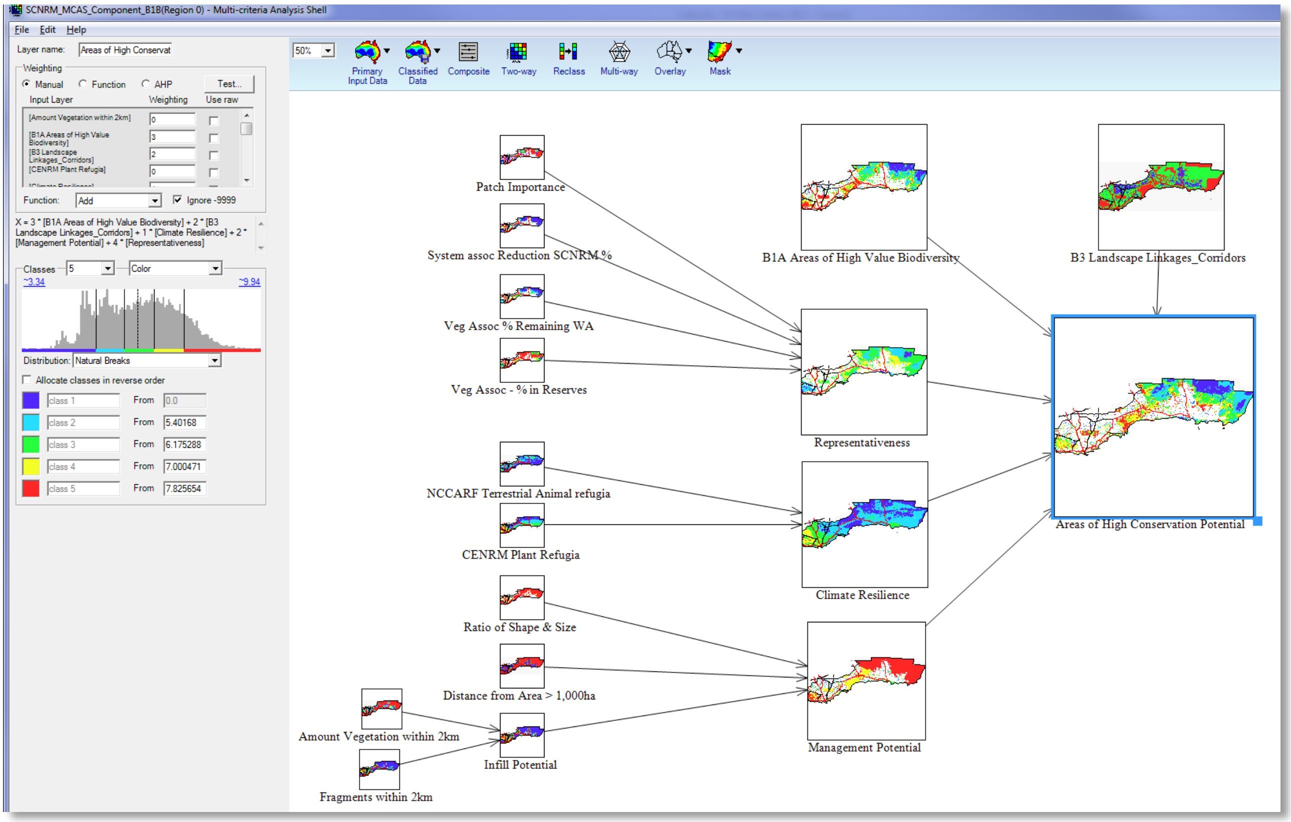


Figure 133: MCAS-S Diagram for Component B1B

4.2.2.1 B1A Areas of High Value Biodiversity

Taken directly from Component B1A.

4.2.2.2 B3 Landscape Corridors v2

Taken directly from Component B3.

4.2.2.3 Representativeness

Representativeness is the extent to which a patch of vegetation embodies conservation values; either through being a representative of a highly reduced vegetation type, or a type that is poorly reserved. An individual patch can also provide for conservation outcomes through its ability to represent a significant proportion of that vegetation type remaining.

Layer 'Representativeness' is a composite layer generated from the sum of:

1 x 'Patch Importance'
1 x 'System assoc Reduction SCNRM %'
1 x 'Veg Assoc % Remaining WA'
1 x 'Veg Assoc - % in Reserves'

The result is classed using an equal interval scale.

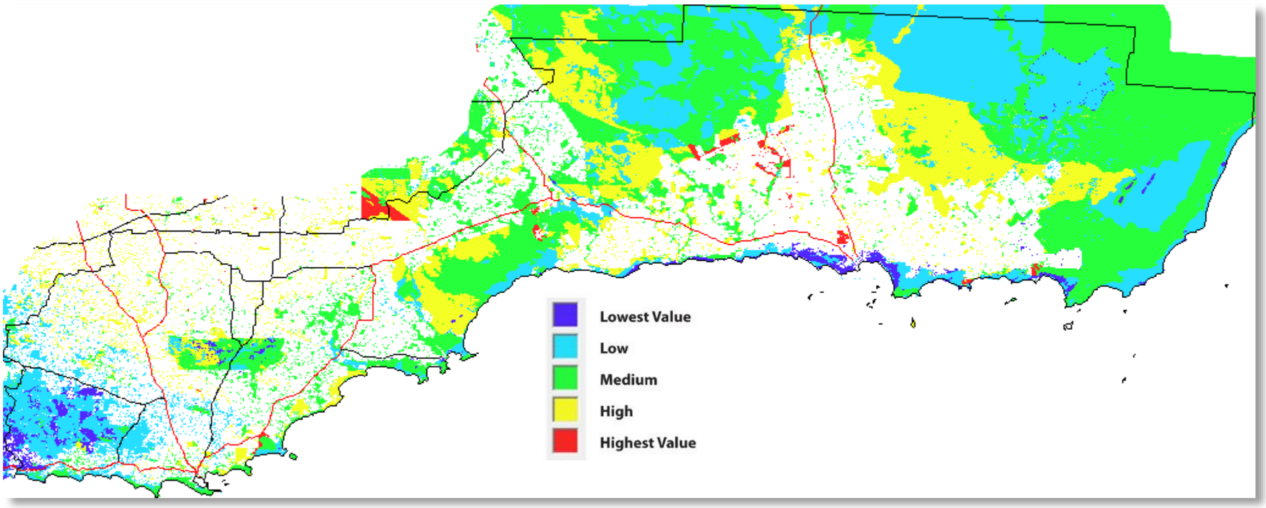


Figure 134: Representativeness

Patch Importance

This value indicates the % of its vegetation association that each individual polygon (patch or vegetation) represents – this is an indicator of the representativeness and relative importance of the patch. Note that some “patches” are very large due to coarse classification, especially in the east of the region.

Derived from Beard Datasets (DEC) & current vegetation remaining dataset (DAFWA) Each individual patch (veg polygon) area was calculated and divided by the remaining area of its association type to create a % value.

The layer is split into 5 classes, where 5 is the highest value; any patch representing over 50% of the remaining area is in the highest class.

1: 0 – 10%
2: 10 – 20%
3: 20 – 35%
4: 35 – 50%
5: >50% (highest value)

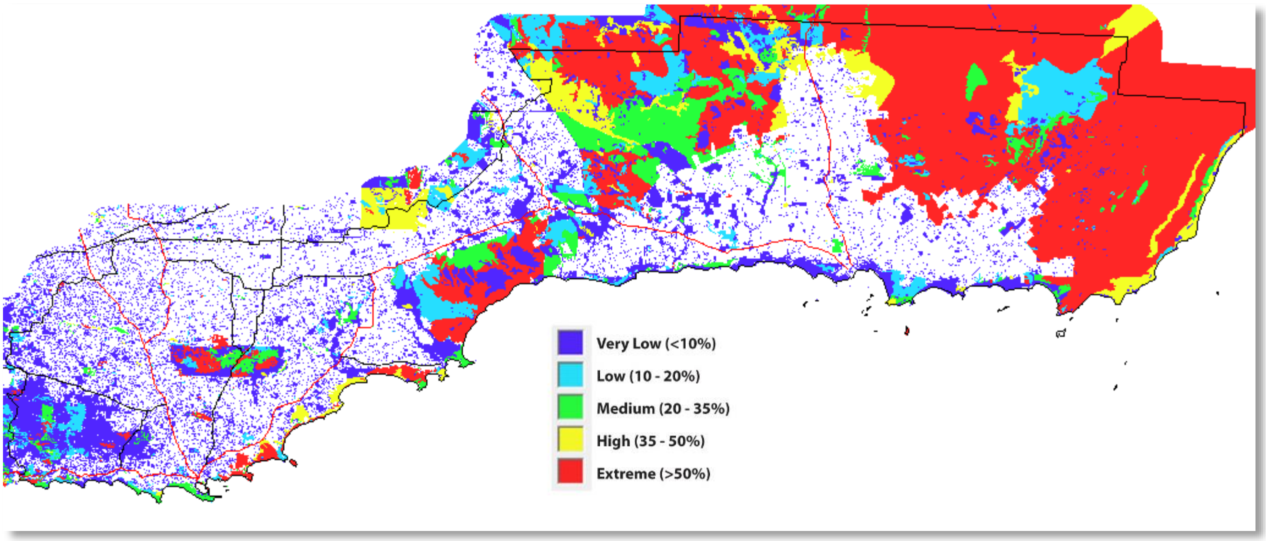


Figure 135: The representativeness and relative importance of each individual patch of vegetation

System Association reduction % (SCNRM)

This criterion uses the amount of reduction in each system association since clearing as an indicator of rarity of the remaining areas. The data is derived from "System Association" – the finest classification type in Beard datasets (DEC) and the current vegetation remaining dataset (DAFWA). The reduction in area for each vegetation type was calculated as a % of the original veg type for the SCNRM region. The workshop was clear that they wanted to provide this measure at both the local and State scale

Split into 5 classes:

1: 0 – 20%
2: 20 – 40%
3: 40 – 60%
4: 60 – 80%
5 : 80 – 100% (highest value)

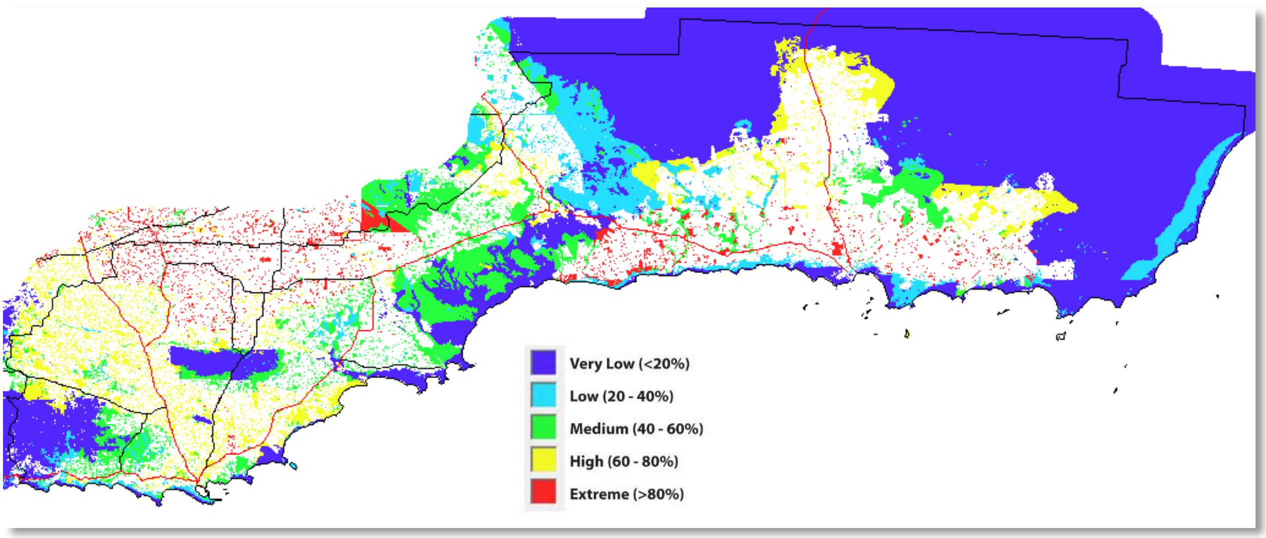


Figure 136: System association reduction (SCNRM)

Vegetation Association remaining % (WA)

This criterion uses the amount of reduction in each vegetation association since clearing as an indicator of rarity of the remaining areas. The data is derived from "Vegetation Association" from the Beard datasets (DEC) and the current vegetation remaining dataset (DAFWA). The area remaining for each association has calculated by DPaW for the entire state of WA.

Split into 5 classes:

1: 0 – 17% (highest value)
2: 17 – 40%
3: 40 – 60%
4: 60 – 80%
5: 80 – 100%

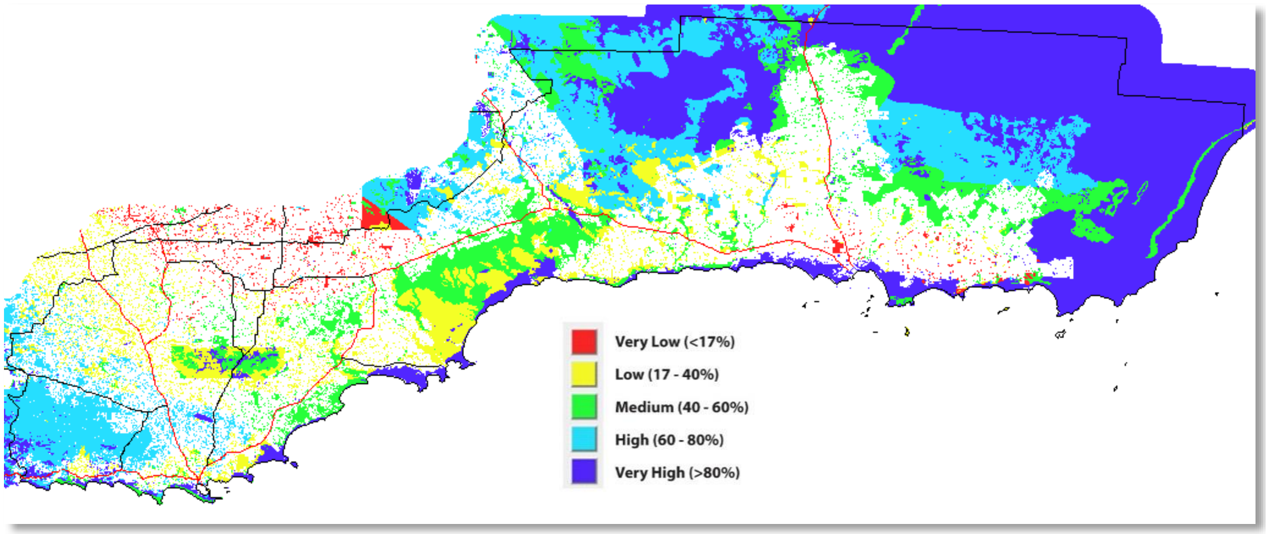


Figure 137: Vegetation Association Remaining % (WA)

Poorly Represented communities - % remaining in reserves

A basic criterion for conservation biology is the extent to which a vegetation community is protected in reserves. This dataset shows the percentage of each Vegetation Association (based on Beard's vegetation associations) which is currently protected within DEC Reserves (2012). The poorer the representation the higher priority for conservation.

The classification uses five equal interval classes, where the lower values indicate the least amount in reserves:

5 - from 0 – 20% (highest value)
4 - from 20 – 40%
3 - from 40 – 60%
2 - from 60 – 80%
1 - from 80 – 100%

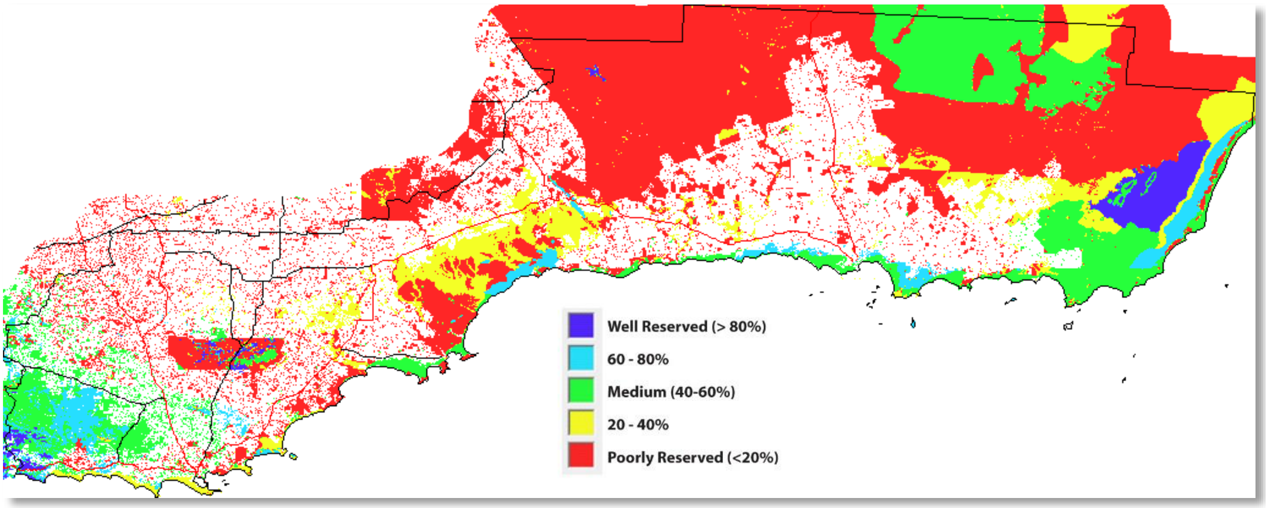


Figure 138: Poorly Represented communities - % remaining in reserves

4.2.2.4 Climate Resilience

As used in Component A3.

4.2.2.5 Management Potential

Management potential is intended to identify areas that suit long-term reservation or conservation action – combing contiguous area (actual or proximal) with locality in infill potential. In either case this is intended to provide for value in conservation work.

Layer 'Management Potential' is a composite layer generated from the sum of:

2 x 'Ratio of Shape & Size'
1 x 'Distance from Area > 1,000ha'
1 x 'Infill Potential'

The result is classified in a custom set of classes which ensure that the coastal areas maintain a medium value.

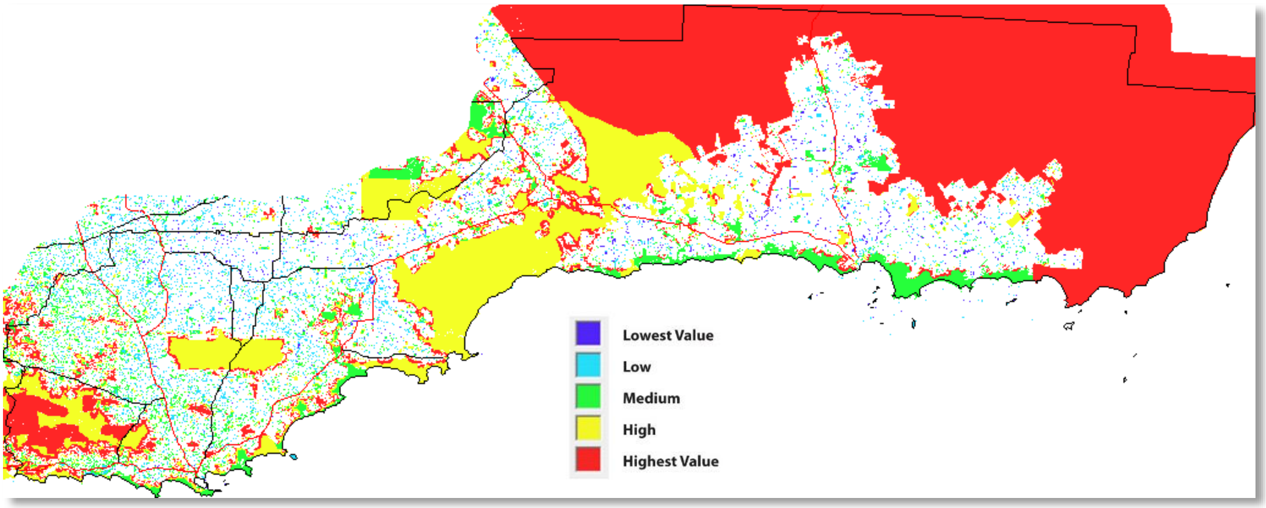


Figure 139: Management Potential

Ratio of Shape & Size

Based on the Native Vegetation Contiguous Area 2014 data from DAFWA, this in index combines shape and size. (Area to Boundary (squared) Ratio x (Area to Boundary Ratio). It ranks areas of contiguous vegetation high if they small with a good shape (close to round or square), moderate sized with reasonable shape, or they are very large irrespective of shape. It is an important indicator both of existing naturalness value and potential to maintain values over time.

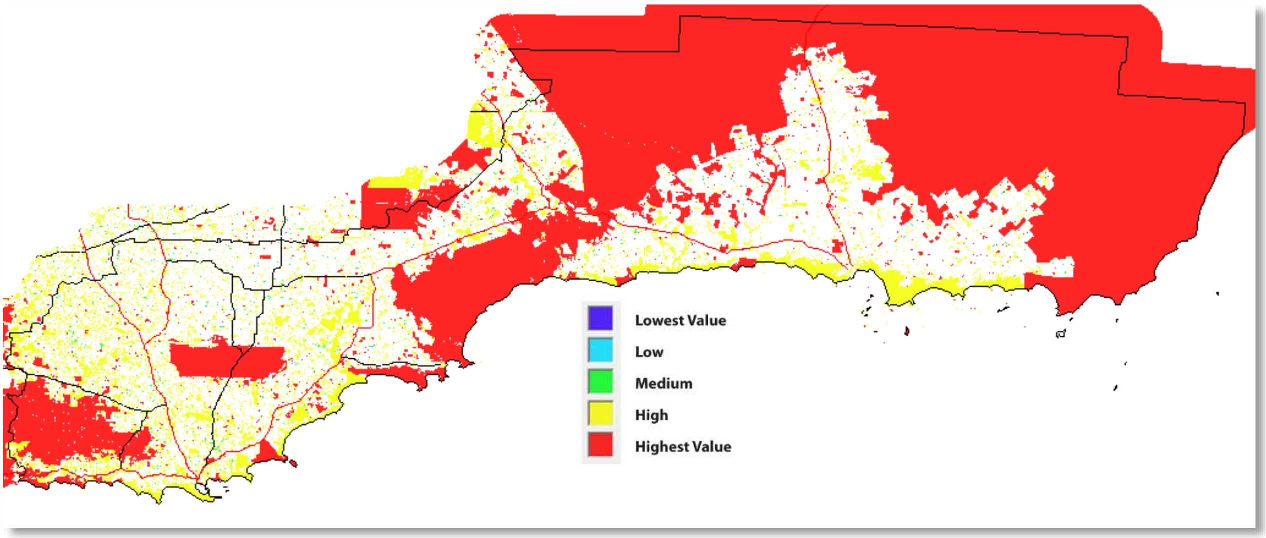


Figure 140: Ratio of Shape & Size

Distance from Area > 1,000ha

This criterion indicate proximity to significant biodiversity reservoirs. The value of 1000ha was chosen as being significant in the local context. Contiguous area is from the DAFWA remnant vegetation data for 2014 – note that roads cut forest polygons into smaller contiguous blocks. Value decreases with distance beyond 2.5km.

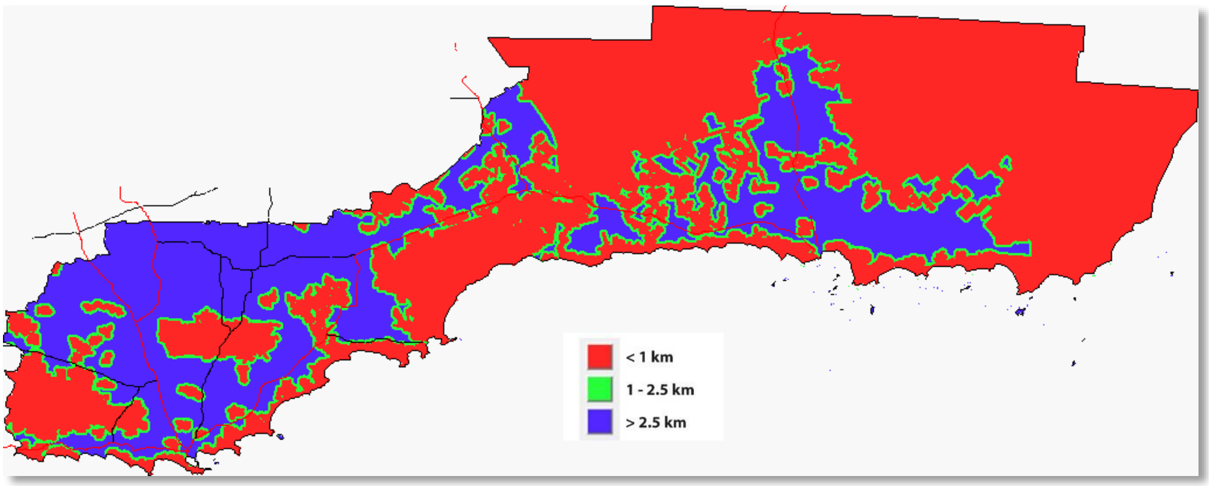


Figure 141: Distance from Areas > 1000ha

Infill Potential

Infill Potential identifies areas that have potential for strategic plantings to increase existing values and improve landscape connectivity. This uses two criterion used in Component A3 (% Clearing & Landscape Fragmentation (number of patches)) – but values them in different ways. It is aimed at identifying areas where low-moderate levels of clearing are associated with large numbers of patches – indicating that planting can be used to connect patches. Class value is given as follows:

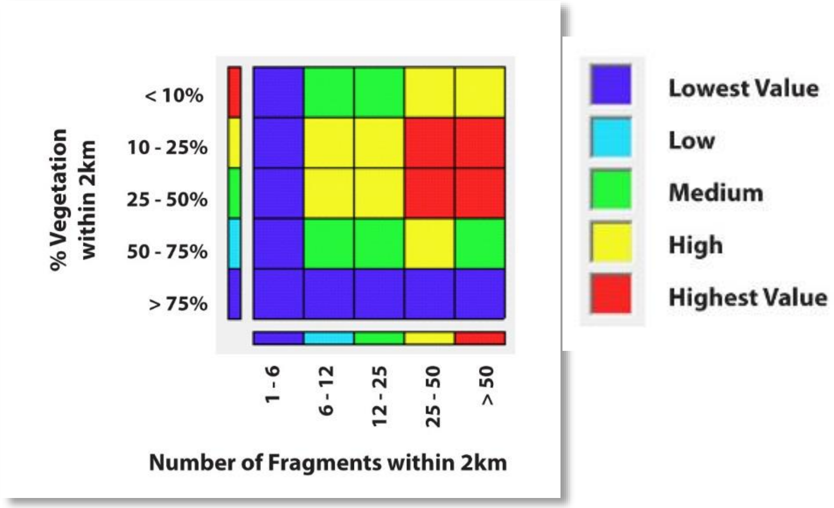


Figure 142: Infill potential matrix for B1B

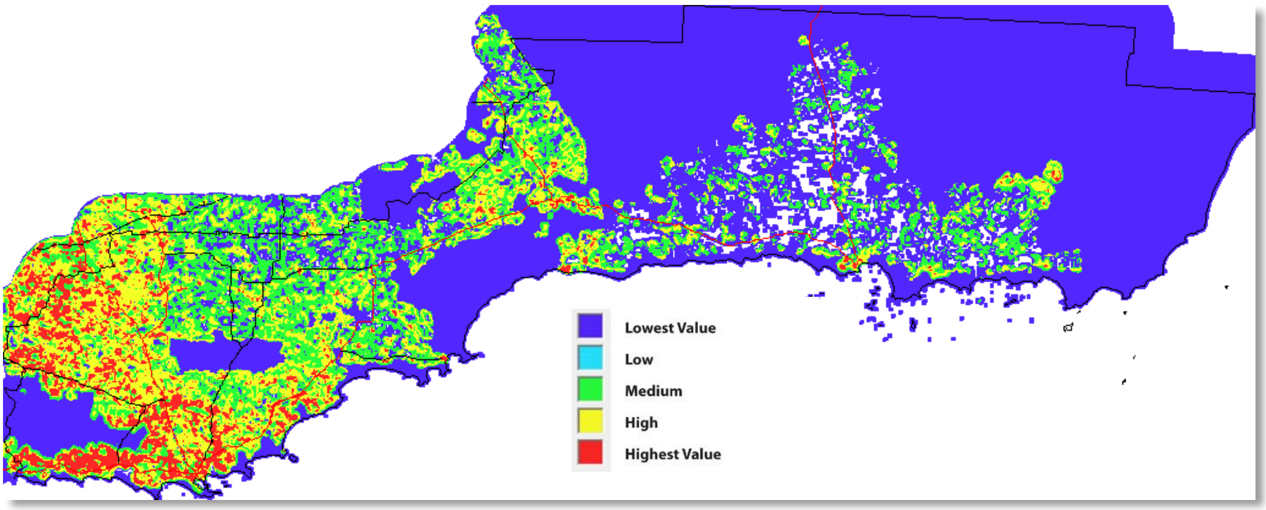


Figure 143: Infill Potential

Amount of Vegetation within 2km

Native Vegetation - % uncleared within 2km (2014) measures the amount of native vegetation within 2km (of each cell) as a percentage. In this case it is split into 5 classes

0 – 10%; 10 – 25%; 25 – 50%; 50 – 75%, 75 – 100%.

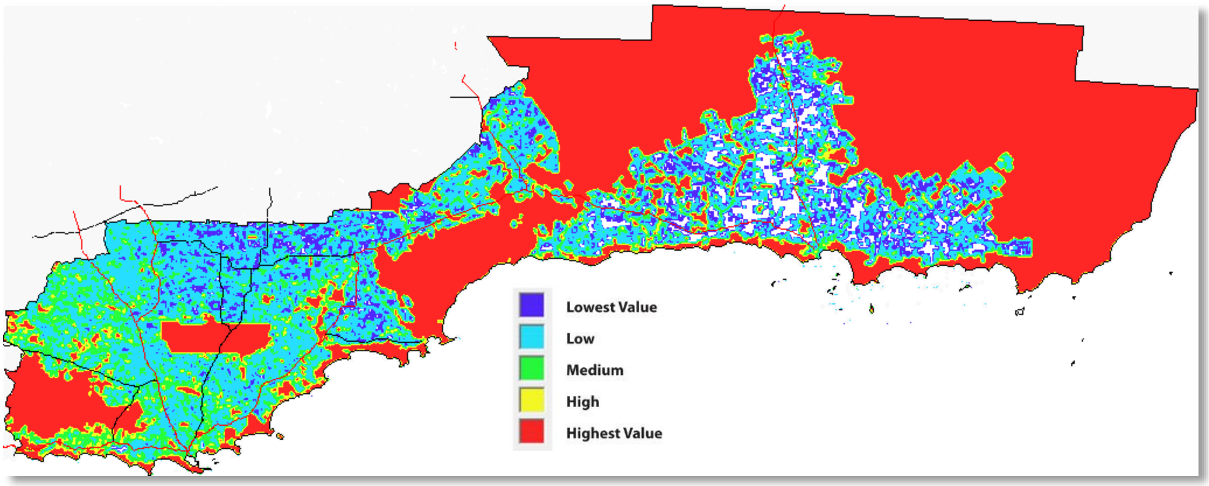


Figure 144: Amount of Vegetation within 2km

Areas with high fragmentation

The second part of potential for infill identifies areas with high levels of fragmentation. The dataset counts the number of patches of vegetation within 5km to indicate the extent to which vegetation has been cut up (fragmented).

This is split into 5 classes:

1 – 5; 6 – 11; 12 – 24; 25 – 49 and >50.

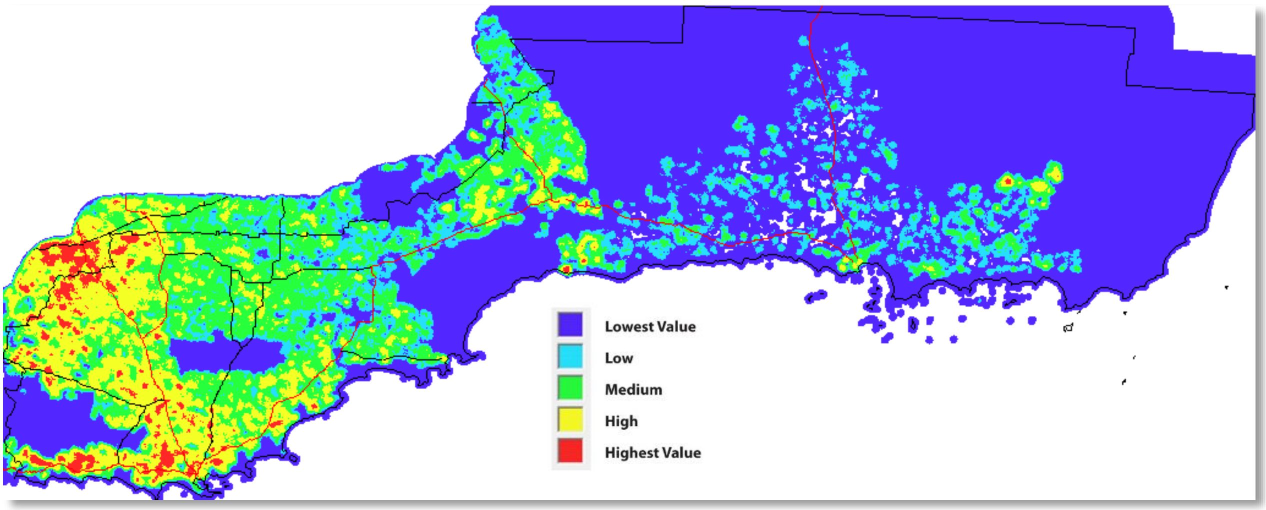


Figure 145: Level of vegetation fragmentation

4.2.2.6 Component B1B Output – Areas of High Conservation Potential

Layer 'Areas of High Conservation Potential' is a composite layer producing 5 classes

The composite function is generated from the sum of:

3 x 'B1A Areas of High Value Biodiversity'
2 x 'B3 Landscape Linkages_Corridors'
1 x 'Climate Resilience'
2 x 'Management Potential'
4 x 'Representativeness'

The result is classed using natural breaks.

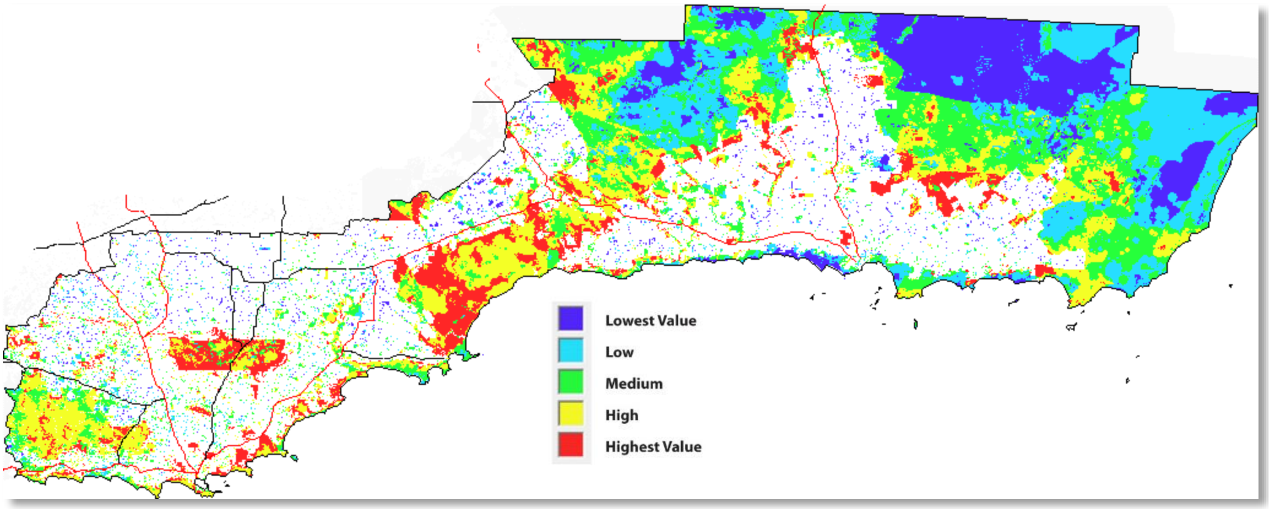


Figure 146: Component B1B Output – Areas of High Conservation Potential

4.2.3 B2 Protection afforded under Existing Tenure

Component B2 assesses potential value of land based on the current protections afforded from vesting and management. It is designed to provide assistance in identifying areas for conservation works, as well as identifying (through intersecting this component and B1B) areas with high conservation value that are un-protected.

Layer 'B2 Protection is afforded under Existing Tenure' is generated from the maximum of:

3 x 'Existing Reserves'
1 x 'Unvested Crown Land'
1.5 x 'Covenanted Private Land'

Using a maximum function means that the best protection from any source is identified. All input layers were classified using the same scale:

1 - No Tenure//Management Protection
2 - Low level protection (Local Government Reserves, Voluntary Covenants)
3 - Medium Protection (eg B Class NP)
4 - High Protection (A Class National Park)
5 - Highest Protection (A Class Nature Reserve)

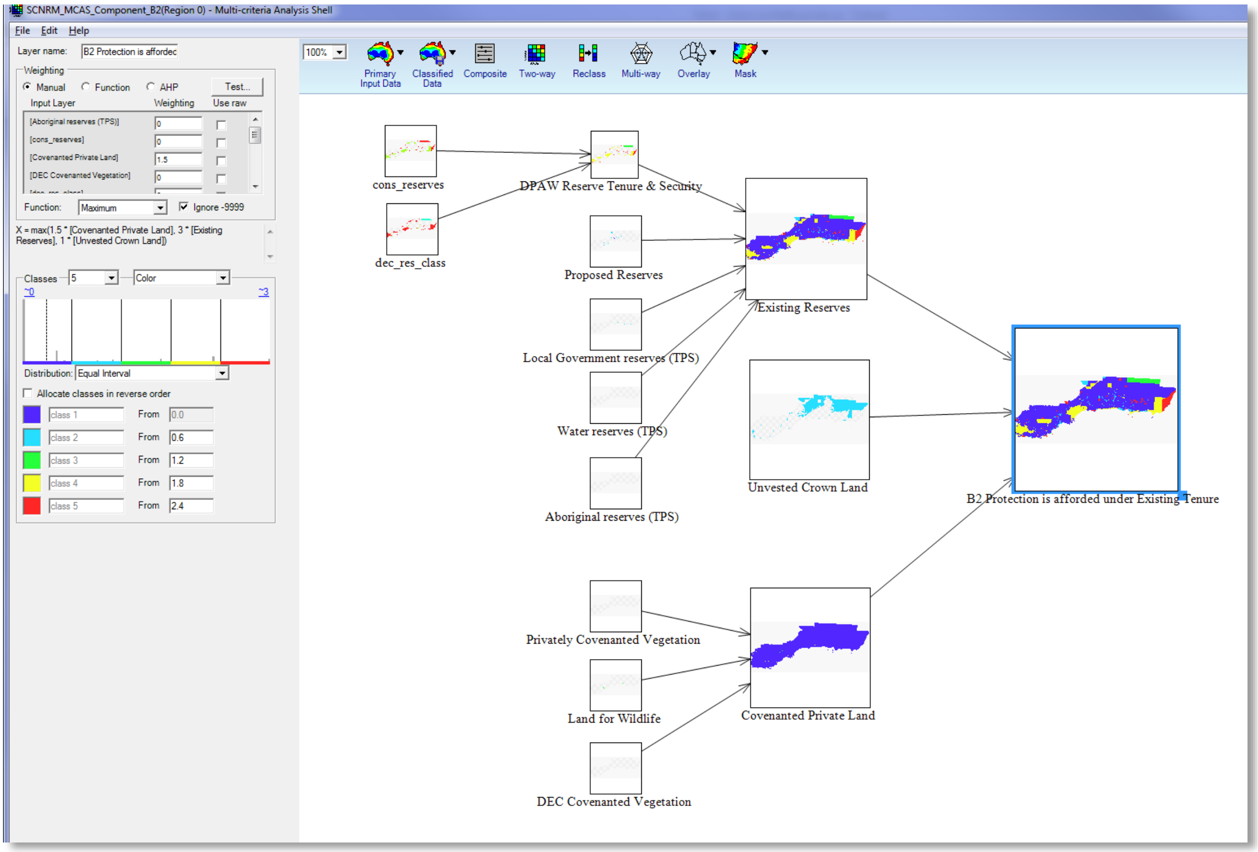
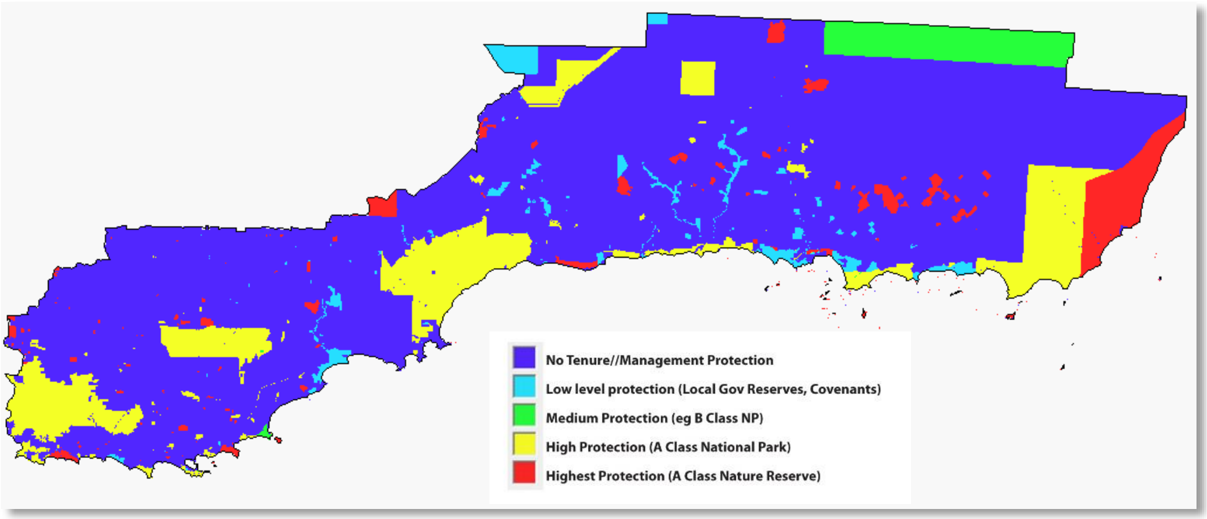


Figure 147: MCAS Diagram – Component B2

4.2.3.1 Existing Reserves

Layer 'Existing Reserves' generated from the maximum of:

1 x 'Aboriginal reserves (TPS)'
1 x 'DPAW Reserve Tenure & Security'
1 x 'Local Government reserves (TPS)'
1 x 'Proposed Reserves'
1 x 'Water reserves (TPS)'



DPAW Reserve Tenure & Security

A combination of reserve type and vesting (reserve class) has been used to give the effective security, with values provided by Deon Utber (DPaW Albany). The implication is that even a National Park can have low security of tenure and therefore protection. These protection equivalents were used throughout this component.

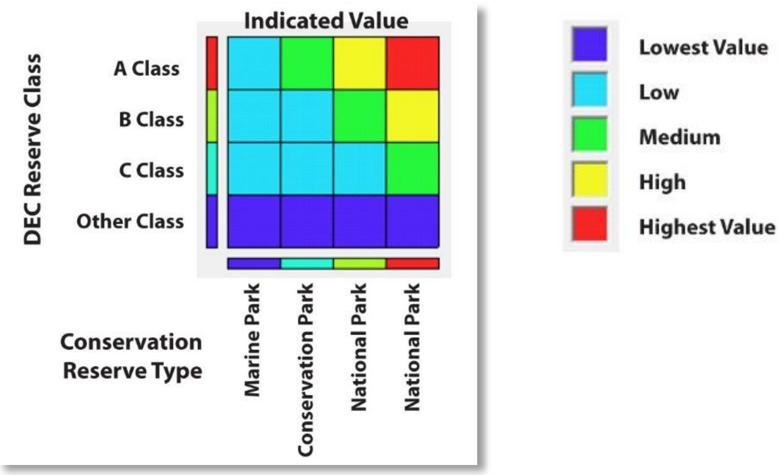


Figure 148: Reserve Tenure & Security 2-Way Matrix

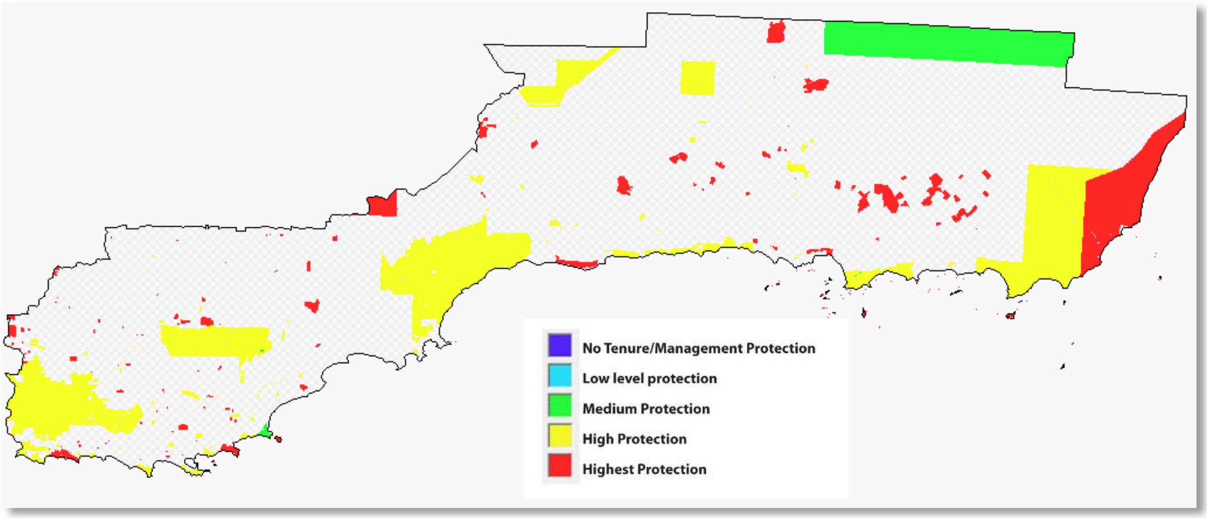


Figure 149: DPAW Reserve Tenure & Security

Proposed Reserves

A range of proposed reserves exist, but those some level of protection is only given to proposed National Park, Nature Reserve and Conservation Park.

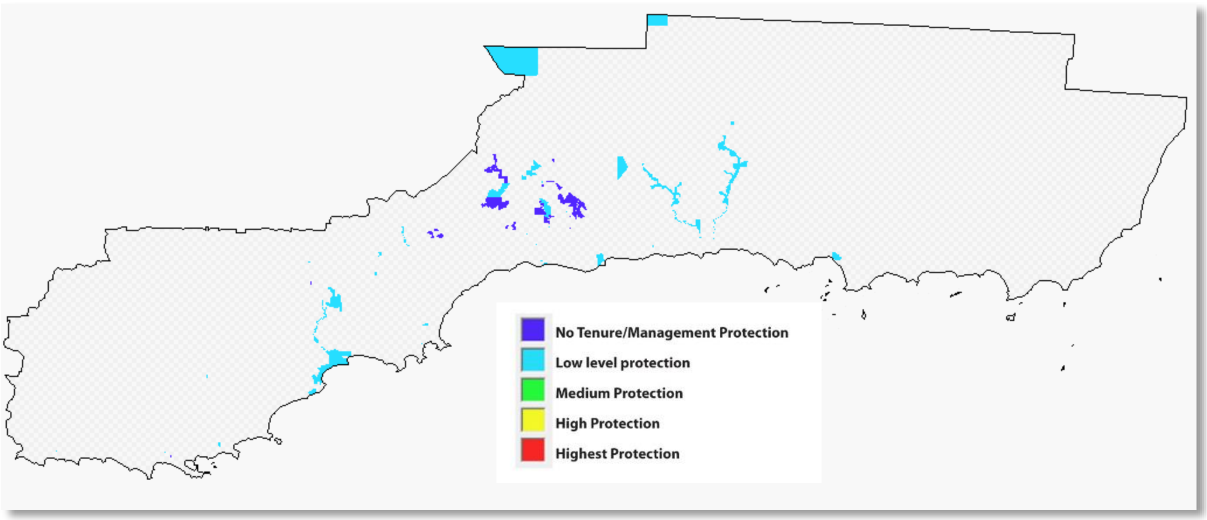


Figure 150: Proposed Reserves

Local Government reserves (TPS)

Extracted from TPS for the SCNRM region – Reserves for 'Nature', 'Conservation' and 'Parks, Recreation and Conservation'.

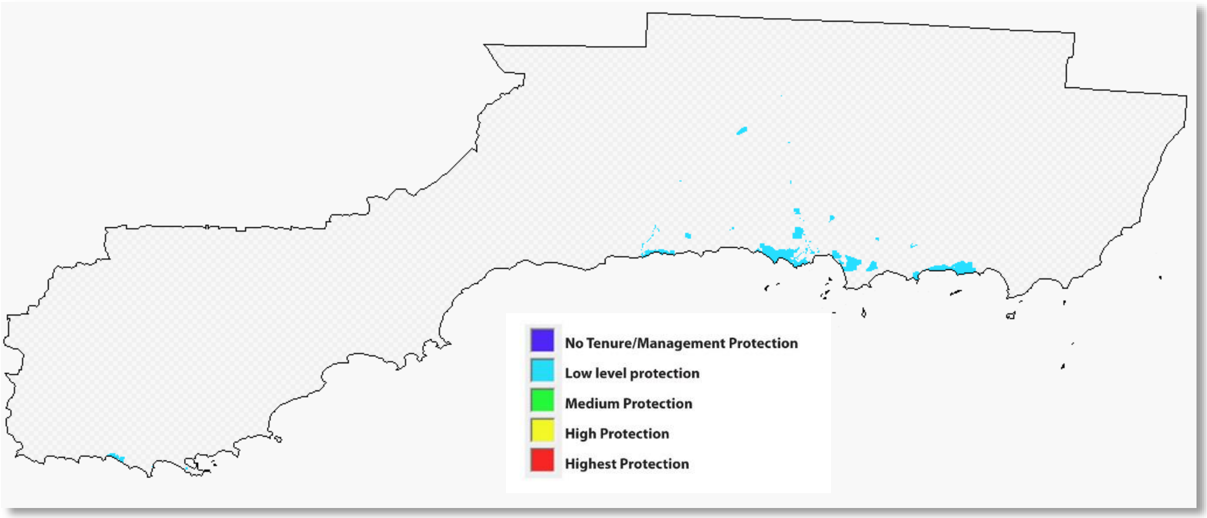


Figure 151: Local Government reserves (TPS)

Water reserves (TPS)

Extracted from TPS for the SCNRM region – Reserves for ‘Water’, ‘Water Supply’, ‘Water and Government Requirements’ and ‘Water and Stopping Place’.

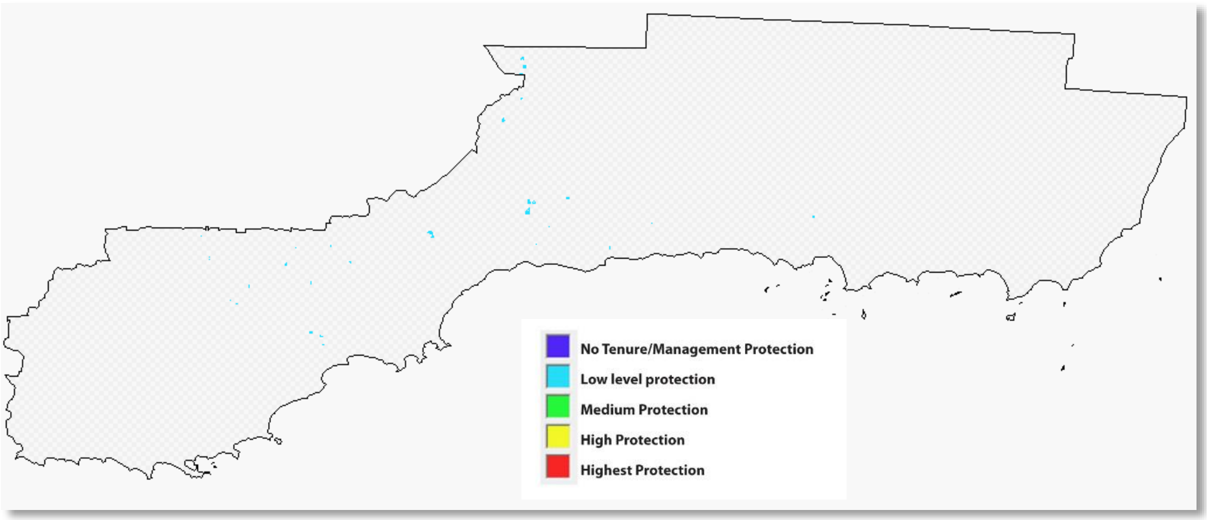


Figure 152: Water reserves (TPS)

Aboriginal reserves (TPS)

Extracted from TPS for the SCNRM region. These reserves are places where some protection is afforded.

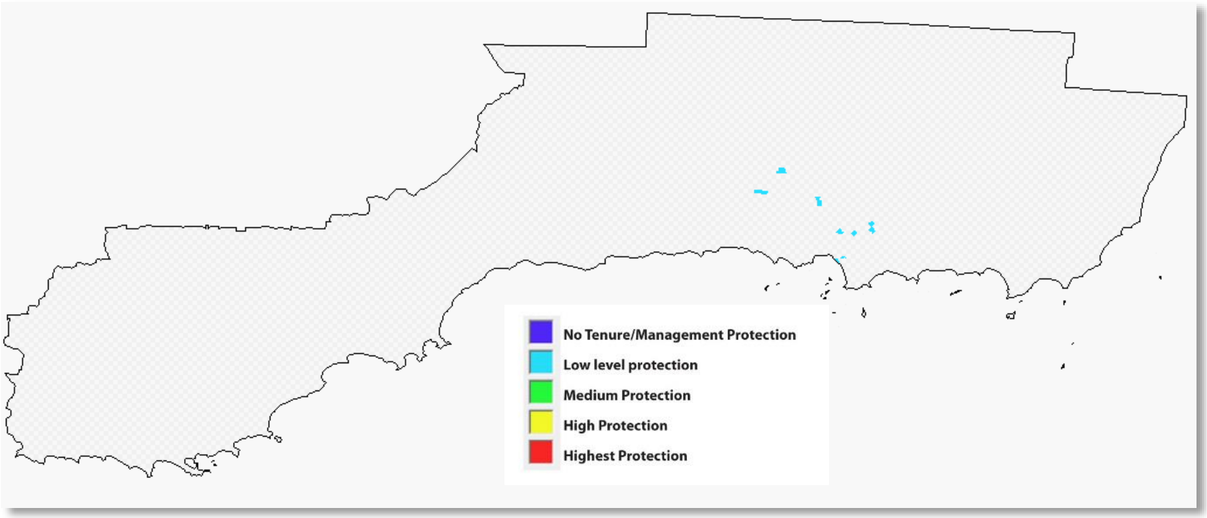


Figure 153: Aboriginal reserves (TPS)

4.2.3.2 Unvested Crown Land

Crown Reserves with no vesting listed at March 2013, include reserves for "'Water', 'Asstd P00xxx reserves', and 'Vacant Crown Land'.

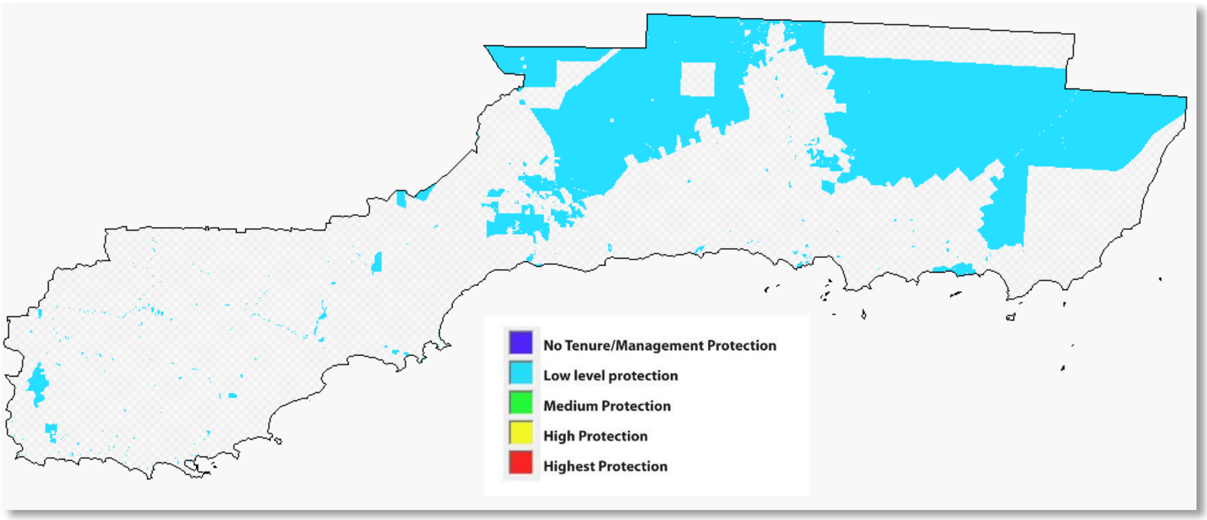


Figure 154: Unvested Crown Land

4.2.3.3 Covenanted Private Land

Layer 'Covenanted Private Land' is generated from the maximum of:

1 x 'DEC Covenanted Vegetation'
1 x 'Land for Wildlife'
1 x 'Privately Covenanted Vegetation'.

Individual data layers are not provided here in order to maintain anonymity, one of the conditions of data provision.

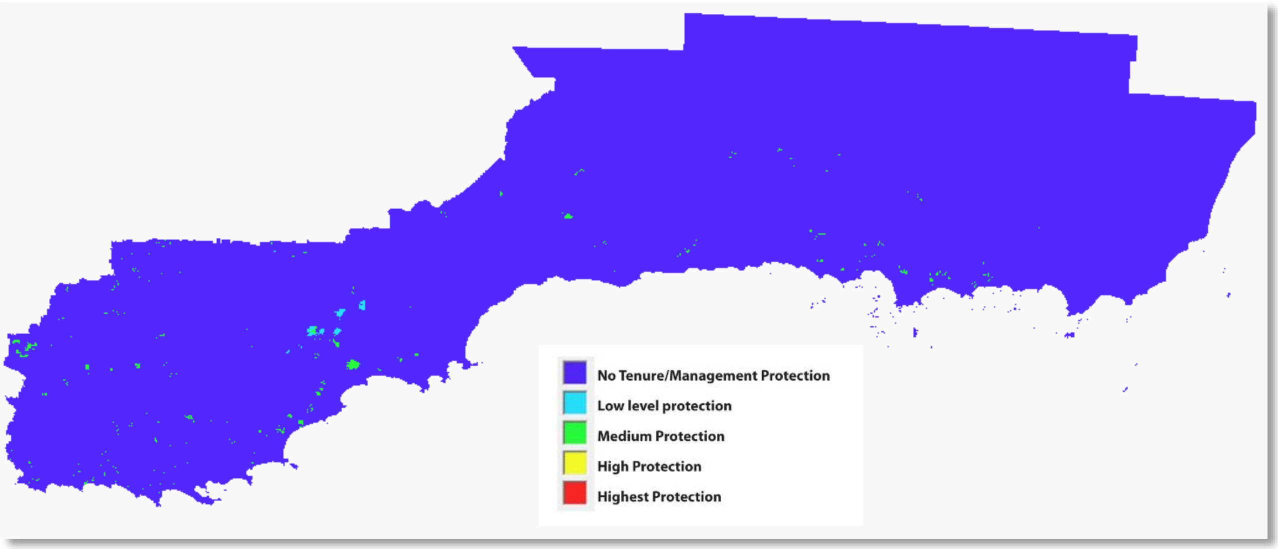


Figure 155: Covenanted Private Land

4.2.3.4 Component B2 Output –Protection afforded under Existing Tenure

The output indicates relative protection through tenure and purpose.

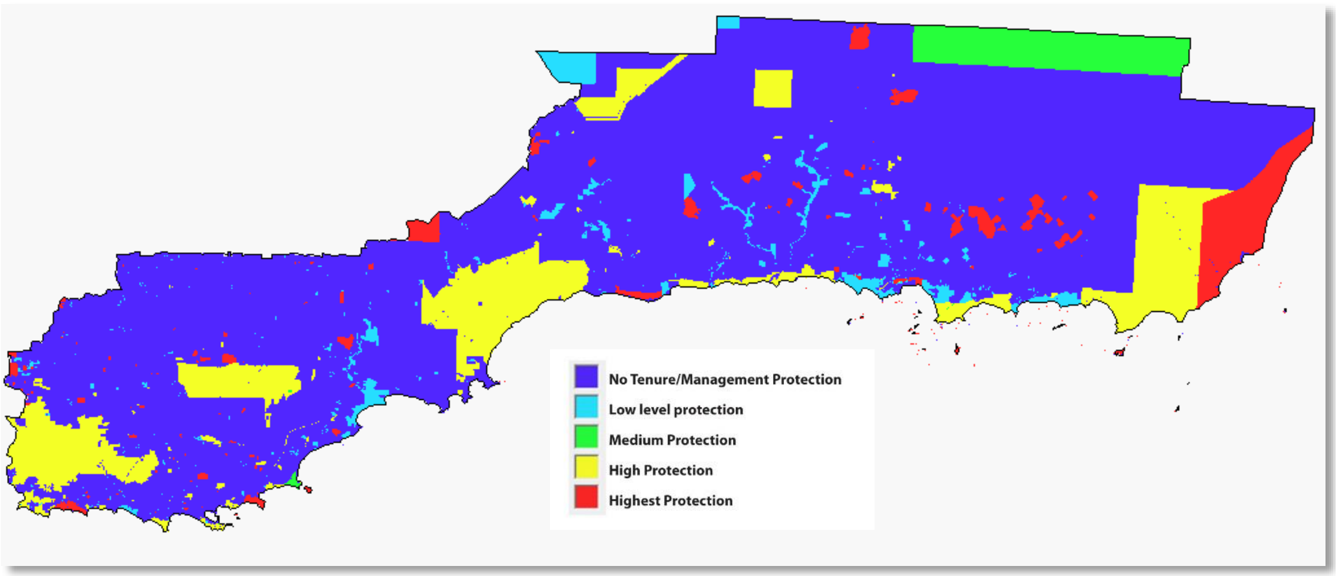


Figure 156: Component B2 Output –Protection afforded under Existing Tenure

4.2.4 B3 Landscape Linkages/Corridors

The conceptual model for this component has three major parts: Cores, Natural corridors and Connectivity. We have collated a number of datasets to provide for these parts.

Layer 'B3 Landscape Linkages/Corridors' is a composite layer generated from the sum of:

2 x 'Connectivity'
1 x 'Core Areas'
1 x 'Natural Corridors'

The result is classed manually so that there are high connectivity values along the coast and major rivers, and all other values are in relationship to these values.

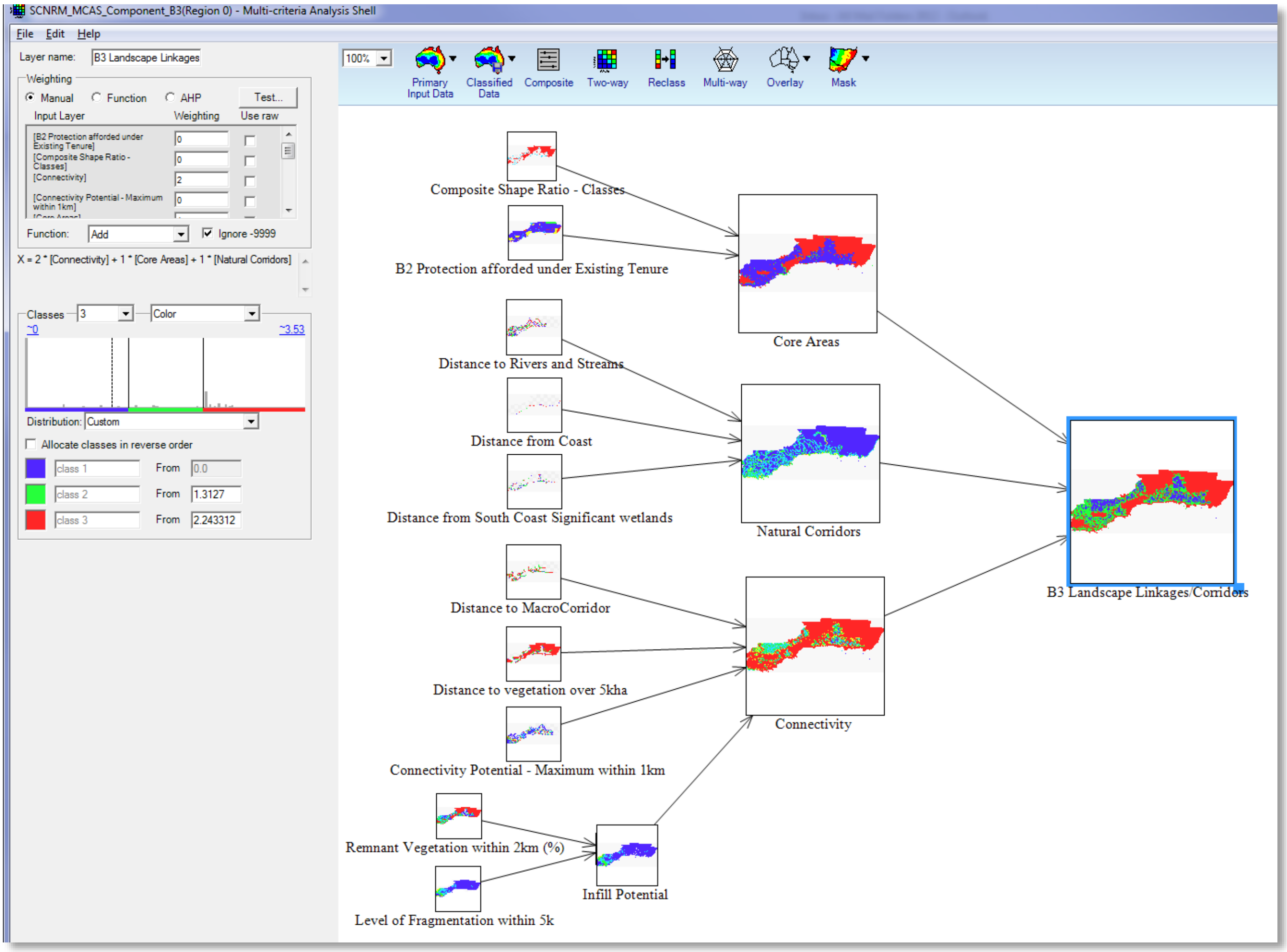


Figure 157: MCAS Model – Component B3

4.2.4.1 Core Areas

Layer 'Core Areas' is a composite layer producing 3 classes generated from the sum of:

1 x 'B2 Protection afforded under Existing Tenure'
1 x 'Composite Shape Ratio'

The result is classed manually so that there is consistent "core' classification for major national parks and reserves, and all other values are in relationship to these values.

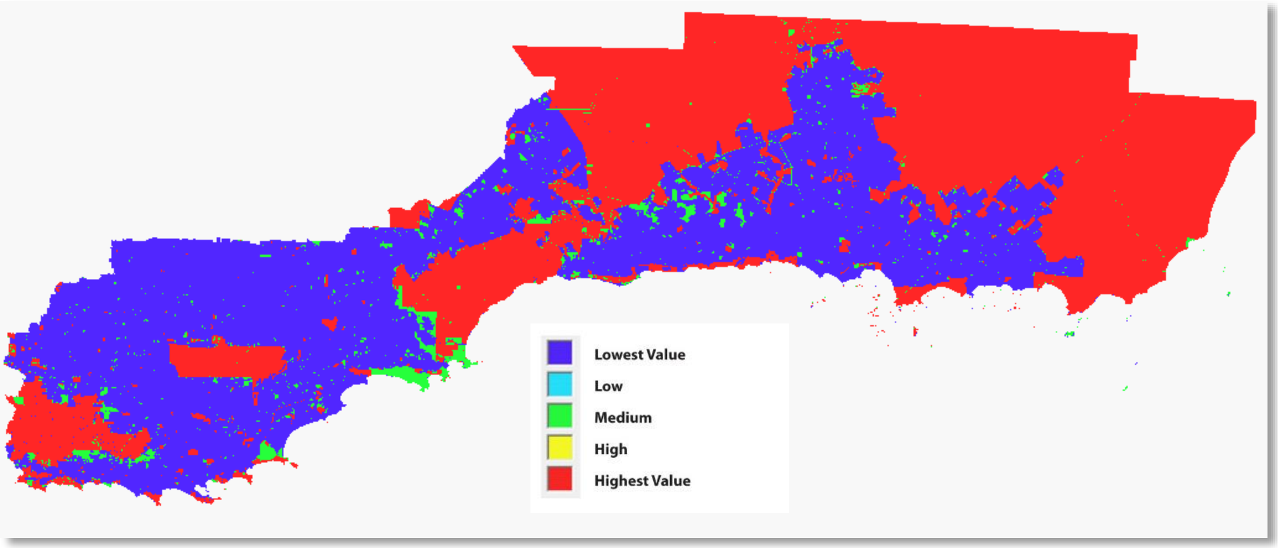


Figure 158: Core Areas

B2 Protection afforded under Existing Tenure

Output from B2 component discussed in section 4.2.3.4.

Composite Shape Ratio

This measure is classified to provide for two classes, with high conservation potential areas (on shape/size) being highlighted.

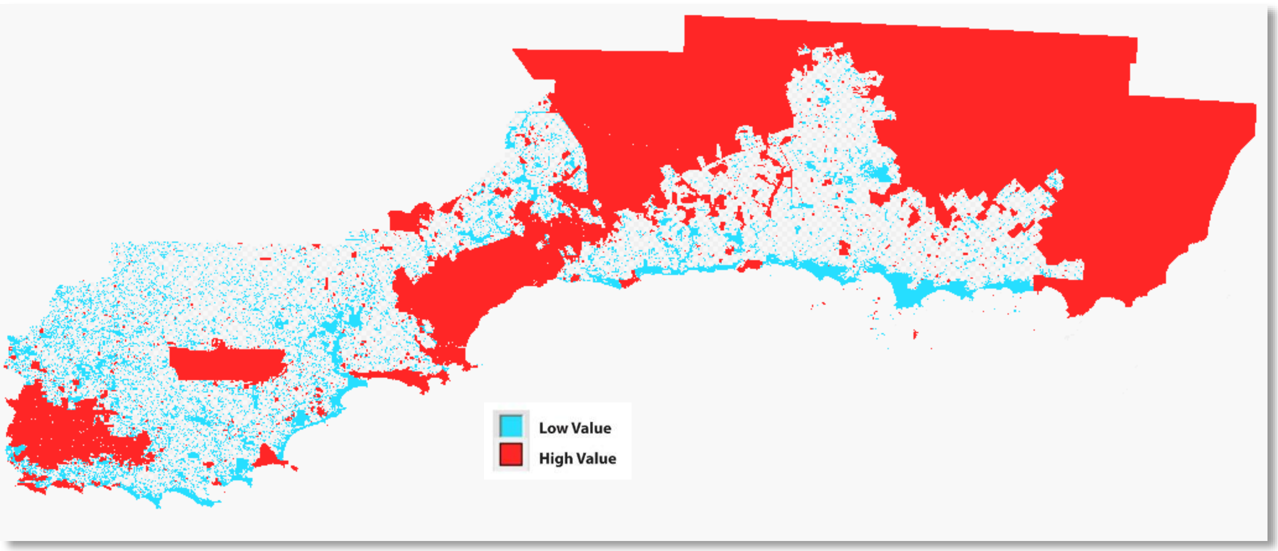


Figure 159: Composite Shape Ratio

4.2.4.2 Natural Corridors

Layer 'Natural Corridors' is a composite layer producing 5 classes generated from the sum of:

1 x 'Distance from Coast'
1 x 'Distance to Rivers and Streams'
1 x 'Distance from South Coast Significant wetlands'

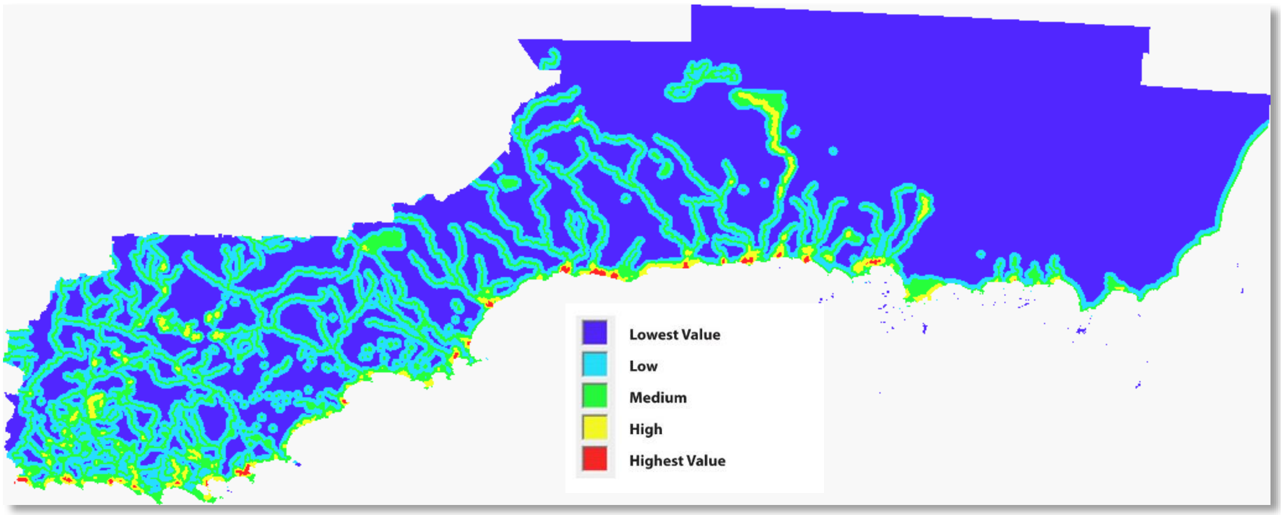


Figure 160: Natural Corridors

Distance from Coast

The coastline was buffered and areas within 2km, 3km, and up to 4km were given descending value, to recognise that the coast is a major natural linkage.

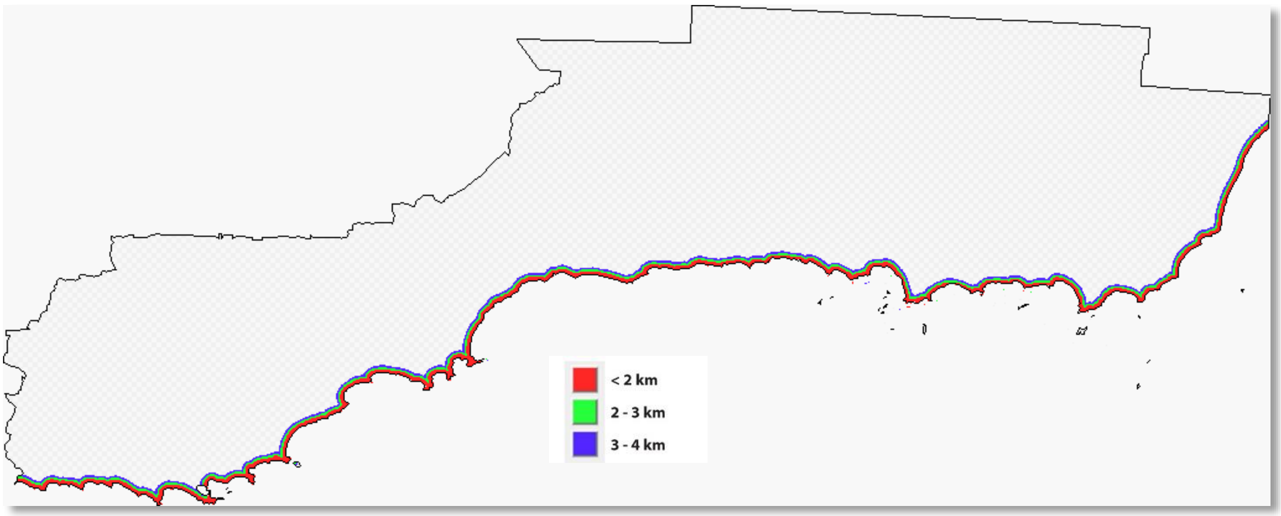


Figure 161: Distance from Coast

Distance to Rivers and Streams

Mainstream, Major river, Minor river & Significant Streams were buffered area within 1km, 2km and up to 3km were given descending values, and recognise that streams are major natural linkages.

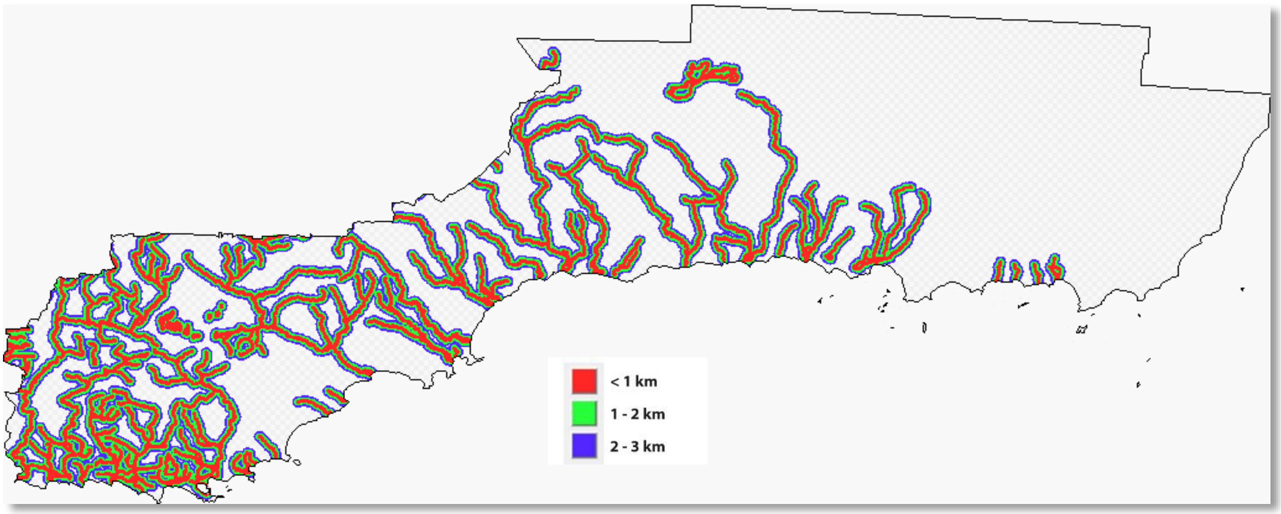


Figure 162: Distance to Rivers and Streams

Distance from South Coast Significant wetlands

All south coast significant wetlands (including Ramsar, ANCA, National Estate registered and unclassified wetlands) were buffered and areas within 1km, 2km and up to 3km were given descending values, to recognise that wetlands provide connectivity to waterbirds.

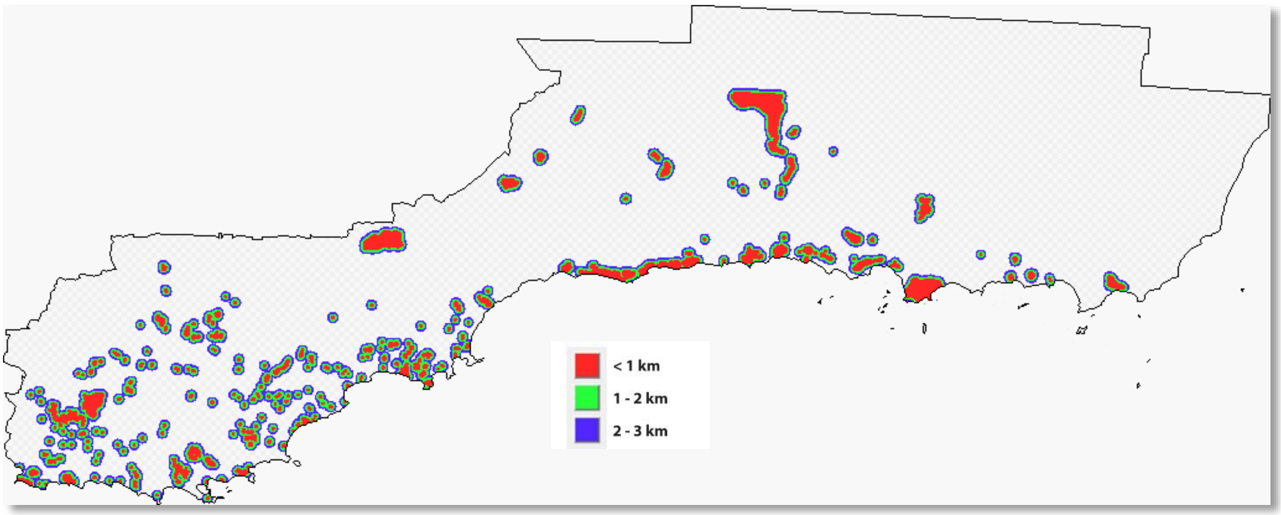


Figure 163: Distance from South Coast Significant wetlands

4.2.4.3 Connectivity

Layer 'Connectivity' is a composite layer generated from the sum of:

2 x 'Connectivity Potential - Maximum within 1km'
1 x 'Distance to Macro-Corridor'
1 x 'Distance to vegetation over 5kha'
1 x 'Infill Potential'

The result is classed by a custom set of classes to ensure that high connectivity was indicated along rivers north and east of Esperance.

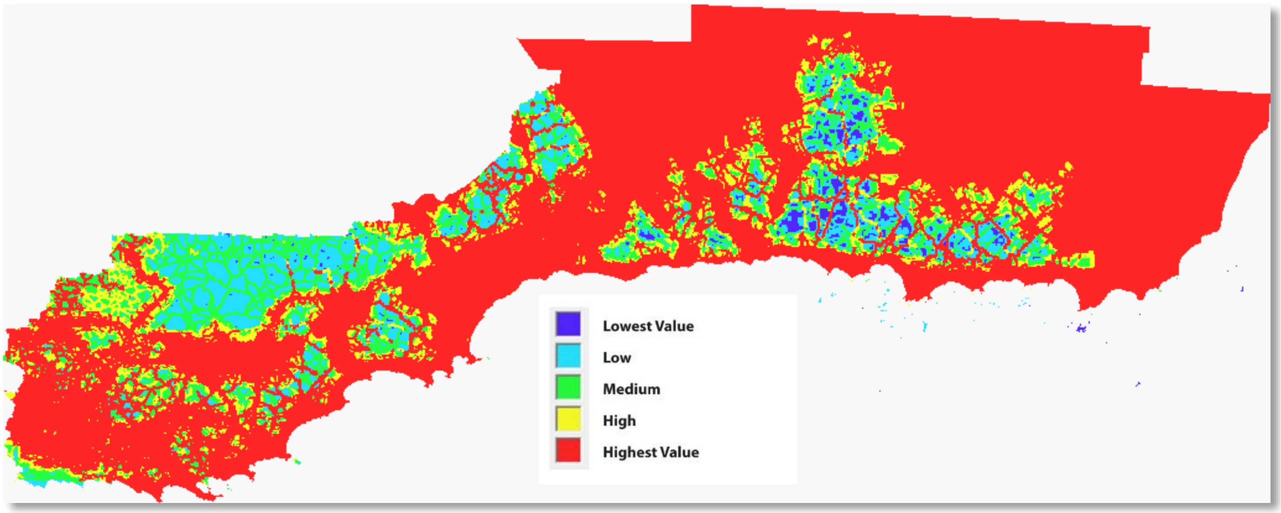


Figure 164: Connectivity

Connectivity Potential - Maximum within 1km

Connectivity Potential is a dataset from the Australian Government Department of the Environment which identifies all potential linkages between all vegetation patches. This is on empirical indicator of potential connectivity. The specific data used is the maximum within 1km of each MCAS cell.

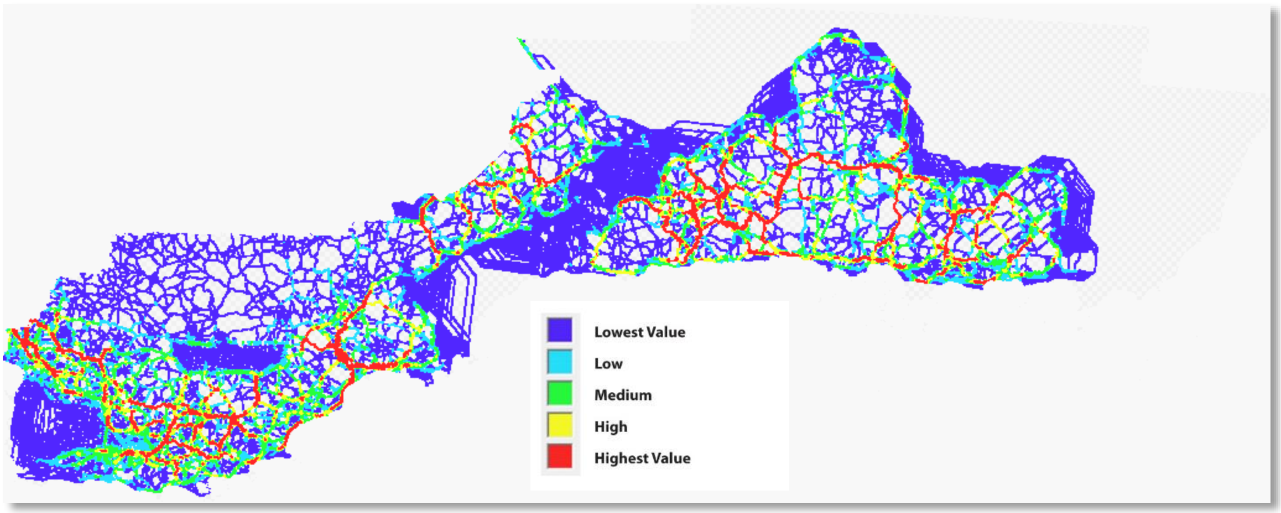


Figure 165: Connectivity Potential - Maximum within 1km

Distance to Macro-Corridor

The South Coast Macro-Corridor network is a recognised dataset from DEC that was included to ensure complementarity with previous work and thinking.

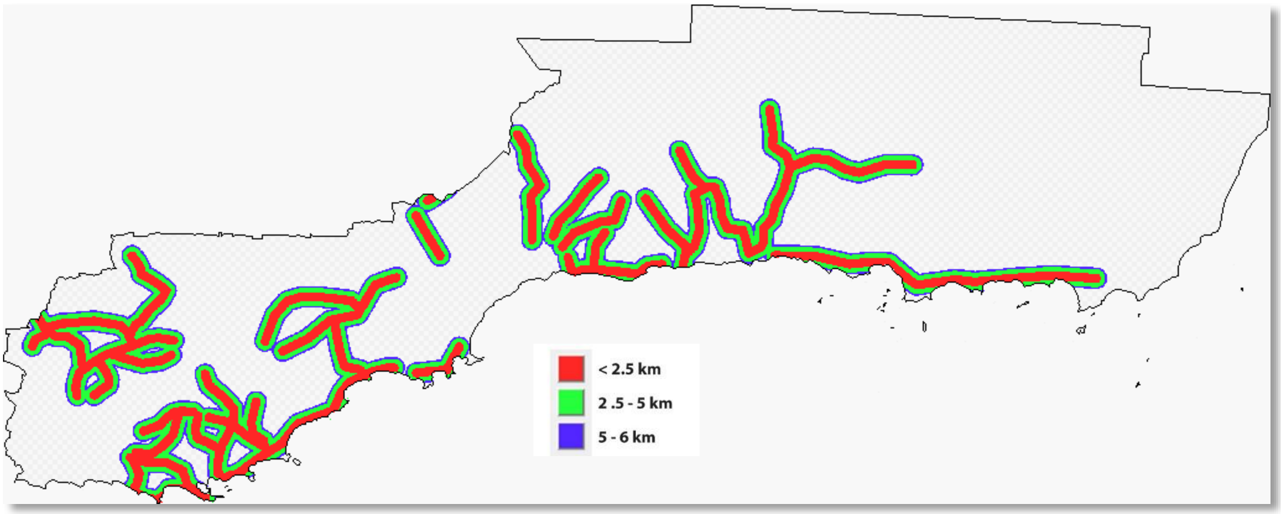


Figure 166: Distance to Macro-Corridor

Distance to vegetation over 5kha

Cells close to large areas of Remnant vegetation (>5,000ha) were identified with descending values to recognise proximity to large intact ecosystems.

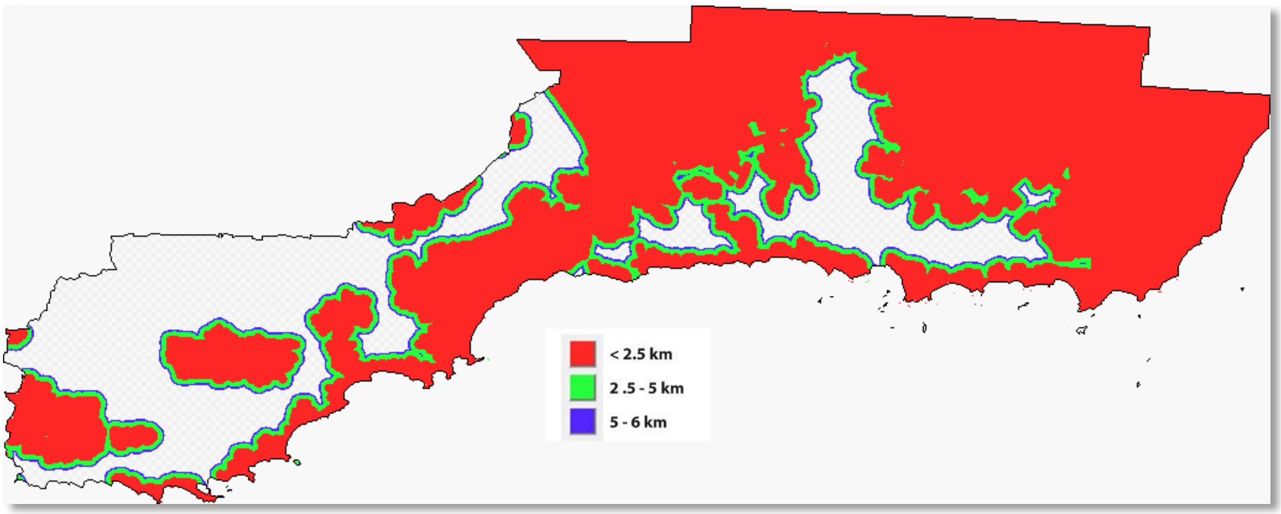


Figure 167: Distance to vegetation over 5kha

Infill Potential

Layer 'Infill' is generated with a Two Way from 'Remnant Vegetation within 2km (%)' and 'Level of Fragmentation within 5km'. The two-way reflects the thinking of the group that in areas with very low numbers of fragments, or low % of vegetation, infill is going to be expensive and ineffective. As the number of fragments increases, so too does the infill potential, regardless of the % of vegetation.

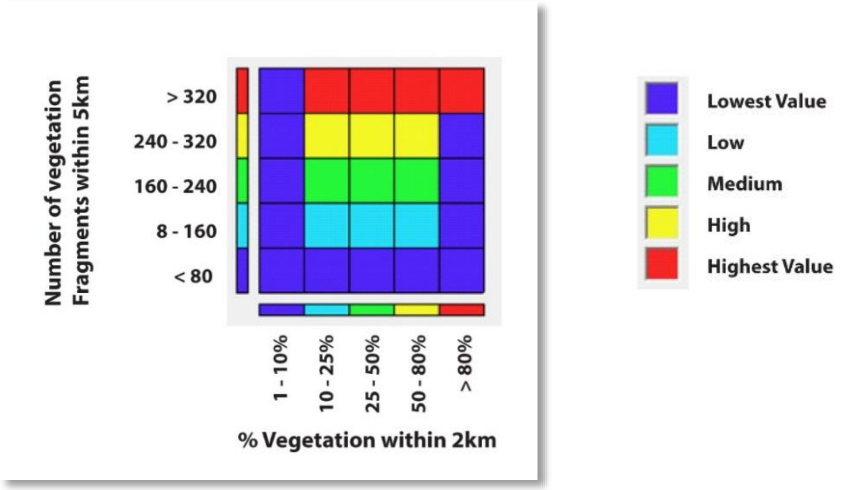


Figure 168: Infill potential two-way classification

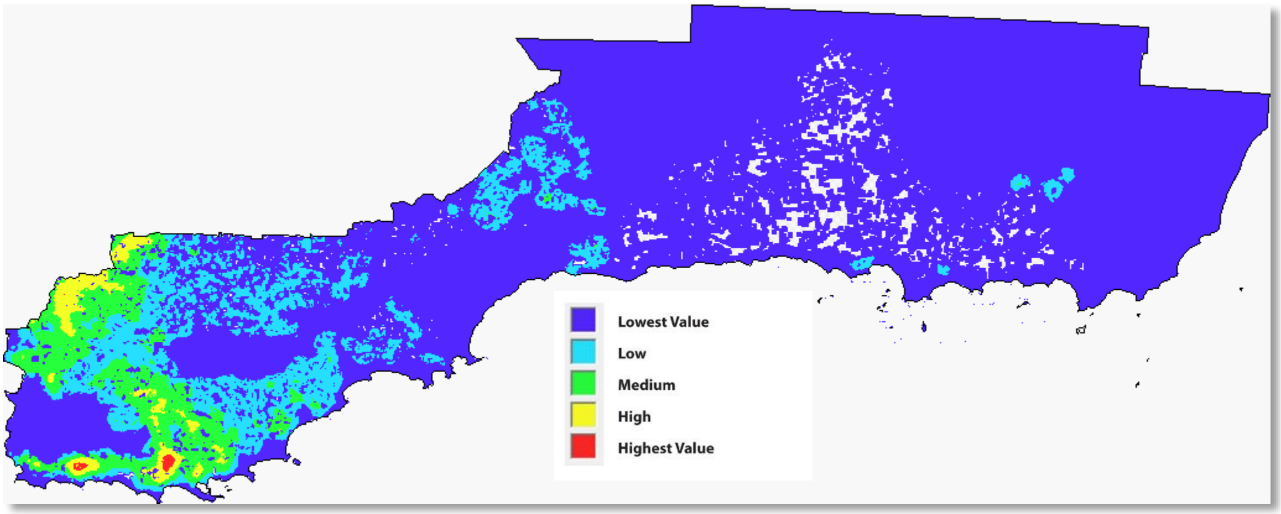


Figure 169: Infill Potential.

Remnant Vegetation within 2km (%)

Split into 5 classes as shown above.

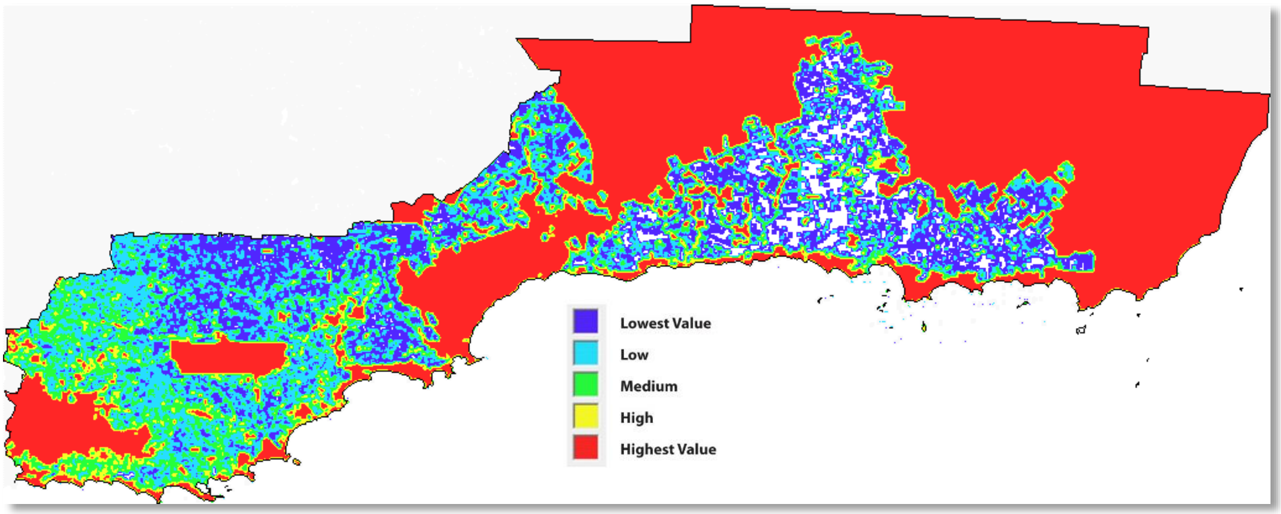


Figure 170: Remnant Vegetation within 2km (%)

Level of Fragmentation within 5km

Split into 5 classes as above.

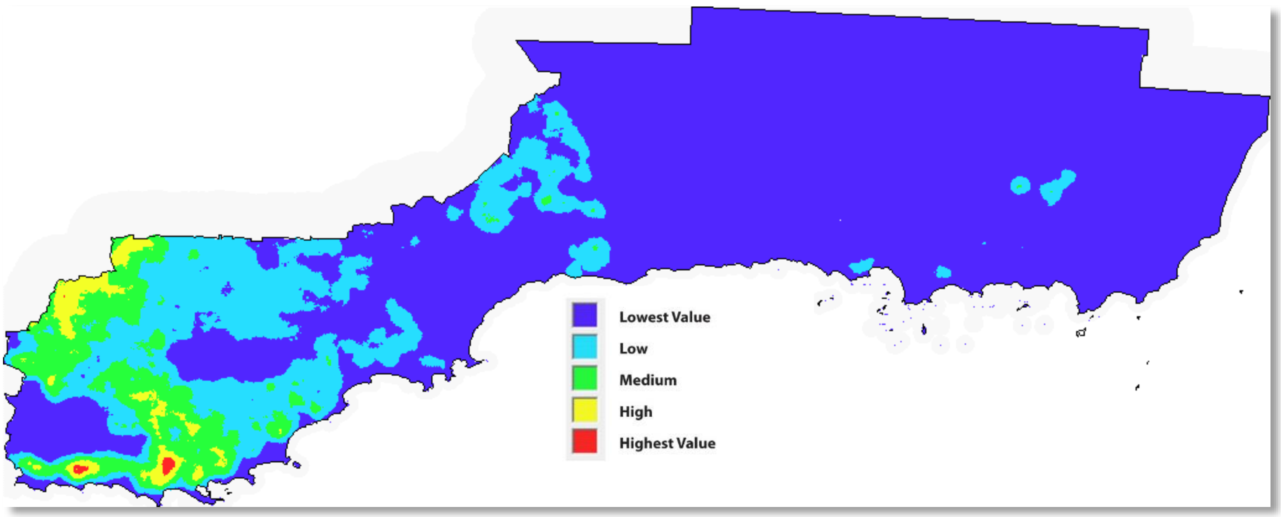


Figure 171: Level of Fragmentation within 5km

4.2.4.4 Component B3 Output – Landscape Linkages/Corridors

The final version of this component is classified into three classes – high, medium and low. The classification intervals were set to clearly define corridors travelling north-south in the east of the region.

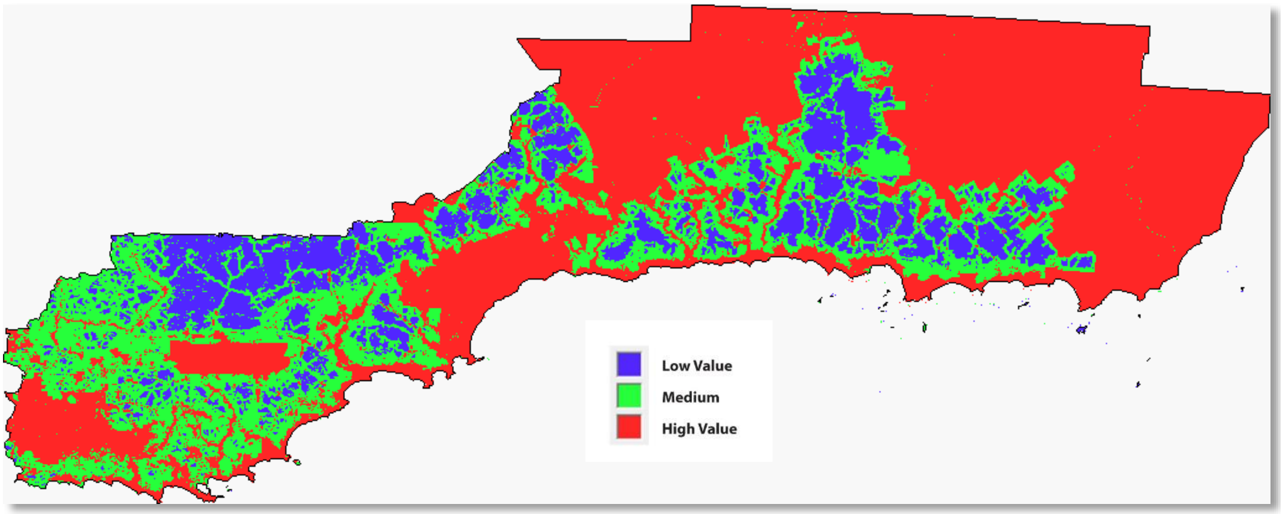


Figure 172: Component B3 Output – Landscape Linkages/Corridors

5. PROJECT DELIVERABLES

The project deliverables are as follows:

Project Report

This document.

Project Presentations

As produced for the project and presented to the Working Group and SCNRM Board

ArcGIS map documents & processed data.

A number of ArcGIS map documents are provided, including two that were used for project data processing, and a single final map document which contains the datasets and maps used for the project outputs in Sections 3 and 4.

- SCNRM_Working1.mxd
- CCDatasets_v2.mxd
- SCNRM Planning for Climate Change Project.mxd

These map documents include a series of simple ArcGIS tools that were used for data processing and can be used in the future by SCNRM. PDF versions of the major maps are also provided for printing at up to A0.

MCAS-S Models

All models used in the project are provided in a single MCAS-S folder:

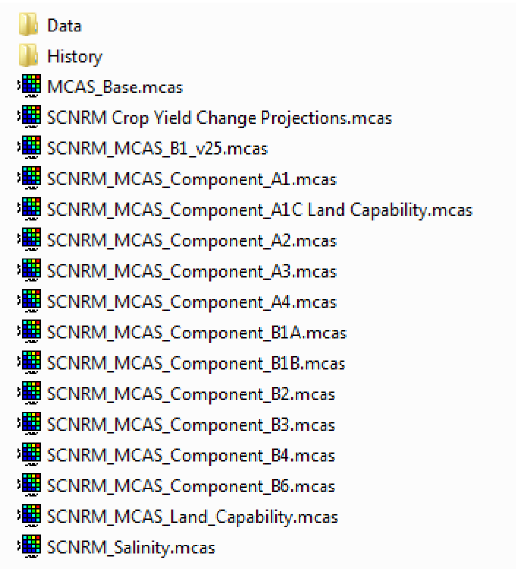


Figure 173: MCAS-S Files Provided

MCAS-S processed datasets for SCNRM

All datasets processed to MCAS-S standards are included in the MCAS-S folder. These are listed in Appendix 2.

6. APPENDICES

6.1 Appendix 1 – SCNRM Carbon Farming Guiding Principles

The purpose of the *Carbon Farming Guiding Principles* is to:

(i) Assist carbon farming proponents ensure their CFI projects adhere to South Coast NRM's Regional Strategy.
(ii) Provide guidance to avoid and mitigate potential risk and adverse impacts associated with carbon sequestration in the landscape (including impacts to biodiversity, water resources and productions systems).

South Coast NRM supports Carbon Farming projects that:

1. Mitigate climate change;
2. Protect, restore and enhance natural resources and build landscape resilience;
3. Protect resilience and cohesion of our communities.
4. Maximise benefits from plantings for environmental, social and economic outcomes

Carbon planting considerations:

1. Protect, enhance and restore areas of high biodiversity conservation.
2. Enhance regional ecological linkages and connectivity.
3. Protect high value agriculture land.
4. Use and enhance low value agricultural land and degraded landscapes.
5. Encourage plantings of higher biodiversity value (e.g. species, local provenance, size and shape of planting, climate resilience).
6. Align with Local, State and Federal government policies and planning requirements.
7. Identify social and community impacts and provide safeguards to minimise adverse impacts (e.g. loss of regional populations, social services and impacts on local infrastructure).
8. Maximise opportunities for community development and enterprise associated with CFI initiatives.
9. Carbon plantings meet the criteria for productivity, duration and maintenance for bio-sequestration.
10. Selection of vegetation species must consider future climate change impacts.
11. Improve hydrological balance and water quality, consistent with catchment objectives.

6.2 Appendix 2 - GIS & MCAS-S Datasets

Metadata Conventions

Input Datasets

All input datasets also had metadata created, which is placed in their MCAS folders and available through MCAS-S:

Description: % of each Vegetation Association remaining (2012) for WA
Custodian: Derived from Beard Datasets (DAFWA/DEC)
Currency: 2012
Lineage: As supplied by DPAW - statistic compiled by DEC and attached to Beard associations.
Calculations for entire Beard Vegetation dataset in WA. Note that these are for Vegetation Associations - a different field (higher level classification) than SYStem ASSOC.

Description: NCCARF Biological Refugia under Climate Change
Custodian: NCCARF
Currency: 2013
Lineage: Source Reside Et al. Projected refugia areas in 2085.
These are the areas with the smallest loss, and greatest gain, of species. 1400 Species drawn from 4 groups - Amphibians, Birds, Mammals and Reptiles
This map shows the areas with the most immigrants and fewest emigrants summed over taxonomic groups.
The detailed refugia are scaled from 1 (lowest priority) to 7 (highest priority). Resampled to 200m grids.

Figure 174: MCAS-S Metadata Examples

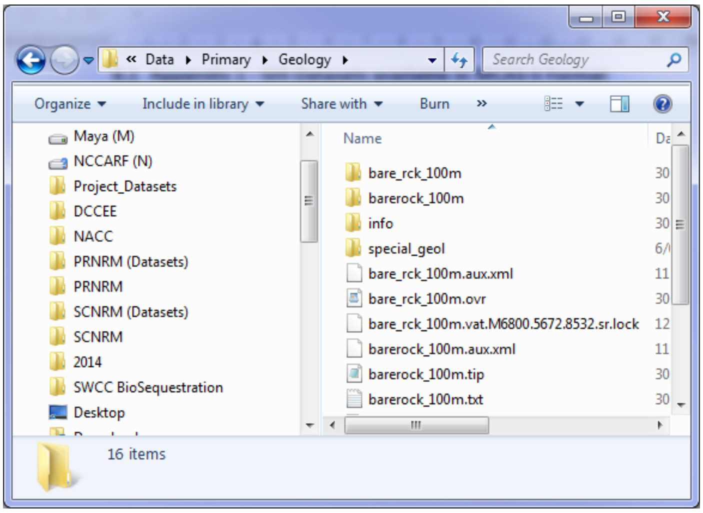


Figure 175: MCAS dataset folder showing grid folders and .tip and .txt files.

Component Outputs (classified datasets)

For each Component output, standard metadata was produced in the following format:

Filename: B1A Areas of High Value Biodiversity FINAL.tif
Description: B1A Areas of High Value Biodiversity FINAL
Custodian: SCNRM
Currency: 2014
Lineage: SCNRM PCC MCAS Analysis process
Source: Component B1A Areas of High Value Biodiversity

This is found in a .xml file in the classified data folder:

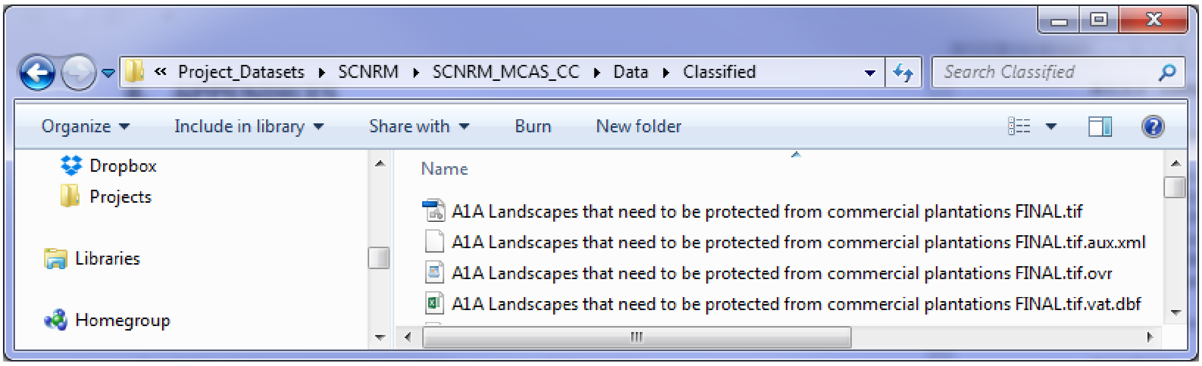


Figure 176: .xml file for Classified Datasets Metadata

GIS Datasets available in MCAS-S Format

Agricultural
Barley - Projected Yield Change % 2005 - 2050. SRES A2
Canola - Projected Yield Change % 2005 - 2050. SRES A2
Lupins - Projected Yield Change % 2005 - 2050. SRES A2
Oats - Projected Yield Change % 2005 - 2050. SRES A2
Wheat - Projected Yield Change % 2005 - 2050. SRES A2

Base
SCNRM 2010 Boundary
SCNRM 20km Buffer
SCNRM 200m Grid

Climate
Projected ANNUAL Rainfall (mm) for 2020
Projected MAY-OCTOBER Rainfall (mm) for 2020

CSIRO Mk3.5 Modelled climatic parameters – Scenario A2 for 2030
Mean MAY - OCTOBER Rainfall % Change (mm) by 2030 from Current
Mean MAY - OCTOBER Rainfall % Change (mm) by 2030 from Current (**downscaled using kriging)**

CSIRO Mk3.5 Modelled climatic parameters – Scenario A2 for 2080 – downscaled using kriging
Max Temp Summer Change (Degrees) by 2080 from Current
Mean Temp Year Change (Degrees) by 2080 from Current
Mean MAY - OCTOBER Rainfall (mm) 2080

Mean MAY - OCTOBER Rainfall Change (mm) by 2080 from Current
Mean MAY - OCTOBER Rainfall % Change (mm) by 2080 from Current
Projected ANNUAL Rainfall (mm) by 2080
Mean ANNUAL Rainfall Change (mm) by 2080 from Current
Mean ANNUAL Rainfall % Change (mm) by 2080 from Current

Covenanted
Privately Covenanted Properties - Bush Heritage or Greening Australia
DEC Covenants
Distance from DEC Covenants
Distance from Land for Wildlife sites
Land for Wildlife sites
Privately Covenanted Properties - Bush Heritage Australia, Greening Australia, Carbon Neutral or Private

Cultural
Aboriginal Heritage Sites - Site Access
Aboriginal Heritage Sites - Site Status
TPS Aboriginal Reserves
TPS - Current Development Areas
TPS - Future Development Areas
TPS - Landscape Protection Areas
TPS - Rural Conservation Areas

Dieback
Distance to Dieback Occurrence (Points)
Dieback Occurrence (polygons)

Elevation
Aspect - 200 metre resolution DEM
Slope (degrees) - 200 metre resolution DEM
Local Relief within 100m - 30m metre resolution DEM
200 metre resolution DEM
Slope (degrees) smoothed - 200 metre resolution DEM

Endemism
Species Endemism (smoothed, 10k km2)
Species Endemism (smoothed, 10k km2) Resampled to 200m

Fire
Number of fires since records kept
Number of fires since 1973
Last Fire
Maximum Time between burns
Minimum Time between burns
Time since Last Fire

Flora & Fauna
Distance to Priority Flora
Distance to Priority Threatened Fauna.
Distance to Priority Threatened Fauna.
Distance to Threatened Flora

Priority Fauna.
Priority Flora
Threatened Fauna.
Threatened Flora.

Geology
Bare Rock - TOPOGRAPHIC DATA DICTIONARY
Significant Geology

Geomorphic Habitats
Geomorphic habitat Type
Granite and Sand (Bare rock)

Groundwater
Proclaimed Groundwater Areas

Habitats
CENRM Catchment assessment: Overall Catchment Ranking (classified)
CENRM River assessment: Diversity Ranking (classified)
CENRM River assessment: Naturalness Ranking (classified)
CENRM River assessment: Rarity Ranking (classified)
CENRM Catchment assessment: Diversity Ranking (classified)
CENRM Catchment assessment: Naturalness Ranking (classified)
CENRM Catchment assessment: Rarity Ranking (classified)
Invertebrate Refugia (liklehood)
TEC/PEC Threatened and Priority Ecological Community buffers in WA

Hydrology
Geomorphic Wetlands - Classification, Swan Coastal Plain
ELPW (Estuaries, Lakes, Pools & Watercourses)
Perenniality of Water Features (Estuaries, Lakes, Pools & Watercourses)
Distance from Estuaries, Lakes, Pools & Waterways
Distance from Rivers and Streams
Distance from EPP Wetlands
Register areas for Lakes EPP, 1992
Public Drinking Water Source Areas (priority)
Public Drinking Water Source Areas (type)
Protection Zones for PDWSA (Public Drinking Water Source Areas)
PDWSA areas unsuitable for plantations (underground water pollution control areas and water reserves)
Ramsar Wetlands
Distance from Ramsar Wetlands
Rivers and Streams
South Coast Significant Wetlands
Distance from South Coast Significant Wetlands
South Coast Significant Wetlands - SuiteID Variety 5km
Water Polygons - TOPOGRAPHIC DATA DICTIONARY

Land Capability
Land Capability for Annual Horticulture
Land Capability for Perennial Horticulture
Land Capability for Vines
Land Capability for Dry Cropping

Land Capability for Dry Cropping Minimum Tillage
Land Capability for Grazing
Land Capability for E. Globulus

Linkages_Corridors
Distance from South Coast
Connectivity Potential
Connectivity Potential - Maximum within 1km
Connectivity Potential - Maximum within 500m2
Connectivity Potential - Mean within 1km
Connectivity Potential - Mean within 1km - Classified
Distance from South Coast Macro-Corridor

Mining
Mining Tenements – Status

Model Results
B1A Distance to High values
B1A High Values
B3 Distance to
B3 High Values
Composite Shape Ratio - Native Vegetation Contiguous Area 2014 – CLASSES

PreEuroVeg
System Association (Beard)

Refugia
CENRM Plant Refugia under Climate Change - A2 2080
CENRM Plant Refugia under Climate Change - A2 2080 Resampled to 200m
NCCARF Biological Refugia under Climate Change
NCCARF Biological Refugia under Climate Change Resampled to 200m

Salinity
Salinity Hazard (height above valley floor)
Salinity Extent
Hydrozone salinity risk 2012
Hydrozone salinity Urgency 2012
Future Salinity (Short term)
Future Salinity (Medium term)
Distance from Future Salinity (Short term)
Distance from Future Salinity (Medium term)
Subcatchment Salinity Hazard (height above valley floor)

Socio_Economic
Population Change 2012 - 2013 (%)
The Index of Relative Education and Occupation (IREO)
The Index of Relative Economic Resources (IRER)
The Index of Relative Socio-economic Advantage and Disadvantage (IRSAD)

SWAEI_Priorities
Southwest Australia Ecoregion Initiative Priority Biodiversity Areas
SWAEI Bio Priority

SWAEI Conservation Targets - Achievability by category
SWAEI Conservation Targets – Achievability

Boundaries
Conservation Reserves
Distance from Conservation Reserves
Crown Reserves by Class
Distance to Crown Reserves
DEC Managed Lands and Waters (ISO 19139)
IBRA Subregions
DPAW Proposed Reserves
TPS Local Government Reserves
TPS Water-Related Reserves
Mining Tenements by Type
UNVESTED Crown Reserves by Class

Vegetation
2014
Cleared Areas 2014 (not covered by Native Vegetation 2014)
Infill Potential (derived from fragmentation & % clearing)
FPC_Plantations
Distance from FPC_Plantations
Native Vegetation Contiguous Area > 1,000ha
Native Vegetation Contiguous Area > 5,000ha
Native Vegetation Contiguous Area > 10,000ha
Native Vegetation Extent 2014
Native Vegetation Contiguous Area 2014
Distance from Native Vegetation Contiguous Area > 1,000ha
Distance from Native Vegetation Contiguous Area > 5,000ha
Distance from Native Vegetation Contiguous Area > 10,000ha

Fragmentation
Native Vegetation - % within 1km
Native Vegetation - % within 2km
Native Vegetation - number of patches within 2km
Native Vegetation - number of patches within 5km

Shape
Area to Boundary Ratio - Native Vegetation Contiguous Area 2014
Area to Boundary2 Ratio - Native Vegetation Contiguous Area 2014
Composite Shape Ratio - Native Vegetation Contiguous Area 2014

Vegetation Associations
% of each Vegetation Association within DEC Reserves (2014)
% of each Vegetation Association remaining (2012) for WA
Area of Vegetation within each System Association (Beard)
Vegetation Association - Reduction in area (%) to 2014
Variety of Vegetation Associations within 2km (2014)
Variety of Vegetation Associations within 5km (2014)
Vegetation Patch - % of remaining Vegetation Association area (SCNRM) – 2014

6.3 Appendix 3 - MCAS Workshop Attendees

Internal Workshop (SCNRM staff), May 21st
Kaylene Parker (Climate Change Project Officer)
Karl Hansom (Biodiversity Program Leader)
Penni Hewett (Land Program Leader)
Karen Ireland (Community and Cultural Program Leader)
Justin Bellanger (Operations Manager)
Melanie Morcombe (Biodiversity Project Officer)
Dylan Gleave (Coastal, Water and Marine program leader)
Julian Neville (Assistant to Climate Change Project Officer)

Biodiversity Prioritisation – Biodiversity Working Group

DPAW Meeting 1 June 5th
Deon Utber (DPAW)
Sara Comer (DPAW)
Sarah Barrett (DPAW)

Biodiversity and Biosequestration workshop 1, June 11th
Kaylene Parker (SCNRM)
Julian Neville (SCNRM)
Penni Hewett (SCNRM)
Justin Bellanger (SCNRM)
Karl Hansom (SCNRM)
Karen Ireland (SCNRM)
Melanie Morcombe (SCNRM)
Louise Duxbury (Green Skills)
Keith Bradby (Gondwana Link)
Amanda Keesing (Gondwana Link)
Nathan McQuiod (Gondwana Link)
Sue Eber (WWF)
Ben Ford (CENRM)
Dawn Pedro (Shire of Denmark)
Klaus Braun (Friends of Porongorups)
Angela Sanders (Bush Heritage Australia)
Geraldine Janicke (consultant)
Alexandra Tucker (City of Albany)
Dylan Gloebe (SCNRM)
Chris Gunby (ex DoW, consultant)
Neil Lantzke (PRNRM)
Laura Bird (CIAC)
David Ford (CIAC)
Simon Elias (CIAC)
Melanie Price (Aurora Environmental)

Biodiversity and Biosequestration workshop 2, July 9th
Kaylene Parker (SCNRM)
Julian Neville (SCNRM)
Penni Hewett (SCNRM)

Justin Bellanger (SCNRM)
Karl Hansom (SCNRM)
Karen Ireland (SCNRM)
Melanie Morcombe (SCNRM)
Amanda Keesing (Gondwana Link)
Sue Eber (WWF)
Barb Cook (CENRM)
Chris Gunby (ex DoW, consultant)

DPAW Meeting 2 July 28th
Deon Utber (DPAW)
Sara Comer (DPAW)
Sarah Barrett (DPAW)

Land Working Group (Plantations)

Land workshop 1, June 18th
Kaylene Parker (SCNRM)
Julian Neville (SCNRM)
Penni Hewett (SCNRM)
Alan Hordacre (Tree Grower)
Gavin Ellis (Plantation industry)
John Blake (Ex DAFWA, consultant)
Julian Fry (ex DAFWA, CENRM, consultant)
Justin Bellanger (SCNRM)
Karl Hansom (SCNRM)

Land workshop 2, July 15th
Kaylene Parker (SCNRM)
Julian Neville (SCNRM)
Penni Hewett (SCNRM)
Alan Hordacre (Tree Grower)
Gavin Ellis (Plantation industry)
John Blake (Ex DAFWA, consultant)
Julian Fry (ex DAFWA, CENRM, consultant)

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water

land

coastal and marine

cultural heritage

biodiversity

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