Hunter & Central Coast
Regional Environmental
Management Strategy

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Application of Interim Biodiversity Data

Hunter & Central Coast
Regional Environmental
Management Strategy

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Abbreviations

ABBREVIATION	DESCRIPTION
ALA	Atlas of Living Australia
AUC	Area Under (the Receiver Operator) Curve
DPE	NSW Department of Planning and Environment
EEC	Endangered Ecological Community
GHVM	Greater Hunter Vegetation Mapping
HCCREMS	Hunter Central Coast Regional Environmental Management Strategy
HCED	Hunter Councils Environment Division
IUCN	International Union for the Conservation of Nature
LLS	Local Land Services
LMCC	Lake Macquarie City Council
MNES	Matters of Environmental Significance
NERP	National Environmental Research Program
OEH	NSW Office of Environment and Heritage
SDM	Species Distribution Model

Executive summary

This report is designed to guide use of the interim biodiversity data products from the Hunter, Central Coast Regional Environmental Management Strategy (HCCREMS) biodiversity program. The data covers the Central Coast, Hunter and Lower North Coast of NSW.

The interim biodiversity data has been produced through two independent studies conducted by the Landscapes and Policy Research Hub and the Environmental Decisions Hub of the National Environmental Research Program in collaboration with the HCCREMS team.

The Interim Biodiversity Data represents two substantial datasets that advance the regional understanding of important habitat patches and key links for multiple species. The connectivity assessment considers general movement requirements for species that use woody vegetation cover (structural connectivity) for dispersal. The Species Distribution Models (SDMs) predict habitat suitability for 621 flora and fauna species extrapolated from correlation between known occurrences and 18 input environmental variables. The combination of these two datasets provides a broad overview of:

1. Spatial distribution of general woody habitat patches greater than 10 ha, as defined by the connectivity assessment
2. Regional least cost links (indicative locations), fragmentation and barriers (component boundaries)
3. A relative measure of likely habitat suitability for 621 species including 151 threatened species (with over 20 records); and 21 Endangered Ecological Communities (EECs)

The interim data sets are part of a long term investment in key, region-wide conservation data sets that may be used by all stakeholders to improve biodiversity management outcomes. The common goal is to identify regionally significant biodiversity areas for long term conservation. The SDMs and connectivity analysis provide key inputs to knowledge of regional biodiversity hotpots.

This report outlines numerous regional scale and local scale applications for the species distribution models and connectivity analysis. The report explores design considerations for future regional conservation assessments building on the new regional datasets.

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1. Introduction

1.1. Objectives

The HCCREMS program has commissioned this report to inform applications of the interim biodiversity data products arising from two independent studies conducted by the Landscapes and Policy Research Hub and the Environmental Decisions Hub of the National Environmental Research Program. The interim biodiversity data are assessed and reported in reference to the following initiatives:

1. Hunter, Central and Lower North Coast Landscape Connectivity Assessment (Lechner and Lefroy 2015)
2. Identifying conservation priorities and assessing impacts and trade-offs of potential future development in the Lower Hunter Valley in NSW (Kujala et al 2015)

Note that the second report refers to the Lower Hunter application of Zonation. Kujala et al applied similar methods to the Hunter, Central and Lower North Coast region and completed a biodiversity prioritisation using Zonation software based on the species and community modelling purpose built for HCCREMS. At the time of this report, the Hunter, Central and Lower North Coast Conservation Priorities Report was not available. Therefore the methods documented in the Lower Hunter report have informed this review and minor differences may exist between the two Zonation applications.

The purpose of this project is to report on the:

- Potential contribution of the above studies in understanding biodiversity values and identifying regional conservation priorities
- Appropriate use and application of this work for local government in the region
- Limitations to the use and application of the products
- Optimal presentation of the data from the 2 reports to Councils

This project has been informed by other technical reports provided by the HCCREMS program in addition to discussion with report authors, a stakeholder workshop on Biodiversity Planning in Lake Macquarie Council (12th March 2015, Argenton), and HCCREMS staff working with the spatial products associated with these 2 studies.

1.2. HCCREMS biodiversity program

The HCCREMS initiative runs a long term, strategic biodiversity program to assist member Councils with biodiversity management and conservation in local areas and through region-wide collaborations. The HCCREMS program invests in collecting high quality, region-wide data to address key information gaps, conservation assessments, policy tool evaluations and pilot studies in support of practical on-ground implementation. The objective of the program is to support local government in achieving strategic, integrated biodiversity management both at local scale and regionally and in collaboration with stakeholders.

Over the last few years the HCCREMS biodiversity program has been focussed on developing data in support of a biodiversity conservation assessment & prioritisation across the whole HCCREMS region.

The goal is to produce a regional biodiversity conservation strategy for local government implementation. This has required investment in the development of region wide vegetation map. An independent review *Hunter, Dr J.T.* (2015) of the Greater Hunter Vegetation Map (GHVM) found serious errors and therefore this dataset cannot be included in the regional prioritisation until these inaccuracies are addressed. The program has refocussed to assemble as much additional data as possible through the Biodiversity Investment Prospectus project and produced a range of interim products that will be of use to Council in the meantime.

Two of these interim products are the result of collaborations between HCED and two National Environmental Research Program (NERP) hubs to identify ecological connectivity and regional conservation priorities. The results of these two studies are the subject of this report.

The following sections provide an overview of the methods and outcomes of each study. Readers are referred to the full technical reports for more detail. The purpose of this summary is to highlight the implications for end users and to aid understanding through an alternative 'non-technical' explanation.

Further information on the HCCREMS Biodiversity Program is available from http://hccrems.com.au/Programs/Biodiversity/Biodiversity-Program-Overview.aspx

1.2.1. CONNECTIVITY ASSESSMENT

The University of Tasmania Landscapes and Policy Hub of NERP was engaged to map ecological connectivity across the Hunter region using the GAP CLoSR framework (Lechner and Lefroy 2014). This follows similar application of GAP CLoSR for the Lower Hunter Strategic Assessment. Readers are referred to the technical report for a full explanation of methods, results and discussion. The project is summarised here to inform conservation and planning applications.

Key reference
Lechner A, Lefroy E.. (2015) *Hunter, Central and Lower North Coast Connectivity Assessment.* A report by the Landscapes and Policy NERP Hub. University of Tasmania May 2015

The connectivity assessment was designed to provide a strategic, broad-scale overview to guide regional planning. Connectivity between habitat patches provides vital movement pathways that allow for the movement of species to access food, shelter and mates. Connectivity is particularly important during the response to or recovery from extreme events such as floods or bushfires. The amount of connectivity in a landscape (referred to as 'intactness') influences the resilience of species or conversely, the vulnerability of species to changes in environmental conditions and habitat extent. The focus of this study is to identify important regional links that facilitate movement for multiple species that require priority conservation or investments to restore landscape connections.

Connectivity was modelled on native woody vegetation (as distinct from non woody native vegetation) and therefore characterises connectivity for species that use woody vegetation for dispersal. Pathways may comprise continuous cover or stepping stones between habitat patches and are regarded as movement corridors not residential habitats. A key term here is 'structural connectivity' which, in this project, means mainly woody vegetation cover, not necessarily native. It is recognised that some species also use grasslands, waterways, rocks and caves for dispersal. The links identified will suit a wide range of species and the connectivity assessment provides a general regional overview to which additional links can be added for specialist species and habitats.

GAP CLoSR identifies a single least cost pathway between patches with consideration of the connectivity network (Foltete et al. 2012) and total connectivity (McRae et al. 2008). 'Least cost' refers to the biological cost (benign to hostile) for species to use the connection. The biological cost is factored into landscape

resistance in the modelling that also considers the fragmentation of the neighbouring landscape.

Patches are simply defined as remnant woody vegetation greater than 10 ha (Lechner and Lefroy 2014) that are "likely to be suitable for the majority of faunal native species in the region and plant species that depend on these fauna for dispersal" (Lechner and Lefroy 2015). As habitat patches were derived from canopy coverage, habitat is underestimated in areas of open woodlands and grasslands. The satellite imagery also omitted some areas of vegetated wetlands due to issues in image processing caused by the reflective properties of wetlands.

A generalised dispersal threshold has been applied rather than species specific thresholds for gap distance metrics. This approach follows prior research (Doerr and Doerr 2005; Doerr et al. 2010) that reviewed the fine scale dispersal behaviour of multiple Australian native species and synthesised the scientific evidence to ascertain a generalized gap-crossing distance threshold and inter-patch crossing distance threshold (Doerr and Doerr 2005; Doerr et al. 2010; Lechner and Lefroy 2015; Lechner and Lefroy 2014). This research finds that the generalised gap metrics met the requirements of the majority of species reviewed and provides a sound basis to guide regional scale connectivity assessments.

Patches are identified as connected based on the distance between patches (<106m), the inter-patch crossing distance threshold (<1.1km), the resistance of the landcover (calculated as 50m grid cell size) and the presence of structural connectivity at the gap-crossing distance threshold (Lechner and Lefroy 2015; Lechner and Lefroy 2014). The Hunter, Central and Lower North Coast GAPCLoSR assessment used woody vegetation canopy coverage mapping derived from 2.5 m SPOT satellite imagery.

The assessment maps critical ecological connections, habitat patches critical for regional connectivity, and characterises landscape connectivity or patch isolation. This may inform impact assessment of potential development, conservation and restoration projects (Lechner and Lefroy 2015). There are many different metrics and maps available from the GAPCLoSR assessment of the Greater Hunter. Table 1 paraphrases several key outputs for simplicity.

The mathematical descriptions provided in the Greater Hunter Connectivity Assessment are useful for comparing links and general landscape connectivity, however for most natural resource managers they represent a new language (graph network terms) and require simplified translation to understand and apply. Figure 1 shows key findings of the connectivity assessment. The two largest components are labelled A and B, whilst the smaller components are unlabelled. This map shows regional patterns of fragmentation that had led to isolated woody vegetation patches. The full connectivity assessment results are presented in a series of more detailed maps that consider uniqueness, fragmentation and local patch links.

Table 1. Key terms used in GAPCLoSR

ATTRIBUTE	DEFINITION
Node (also referred to as patch or element)	Refers to the woody vegetation patch, also referred to as an element. The node is the point of connection. The "node degree" indicates the number of links associated with a patch
Component	Refers to the landscape context. Areas where patches are connected to each other, but isolated from other patches, are known as components. The "number of components" indicates the level of isolation across the landscape.
Link	The link between two nodes is the least cost pathway. Links are described within a graph (mathematical description of pairwise relations between nodes).
Patch scale graph metrics	These are measurements describe the local landscape matrix within which nodes and links occur. Include 'betweenness centrality', 'node flux', 'clustering coefficient', 'closeness coefficient', 'closeness centrality', 'connectivity correlation', 'node degree', 'eccentricity', 'integral index of connectivity', 'graph diameter' and 'harary index'.
Landscape scale graph metrics (Landscape is also referred to as Network)	These collectively describe the landscape matrix surrounding patches. Reported as 'mean size of components', 'size of largest component', and 'number of components'.

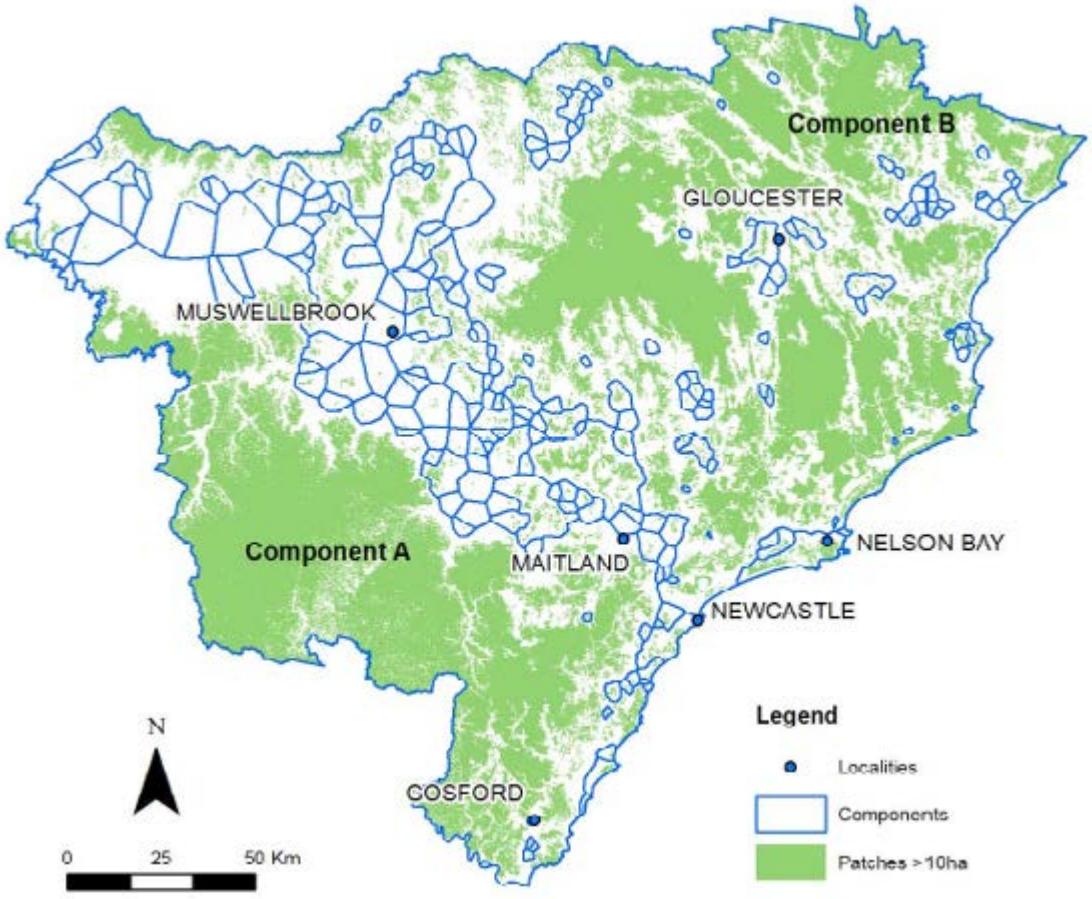

Figure 1. Hunter, Central and Lower North Coast Connectivity Assessment showing fragmented areas. Component boundaries show unconnected, isolated patches (source Figure 7 Lechner & Lefroy 2015)

1.2.2. SPECIES DISTRIBUTION MODELS

The University of Melbourne Environmental Decisions NERP Hub was engaged to model the distribution of flora and fauna species and endangered ecological communities (EECs) across the Hunter Central & Lower North Coast regions to inform the regional biodiversity prioritisation. The species distribution modelling follows on from a separate contract as part of the Lower Hunter Strategic Assessment. Readers are referred to the full technical report for more a full explanation of methods, results and discussion. The project is summarised here to inform conservation and planning applications.

Key references

Kujala H, Whitehead A, Wintle B. (2015a). *Excerpt from a report on the biodiversity prioritisation analysis: modelling species and threatened ecological plant communities in the Hunter, Central & Lower North Coast Region of New South Wales.* A report by the NERP Environmental Decisions Hub. The University of Melbourne.

Kujala H, Whitehead A, Wintle B. (2015b). *Biodiversity Analysis in the Hunter, Central & Lower North Coast Region of NSW. Report In prep.* Environmental Decisions Research Hub, the University of Melbourne, Victoria.

The sub project was designed to collate all occurrence data for flora, fauna, including Matters of Environmental Significance (MNES), known occurrence data for listed communities, and threatened species.

The occurrence data were sourced from NSW BioNet, the Atlas of Living Australia (ALA), and direct contributions from the NSW Office of Environment and Heritage (OEH) and local botanists. The records were filtered for spatial accuracy, currency and duplicates within the 100m grid cell. Only species with more than 20 records (after filters were applied) were modelled to map predicted habitat distribution using MaxENT software. The models predict species distribution by interrogating the occurrence records against a standard suite of spatial environmental variables. In this application MaxENT has been used to systematically interrogate and identify statistical correlation between the species and each environmental variable. In this way the approach has sought to avoid pre-empting the drivers that dictate species distribution. The model extrapolates from the statistical correlations with environmental variables to map the full distribution of the combined overlap of environmental variables. The output is a prediction of the relative likely distribution of that species, which was then subject to expert ecologist review and modified where possible and required. The result of this process was 621 Species Distribution Models (SDMs) including 151 threatened species. Whilst specialised treatments were applied to reduce the influence of sampling bias inherent in the occurrence records, it is important to understand the geographical spread of occurrence data and extrapolations for individual species when applying the SDMs to decision making. The authors recommend field validation to support environmental decisions applying the SDMs.

In addition to the species models built individually using MaxENT modelling software for flora and fauna species, the distribution of 21 EECs was modelled using boosted regression tree analysis. The models fit interactions of presence and pseudo-absence data to environmental variables to predict the probability of EEC distribution across the whole study area. The term pseudo-absence here refers to the unique presence of an EEC which, by definition, precludes the presence of another EEC at the same location. It is not true absence data in the sense that the region has been systematically surveyed to determine all locations and absences of EECs.

The results of the models were tested for robustness and this is reported fully in the technical documentation. Outputs from this sub project are available as individual SDMs, with associated statistics and summarised by taxonomic group. Figure 2 shows the species richness across the study area predicted

as a relative probability by the SDMs and the geographic areas of relative predictive uncertainty. Authors report that the models show that seasonal rainfall, slope and local vegetation were important drivers for all taxonomic groups (Kujala et al. 2015). Individual species models are accompanied by the relative importance of each environmental variable so that end users may understand what is driving the predicted relative likelihood of habitat distribution.

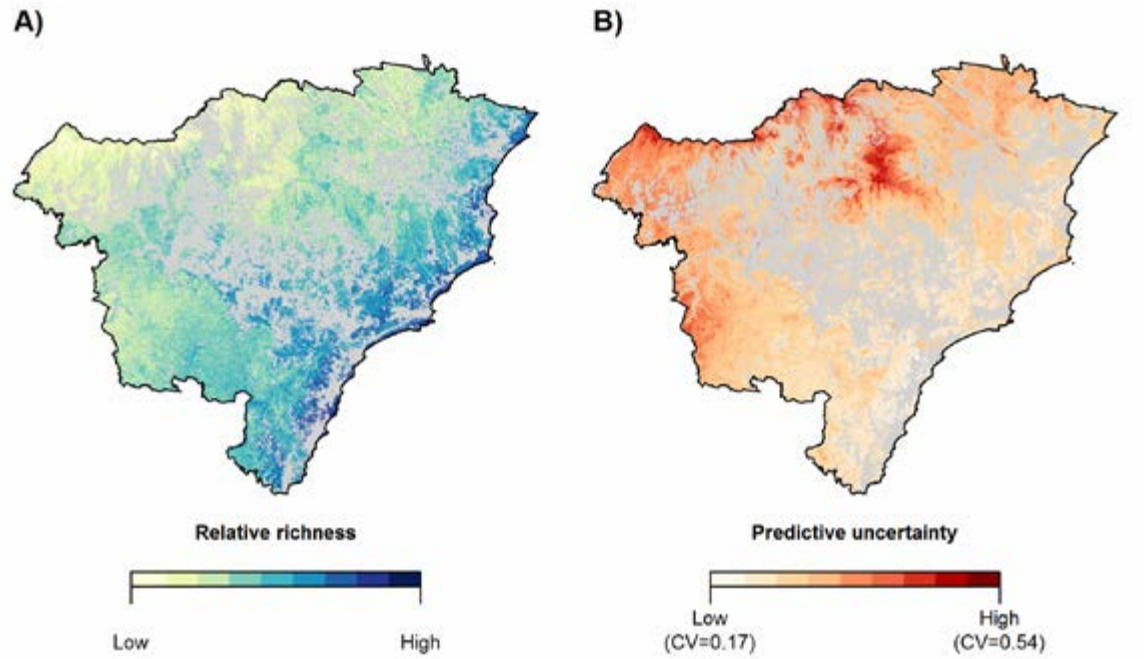

Figure 2. Spatial distribution patterns of relative species/ EECs richness (A) and mean predictive uncertainty across the region. From Figure 3 Kujala et al (2015).

A) Relative richness of species and EECs included in Kujala et al 2015, calculated by summing the outputs of the distribution models retained for inclusion in the spatial prioritisation.

B) Mean predictive uncertainty across modelled species distributions. These data were calculated by quantifying the coefficient of variation for each species' MaxEnt predictions based on five-fold cross validation and then averaging across all species (see Figure 3 Kujala et al 2015).

1.2.3. CONSERVATION PRIORITISATION IN ZONATION

The regional conservation prioritisation followed on from the species distribution modelling to identify priority areas for conservation in the study area. The Environmental Decisions Hub of NERP used the SDMs to inform a regional biodiversity prioritisation developed in Zonation software. Readers are referred to the full technical report for more a full explanation of methods, results and discussion. The project is summarised here to inform conservation and planning applications.

Key reference

Heini Kujala, Amy Whitehead and Brendan Wintle. University of Melbourne. (2014). *Identifying conservation priorities and assessing impacts and trade-offs of potential future development in the Lower Hunter Valley in New South Wales.* A report by the NERP Environmental Decisions Hub.

The prioritisation was assessed using Zonation v4.0 software (Moilanen et al. 2012, 2015 in Kujala et al. 2014). Zonation is a spatial modelling tool that calculates the relative contribution and uniqueness of each cell with respect to the biodiversity input data. The algorithm ranks all sites by removing the sites that cause the most marginal loss in conservation value and iteratively recalculating the relative value of remaining cells across all features. In this application all of the SDMs were used as inputs (normalised value 0-1). In addition, point data were included for those threatened flora and fauna species that had less than 20 points (and therefore were not modelled).

The spatial analysis identifies the best 30% of the landscape based on the modelled footprint of relative likelihood of 621 species distribution maps. This selection of grid cells represents the most comprehensive areas of biodiversity values (defined as SDMs of threatened flora and fauna species). This application assumes that an area has relatively good habitat quality if it is represented as likely habitat for multiple species as shown in the SDMs.

The authors recommend developing further prioritisation scenarios with the results of the connectivity assessment. The technical report for the regional prioritisation outlines issues to consider when interpreting the results. These are summarised as follows:

- Areas are selected based on their predicted (modelled) habitat qualities. Field validation is recommended to inform specific decisions.
- Model quality is intrinsically linked to the quality of the input data. Users should consider the geographic coverage (completeness), currency and resolution of input data.
- The results provide a regional scale overview to aide in prioritising investments across the region. There will be additional local priorities and important biodiversity assets that are not identified at this scale.
- The development scenario assumes that zero biodiversity values persist in areas zoned for more intense land use. This will vary on ground depending on the nature of development and subject to the development approvals process. Therefore this assumption is conservative and intended to flag the broad vulnerabilities of the threatened flora and fauna in the region for conservation planning purposes.
- Authors recommend further analysis of patch dynamics and landscape intactness to ascertain population viability within areas selected for conservation.

OUTPUTS

The results of the connectivity assessment, species distribution modelling, EEC modelling and the prioritisation scenario have been received by HCCREMS as spatial files.

1.3. Key terms and definitions to assist data interpretation

Understanding the development process used to derive the regional interim biodiversity data is important to ensuring accurate applications of such data. In particular, it is important that users appreciate the maps are based on predictive models that are designed for regional planning processes rather than local assessments. These models are constrained by the quality of input data and the assumptions embedded in the modelling process.

It is also valuable to explain key terms commonly used in mapping to assist end users in correctly understanding data uncertainties and risks that arise from decisions based on these inputs. There are inherent uncertainties in all forms of mapping. This should not deter users, instead it should highlight the importance of ensuring the data are used in a manner that is "fit for purpose", with explicit understanding of data limitations. The precautionary principle requires conservation managers to proceed with the best

available information. Planners can apply the regional datasets to inform a strategic land use decision and support implementation of that land use with a procedural pathway to verify the predicted values at site scale.

1.3.1. SCALE, RESOLUTION AND ACCURACY

Conservation decisions often require use of data at multiple scales. Whilst 'scale' is a commonly used term it is important to understand the implications of scale especially when data are used in a geographic information system (GIS) in a 'scale-less' manner. Scale refers to the relationship of a mapped feature to its actual size in reality. Features have to be reduced in order to depict them on paper or screen. The scale is the ratio of the amount of reduction required to show the representation on the map (Morais 2001). Therefore the bigger the number, the more times it has been reduced to fit into the map, and the 'smaller' its scale. Whilst paper maps are not used as frequently as they once were, scale is still referred to as an indicator of the level of detail.

For environmental layers scale is determined by the scale of input data including the intensity of survey effort or density of sampling points (Siversten 2009). The Interim Biodiversity Datasets are predictive surfaces extrapolated from known sampling points and broad maps of environmental variables. The type, source and scale of input layers is therefore critical to the output scale. For the connectivity analysis the cost grid was resampled to a 50m grid cell (pixel) size (mean value) and therefore the output can only show or differentiate features in 50m lengths or widths. This may affect narrow linear links or riparian features and the end map will appear blocky when observed at a large scale. The end user must take the outlined link (or barrier) as indicative of location. For the species distribution models, the grid cell size is 100m and input variables have been resampled to this consistent grid resolution.

Occasionally confusion may arise from the terms 'smaller' versus 'larger' scale maps. The smaller the number on the right hand side of the ratio, the larger the map scale. Large scale maps show a greater amount of detail of a smaller area (e.g. 1:1,000). Small scale maps show less detail over a larger area (e.g. 1:100,000).

Resolution refers to the detail that the map depicts (ESRI 2014). The resolution of data is the smallest space between two features (ESRI 2014) expressed in pixel size, dots per inch. The resolution of data is determined by the size of the feature, the scale of representation and input data layers (where applicable). Regardless of the scale at which the map is viewed, the quality of input data determines the resolution and accuracy of the map (DPI 2012; Siversten 2009). It is worth considering the resolution and the natural variation in the 18 input environmental variables. For example, climate data (extracted from ANUCLIM based on a 9 second Digital Elevation Model) would not be expected to vary as much in sub regions as soil and topography.

Accuracy refers to the position (trueness to the location of the feature in the real world) and the attribution (whether the feature is described correctly). The locational accuracy of real world features is scale dependent, but the level of attribute detail may be dependent upon the method of data capture (Siverstsen 2009). The SDMs are reliant on the existing records for threatened species and communities. This first assumes correct identification of the species/community. The occurrence data are known to be biased towards populated locations (near the observers) and geographically clustered (i.e. not systematic across the whole region) as a result of the data collection processes. The SDM process has applied filters to avoid as many inaccuracies as possible and has applied statistical treatments to reduce the influence of bias but these steps may not completely overcome the lack of knowledge in some areas (e.g. north western portions of the study area). This is why the authors have included Figure 2. Therefore it is important to check the geographic reliability map as well as the SDMs to obtain a visual understanding of the variable confidence in the models. The reliance on existing data is an accepted compromise in order to complete region -wide analysis of biodiversity priorities. The process also legitimately highlights areas of knowledge gaps. It is important to appreciate the limitations of SDMs when applying them individually or comparing to local

scale data.

As modelled data, the accuracy of the Interim Biodiversity Data reflects how well the models predict the distribution of features. This is referred to as model fit. The 'Area under the Curve' is a statistical measure of how well models discriminate species distribution (Jimenez-Valverde 2012). Kujala et al. (2015) assessed the SDM performance and discarded models where AUC was below threshold 0.7. The spatial uncertainties within the SDMs were checked by running five iterations with different random portions of the input occurrence data. By comparing the outcomes (fivefold cross validation) the team investigated the influence and confidence intervals of different inputs. A further test of model fit would involve collection and comparison of a new set of point data to the SDM.

Aerial photos or other imagery is frequently used in GIS as contextual biodiversity data to guide interpretation by end users. Aerial photos are often more detailed than map data (polygon or grid) and may be more current. There is a general tendency to overlook the differences of the sources when viewing within GIS and over interpret the mapped data as a result.

1.3.2. WHY USE GRIDS AT ALL?

Grid layers or raster surfaces are particularly useful for representing data in GIS as defined on a continuum, so one grid cell can show the relative value on a continuous scale. Grid data are also useful within modelling applications due to the computational framework of model programming. The alternative GIS types are vector files - polygons, line, or point files. Polygons refer to the 3-dimensional area within a boundary line, lines depict 2-dimensional linear features (e.g. powerlines) and point files simply depict the 1-dimensional geographic coordinates of a feature (e.g. fauna location record).

Selecting the grid cell (pixel) size within a grid or raster layer is typically informed by the scale of the assessment, the scale of input data, practical considerations of computing power and display requirements, and most importantly the scale of relevant landscape features or species (McRae et al. 2008). The grid cell size also needs to consider the factors influencing the relevant landscape feature, for example the scale of barriers impacting corridors, or proximity to water sources. One cell typically contains one value (the most probable).

In the case of the SDMs the grid cell size is 100m, so the location of features can only be represented within 100m blocks (Kujala et al. 2015). For the connectivity assessment this is dictated by the underlying vegetation map derived from Spot5 and resampled to 50m grid cell size. A grid cell size of 100m translates to approximate scale equivalence of 1:25,000 (Siversten 2009). In addition, within any grid cell, multiple environmental variables may be present. Therefore a rule set or definition is provided so that end users understand whether the variable represented in the map is the majority (most frequent), mean, range, minimum, and/or maximum value. In the case of the SDMs the grid presents the probability of suitability for the species, where suitability is defined by the statistical relationship pattern between occurrence data and the suit of input environmental variables.

2. Regional scale applications

2.1. Introduction

With the Interim Biodiversity Data, HCCREMS now have access to two substantial datasets that advance the regional understanding of important habitat patches and key links for multiple species. The connectivity assessment considers general movement requirements for species that use woody vegetation cover (structural connectivity) for dispersal. The SDMs predict habitat suitability for 621 flora and fauna species extrapolated from correlation between known occurrences and 18 input environmental variables. The combination of these two datasets provides a broad overview of:

1. Spatial distribution of general woody habitat patches greater than 10 ha, as defined by the connectivity assessment;
2. Regional least cost links (indicative locations), fragmentation and barriers (component boundaries);
3. A relative measure of likely habitat suitability for 621 species including 151 threatened species (with over 20 records); and 21 EECs;

In addition to the SDMs and connectivity assessment, the Interim Biodiversity Data also includes a third informative data layer in the first regional prioritisation based on the SDMs developed in Zonation. The regional prioritisation identifies the top contributing probable habitat areas for the maximum number of the 642 species/EECs (without selecting or weighting any particular species). This prioritisation is regarded as an initial analysis and has not been treated as a release product in this report. It may be used to guide the design of future analyses.

The dataset contains multiple files, providing a large scope and thus a powerful tool to support NRM applications when used in a 'fit for purpose' manner. However the size and complexity of the spatial information also makes it challenging to work within an appropriate context. This report has reiterated and summarised the key modelling inputs, process and limitations to emphasize how the regional datasets predict biodiversity values.

2.2. Identifying regional biodiversity priorities

In order to develop a comprehensive understanding of key regional biodiversity priorities it is necessary to take a staged, systematic approach similar to the scheme shown in Figure 3. All conservation approaches must rationalise how to represent biodiversity and manage data constraints. In the scope and design of data capture, HCED has been guided by an expert technical reference group and their advice has led directly to the interim outputs discussed in this report.

The interim data sets are part of a long term investment in key, region-wide conservation data sets that may be used by all stakeholders to improve biodiversity management outcomes. The common goal is to identify regionally significant biodiversity areas for long term conservation. The SDMs and connectivity analysis provide key inputs to knowledge of regional biodiversity hotpots.

Several steps now need to be revisited to define the overarching objectives held by stakeholders for long term, biodiversity conservation in the Central Coast, Hunter and Lower North Coast. This will guide the analysis pathway and provide measurable performance targets along the way.

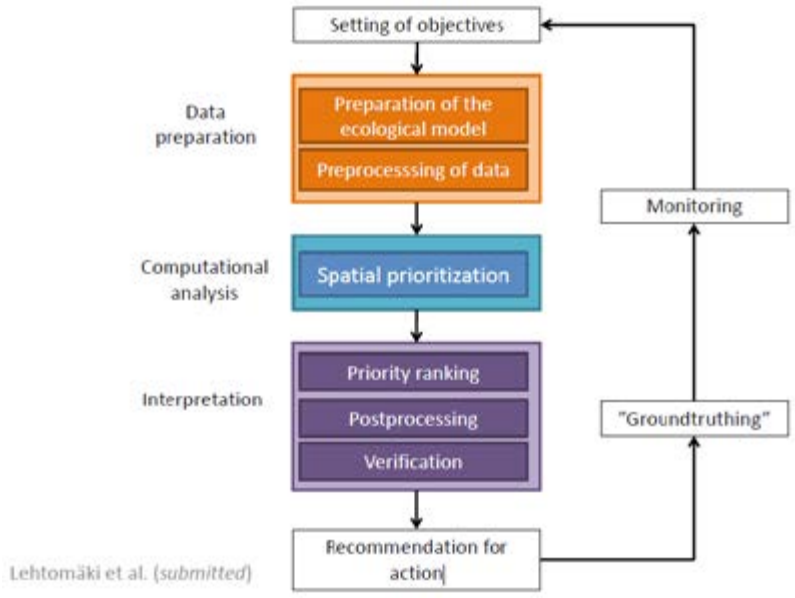

Figure 3. Steps in the development of a regional conservation prioritisation (source Lehtomaki 2012)

Key questions for HCCREMS are;

- 'how to select a subset of species to drive future prioritisation?' and
- 'what other data are required to supplement existing data to improve the conservation prioritisation?'

These questions will help define the ecological model (step 2 from Figure 3) and inform selection of input variables schematically represented in Figure 4. The types of spatial data commonly used to assess significance include habitat diversity which refers to the variety and extent of habitat types, often represented by vegetation type, vegetation extent (and percent cleared), habitat value indicated by number of species supported, patch size and structural integrity, habitat linkages and conversely isolation also referred to as landscape intactness, unique environments such as riparian features, wetlands and other unique values or special features (e.g. important coastal foreshore refugia, caves and cliff lines). Additionally some biodiversity assessments consider condition data such as presence of exotic species (weeds, feral animals), and/or distance to infrastructure, to help differentiate quality of patches and threat data such as vulnerability and exposure to projected climate changes, and/or gazetted development potential defined in environmental planning instruments, to help prioritise timeframes for conservation actions.

The use of conservation prioritisation software tools e.g. Zonation is intended to identify the most efficient spatial configuration to contribute towards protecting the range of biodiversity values input (Kujala et al 2015, Lehtomaki 2012).

The regional biodiversity prioritisation output from Zonation represents a 'first cut' scenario. So far the regional prioritisation has been run on all species (with > 20 records post filtering), and with 21 EECs. The species have not been weighted and the only selection criteria applied was sufficient, reliable occurrence data.

The HCCREMS Biodiversity Program intend that further prioritisation scenarios be developed in Zonation, particularly to jointly consider threatened species, communities and connectivity across the study area.

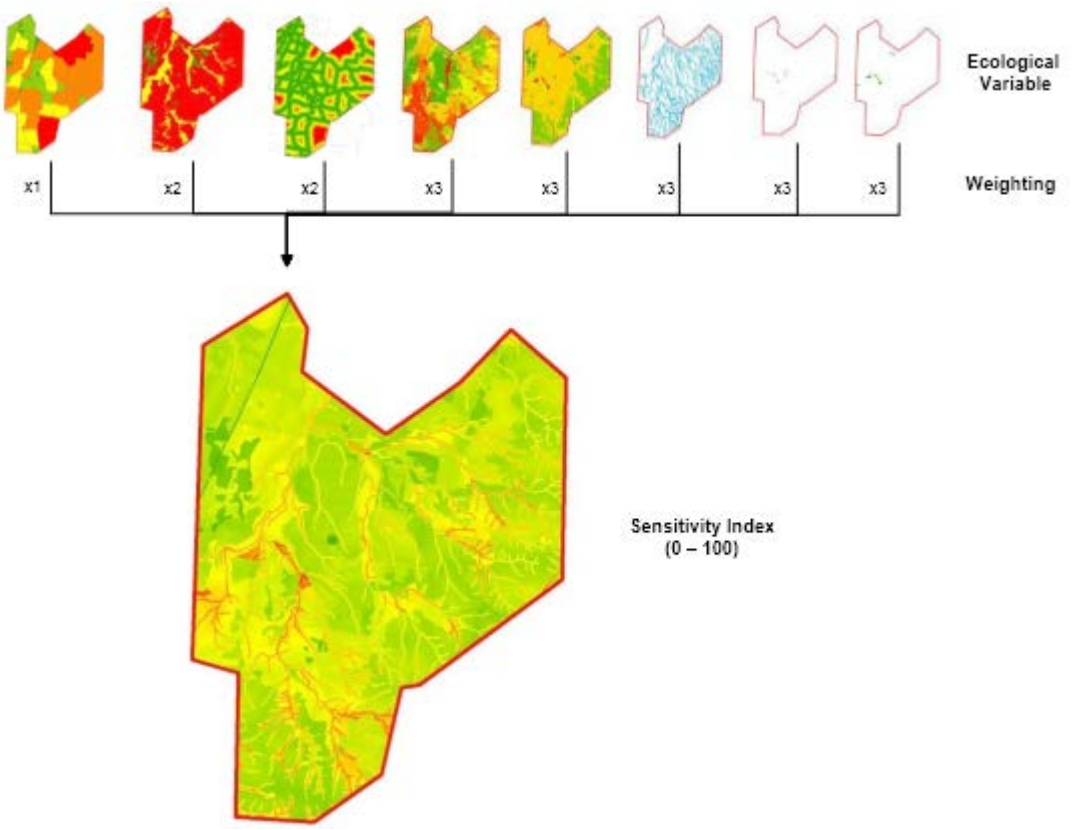

Figure 4. Schematic representation of multi criteria analysis for conservation planning

It is recommended that the HCCREMS team work in consultation with stakeholders to identify a subset of species distribution models to achieve a balanced, regional prioritisation. The rationale for working with a subset of species, rather than the total 621 models, is to address biases towards some taxa that are inherent within the occurrence data. The effect of these biases appears to select areas for conservation that are more suited to limited taxa, rather than to identify priority sites suitable for a broad range of biodiversity features.

The criteria for selecting a subset of species should be set in consultation with stakeholders and may consider the following;

- Statutory listing (NSW and Federal) – as a key driver of conservation and are obligatory considerations
- Local relevance – e.g. those species frequently addressed in land use conflicts, or species frequently overlooked due to data paucity but important to local ecology
- Species iconic to the community – e.g. species actively managed by Council
- Species at the boundary of their natural range

This process should also have an overarching filter to ensure that the end suite of species selected occupy exclusive habitat space so that there is representation of each environmental space and no unintended bias towards certain environments. It is further necessary to consider the strength of models for the species selected for inclusion into a prioritisation analysis. It may be that a similar species is representative of the same habitat requirements and have greater robustness in the SDM in which case consider using the

stronger SDM as a proxy for the other species needs.

It is recommended that the selected SDMs are pre-processed into a composite, and potentially weighted, input to Zonation (or similar software). This would create a species heat map. Weightings may be increased according to IUCN (International Union for the Conservation of Nature) categories of threat and down weighted according to model reliability if there is considerable variety across inputs. The effect of this in Zonation will be to pull out areas that service multiple species, address statutory conservation requirements and for which we have greater confidence. The weightings suggested may be separately engaged, or not as required.

Alternative criteria for selecting a subset of SDMs are:

A. Establish a proportional sampling regime of SDMs based on MaxENT habitat types. The study area is divided into unique combinations of environmental variables (sampling units also referred to as strata) and the relative proportion (area) of each stratum within the study area is calculated. Each SDM is assigned to an environmental sampling unit. A proportional sampling rule set is agreed and documented that assigns a greater number of samples (SDMs) to those strata covering a wider area and a smaller number of samples to those strata more restricted in geographic extent. The rationale is that larger areas need to be sampled more frequently to characterise any variations (heterogeneity) within. This follows a systematic sampling regime developed for broad vegetation mapping (Siversten 2009). It is noted that not all strata will have SDMs to sample them.

B. An alternative proportional sampling regime may be applied to the fauna taxonomic groups where consideration is given to the number of threatened species listed in each genera, and accordingly SDMs would be sampled proportionally. Note this approach accepts the current listings that inherently reflect the threatened species nomination process and is not 'representative' of species proportions.

C. Prioritisation with SDMs selected to represent the variety of positions in the landscape. This requires development of an expert derived sample rule set to partition the study area into units of similar topography and substrate (e.g. coastal alluvial flats, coastal foothills, etc.). SDMs are then selected in a similar manner to focal species where each SDM is considered by an expert ecologist (or group of ecologists) to be broadly representative of that particular environment. This focal species approach follows the rationale developed for the Port Stephens Biodiversity Corridor assessment (ELA 2012a).

D. Prioritisation with subset of SDMs selected with even representation amongst the threatened species across guilds. Guilds represent species groups with similar needs and may be defined in broad habitat types (similar to Option 2), nesting requirements, food requirements, foraging (feeding) habits and so on (MacHunter et al. 2009; MacNally et al. 2008).

A separate link layer will need to be developed from the GAPCLoSR metrics prior to conducting a combined prioritisation. The ecological model for selecting links should consider the link magnitude that is the size of patches at either end as well as the link integrity ranked on entity, length and width (ELA 2012b). Link integrity addresses what the link is crossing over, the length of link as biological cost increases up to redundancy of 1.1km and the width is indicative of the protection afforded by the link.

HCCREMS have prepared a node dataset based on two GAPCLoSR metrics that are most informative for planning applications;

- Delta Integral Index of Connectivity (dIIC) represents the value a patch contributes to the overall connectivity of the region.
- Betweenness Centrality (BC). High BC values show where patches are used by other patches to access habitat, and can be described as stepping stones.

Nodes with above mean values for the dIIC or BC are labelled with "Above mean dIIC values", "Above mean BC values", or "Above mean values for both BC & dIIC".

The node metrics may form an additional input to the composite link layer, or may be entered separately into Zonation.

A major limitation for the regional prioritisation is the lack of reliable, region-wide vegetation data. This is discussed further in the Future Data Investments section. The regional prioritisation may be delivered in phases as new data becomes available to improve regional projections.

Separate to the ecological framework, the next steps to developing a conservation plan will need to consider the thresholds for regional priorities. This refers to the definition of top contributing patches or links, definition of current conservation levels and conversely threat from different levels of development potential. The Lower Hunter Zonation analysis used 30% to define the top priorities. There is precedence for this threshold in native vegetation and threatened species management in NSW. Constraints analysis can also be weighted for 'permeability' in land use zones to account for the variable, and unknown, uptake of development potential.

2.3. Planning applications

Regional datasets are chiefly used to indicate values and it is appropriate to deliver regional scale decisions based on the current data with an accompanying recommended validation pathway. This will help iteratively manage the uncertainty associated with those datasets (Drielsma et al. 2014; Briggs 2006; Reinke and Jones undated). The SDM and connectivity modelling can be used singularly and in combination to inform regional scale planning and whole of LGA strategic planning.

The regional links map may be used immediately to support retention of key regional links. As a regional scale dataset, the links should be regarded as indicative of the preferred single least cost pathway generated by modelling. This means that the output maps are constrained by the region-wide input data. Given that the regional connectivity assessment has considered pathways broadly as structural, vegetated links, the actual location of the optimal pathway may require some minor alignments with reference to aerial photos.

The component map may be used to prevent further fragmentation of isolated components in conjunction with the patch metrics.

The SDMs identify habitat suitability, or candidate habitat across the region for the species studied. It is important to note the difference between (modelled) habitat suitability and confirmed habitat occupancy. The SDMs show areas with characteristics best suited to each species as determined by the statistical relationship between known locations and the environmental variables input to the models. The SDMs predict habitat value scaled relative to each model. The output maps show indicative habitat areas for each species. This information can be used to inform regional conservation planning and to highlight geographic locations for further research. Further research may be targeted to validate model predictions, particularly in habitat areas predicted outside the current, known recorded habitat areas.

Examples of regional scale applications include;

- identify conservation priorities for strategic planning through multiple channels including NSW Government planning, Local Government planning and non-government land use planning initiatives,
- flag species considerations for development proposals,
- inform the new regional plans under development by NSW Department of Planning and Environment,

- inform further analysis of strategic, regional, conservation priorities,
- identify strategic areas for conservation covenant such as biobanking
- contribute towards formal reserve planning (OEH function)

If the Regional Planning process by DPE does not incorporate the SDMs and connectivity assessment in mapping environmentally sensitive lands, the data may be used to inform independent analysis of the priority conservation areas identified in the draft regional plan during the public exhibition phase. In addition, NSW Department of Planning and Environment (DPE) recently informed this study that a separate regional environmental sensitivity analysis will be developed for the Lower Hunter as one input to the Hunter Development Corporation Integrated Infrastructure Planning Tool (IIP) (Mark Cameron, OEH pers comm).

2.4. Validation in support of planning applications

An important part of ongoing investment for the program will be the validation of the model predictions as shown in Figure 2 (Kujala et al. 2015; Lechner and Lefroy 2014; Lehtomaki 2012; Parris et al. 2011). Therefore it is recommended that decisions guided by the interim regional biodiversity data are supported by validation of the modelled values.

Validation options include desktop validation with reference to other spatial data and/or aerial photos, or via targeted or systematic field surveys. Field surveys may be designed as general fauna habitat assessments or targeted, seasonally appropriate, fauna surveys to confirm use by key species.

GAPCLoSR data requires expert interpretation to guide sensible ecological corridor configuration on the ground. It is likely that visual assessment of aerial photos will indicate alternative pathways for regional biodiversity links. If the alternative pathways do not incur a greater biological cost (more resistance for multiple species movement) then the corridor may be moved to the more sensible location. This will effectively update the regional connectivity layer and will need to be fed back to the regional data custodian for iterative updates.

Further work is required to assess the adequacy of the general habitat patches defined by presence of woody vegetation above 10 hectares. This may be assessed by a combination of desktop analysis and targeted field surveys. Desktop techniques include investigating the vegetation intactness, broad condition indicators and preliminary vegetation composition analysis (ELA 2012b; Drielsma et al. 2014).

2.5. Data sharing

Data delivery will require a stakeholder communication strategy and an adaptive management framework. The data are considered Interim and will be subject to updates over time. This needs to be understood by end users and considered in all applications. Strategic planning decisions are usually subject to statutory review periods. Downstream analyses based on the interim products can be designed to facilitate updates of single inputs as they become available.

An adaptive management framework requires a mechanism for collating and processing updates. As the Interim Regional Dataset layers are used and validated over time there is an opportunity to harvest these incremental improvements. This has always been challenging and resource intensive. With the advent of web platforms to serve spatial data and capture public comments, it is increasingly viable to consider investing in a web portal dedicated to serving and sharing regional biodiversity data amongst stakeholders. The framework will need a filter process to manage the variability in validation data received.

Local Government uses can be categorised into queries based on location or topic. It is recommended that data be accompanied by a master look up layer that integrates all of the SDMs as presence or absence of habitat per species per grid for easy reference. A digital look up table can also be used in regional flora and fauna survey guidelines to direct future ecological surveys.

To facilitate end user understanding of these complex products, a self-guided power-point package is recommended in addition to the technical reports and metadata to explain the general structure of the data to Local Government. This presentation should summarise the key methods and outcomes in plain English for a wide variety of audiences.

Council stakeholders reported some concerns and limitations using raster data formats in their own GIS systems and alongside polygon, vector and point data (ELA 2009). Consideration may be given to a webinar forum for education and practice exchange.

2.6. Future data investments

There are several key datasets that are recommended to improve regional biodiversity knowledge as follows:

New fauna surveys – An important consideration for the HCCREMS Regional Biodiversity Program is investing in targeted fauna surveys to verify habitat presence within top priority areas. Kujala et al. (2015) recommend verification of the predicted habitat values for each species modelled. The strength of the model fit can be improved with additional systematic fauna surveys (Kujala et al. 2015; Feely and Simmon 2011).

Vegetation mapping – The results of the SDMs highlighted the importance of vegetation type in predicted habitat suitability for the region's threatened flora and fauna. The accuracy of the GHVM is a limitation on the accuracy of model outputs for those species where vegetation type is important. The connectivity assessment deliberately avoided the GHVM and instead defined the presence of woody/non woody vegetation via Spot5 satellite imagery which resulted in the underestimation of habitat in open woodlands, grasslands, and some wetlands. Therefore improved vegetation mapping will also enhance the outputs of the connectivity assessment.

In future prioritisations, it is recommended to include vegetation community analysis.

Habitat quality – The interim biodiversity data was constrained by the available data and consequently information on the relative condition of patches is absent in its current form. The relative condition of patches can be used to differentiate between patches and is another indicator of habitat quality. The interim data cannot distinguish between candidate habitat areas that are theoretically suited to species needs or between predicted and occupied habitat areas. HCCREMS has plans to do desktop constraints analysis to inform future prioritisations. The constraints analysis will look at factors such as proximity to roads, land use and other indicators of disturbance.

There are two levels of habitat condition information. The desktop constraints analysis will provide an indicative regional scale perspective. Site scale condition is best informed by field reconnaissance. Unfortunately there is very little overlap between site condition indices and regional indices used to infer condition at a landscape scale. Therefore a condition accuracy rating is often applied to distinguish these types and give end users confidence in the reliability of the condition rating.

It is also noted that Kujala et al (2015) use the term 'habitat quality' differently to ecology practitioners. Kujala et al refer to relative 'quality' where an area meets multiple species requirements.

The capacity of habitat to support a species also points to population viability analysis as the next step to ensure that investments into protecting areas deliver on ground biodiversity gains (Kujala et al. 2015).

3. Local scale applications

3.1. Introduction

As regional datasets, the species distribution models and region wide connectivity analysis may be used to inform a wide range of local scale planning applications. Both datasets are best used as indicative of on-ground values and field validation is highly recommended for local scale decisions.

Local governments are likely to be the prime user of the regional data, however, the data is informative to other land managers and advisors including non-government groups, academics, consultants, and regional NRM bodies.

The interim biodiversity data may be used to inform a number of statutory and non-statutory Local Government responsibilities. The data may be used in Council's GIS in conjunction with other information to improve staff access to a broad range of species data and connectivity analysis that may not otherwise be available LGA wide or in consistent spatial format. Overlaying data provides powerful visual representation of ecological constraints and opportunities to inform a wide range of natural resource management decisions (ALGA & ANZLIC 2007). The data is a valuable reference in areas without existing local data, when used in conjunction with aerial photo interpretation and other validation sources.

3.2. Types of local government applications

The species distribution models and the connectivity assessment may be used independently or in combination as required. Table 2 shows examples of potential data applications across different Council functions. This list has been informed by Council consultation on stakeholder needs analysis for regional vegetation mapping (ELA 2009). These applications relate to the use of the connectivity maps and species habitat maps. The regional prioritisation layer is not recommended for direct local applications pending further analysis by HCCREMS. The list is provided as indicative and there may other applications for the regional data not included. As well as the types of applications, it is critical to consider how the data is applied so that it is used in a 'fit for purpose manner' and not over interpreted. This is discussed further in the following section.

Table 2. Local government applications

FUNCTION	APPLICATION
Conservation planning	Setting strategic priorities – indicates hotspots for conservation e.g. Interconnected, high value patches provide relatively more landscape resilience than isolated patches
	Resource investment prioritisation – indicates where in the landscape needs the most urgent attention e.g. relative fragmentation (and conversely persistence) of species habitat and biodiversity links, particularly when considered with other threat data
	Direct on ground rehabilitation towards strategic gains e.g. reconnecting, strengthening (widening) or lengthening links
	Maps areas of multiple species benefit that may be a priority for inclusion in biodiversity strategy or similar conservation plan e.g. a habitat patch that serves multiple threatened species contributes more to protecting regional biodiversity relative to patches that do not protect threatened species.
	Information input to cross boundary collaborative planning e.g. maintain continuous vegetated corridor across LGAs
	May inform research partnerships e.g. Species specific studies in conjunction with NGO or academic researchers
Land use planning	Informs referrals to LLS in rural zones. Council may recommend local values for consideration by consent authority e.g. avoid, mitigate or offset impacts within regionally important, mapped biodiversity links
	Informs site assessment parameters for consideration either by Council staff or by expert consultants and reviewed by staff e.g. highlights issues to be considered during due diligence checks
	May inform environmental sensitive lands mapping (LEP)
	May inform review Rural Strategy where applicable
	Identifies areas of potential land use conflict or areas at risk of loss of regional integrity e.g. overly growth areas mapping with connectivity and species mapping
	Identifies areas for potential offset subject to further investigation of modelled values
Landscape context	Can highlight matters of regional significance beyond existing mechanisms e.g. Mitchell landscapes also referred to as over cleared landscapes
	Maps projected regional extent of links – may highlight importance of link previously regarded as locally significant, may also highlight gaps between local biodiversity corridors and regional links mapped (and flag need for further investigation)
	Maps regional extent of large habitat patches serving multiple species (not just threatened species)
Council maintenance	Some routine Council maintenance works require a Review of Environmental Factors. The regional data may inform preliminary considerations for review of environmental factors in conjunction with other information sources
	Tree planting and urban forest management may consider regional connectivity pathways to identify strategic planting locations
	Management of Council owned land may use regional data as indicator of habitat value for consideration in preparing plans of management and undertaking routine maintenance. If high habitat values are indicated, Council may consider further investigation of biodiversity credit values.
Knowledge building	Staff education – the regional data may engage staff interest through the variety of flora and fauna species present across region and within LGA, the persistence of well connected patches and conversely the level of fragmentation in locations and so on
	Community education – Landcare and similar groups will be interested in the broader context of their site. In addition citizen science may contribute towards verifying modelled values particularly for locally important species
	Shows gaps in biodiversity knowledge – particularly reliability maps, condition and threat data– where to target future surveys
	Source of info for State of Environment Report where alternate maps are not available

3.2.1. STATUTORY APPROVALS PLANNING

As part of Development Assessment, the SDMs may guide applicants and Council on ecological constraints to be considered during impact assessment. The regional scale data provides a high level indicator of values that require further consideration. Applicants may access this data directly from HCCREMS or through Council and use it to inform survey effort and types of habitat to look out for. As part of the development impact assessment, proponents need to determine how much a proposed development will disrupt functional connectivity and impact the extent and viability of species or communities.

The data provides Council with an independent source to verify the scope of consultant reports. Note that biodiversity values identified through field surveys should be given more weighting than predictive, regional modelled values in local scale decisions.

Council staff may refer to the regional modelling when assessing the adequacy of information supplied by proponents. In addition the regional data can inform the landscape context of the predicted site impact.

Councils can formalise reference to these datasets if required. Council may integrate regional data with other sources to inform flora and fauna survey guidelines and trigger use of the flora and fauna survey guidelines via Development Control Plans (DCP).

3.2.2. STRATEGIC LAND USE PLANNING

The data may inform a variety of land use planning strategies including growth strategies, social planning, infrastructure planning, DCPs and in the review of Local Environment Plans. The regional data may be useful when identifying the desired character of localities in the strategic planning process.

A data audit is usually conducted in initial stages of planning and emphasis is placed on new data sets available since preparation of previous version. The regional species distribution models and connectivity assessment maps can be overlaid on as many other forms of environmental and landscape data available to create a map of environmentally sensitive lands. In general there is a focus on statutory obligations to protect threatened species and communities, however, there is an opportunity to identify areas for environmental conservation, environmental management, environmental living within the LGA. Care should be taken to understand the model parameters and relative confidence across the area of interest when applying the SDMs. It is unlikely that Councils will be able to consider all 621 SDMs separately in the planning process. Once the regional prioritisation is completed this will inform the combined values across the region. In the interim, Councils may select a sub set of species of interest or use a heat map approach as outlined in Section 2.2.

Whilst the regional datasets can indicate values for investigation they are not sufficiently detailed to identify areas of low environmental significance. This increases the importance of using multiple data sources to inform local scale planning. If no alternate equivalent mapping is available, Council may rely on aerial photography, advice from OEH or external experts to delineate environmental zones (ELA 2009).

3.2.3. BIODIVERSITY MANAGEMENT

The data has multiple applications for biodiversity management and conservation planning in local government. Biodiversity strategies are an important tool for articulating and coordinating action towards Council's strategic vision for conservation. The regional species distribution models and connectivity analysis provide additional, contextual data sets to support local goals. In some cases the new interim biodiversity data will highlight areas for further consideration in establishing specific local goals. In addition to strategic conservation planning, the interim, regional biodiversity data may be used to expand current Flora and Fauna Survey Guidelines by flagging areas for further surveys. The regional data layers can be also be used to supplement biodiversity values reported through the State of the Environment Report (SoER).

3.3. Things to consider when applying regional biodiversity data layers

The regional maps provide an indication of predicted species habitat and connectivity across the Hunter Central and Lower North Coast based on model predictions. The mapping accuracy varies across the region with the density of data inputs. The authors of both suites of models have described the assumptions embedded in the models to assist end users in interpreting the map outputs. The species distribution models will likely over predict candidate habitat (Kujala et al. 2015). The connectivity modelling should be considered in context with individual species habitat requirements. The modelling assumptions seek to characterise habitat and connectivity for the majority of the native fauna species that utilise woody native vegetation and the plant species that depend on these fauna for dispersal (Lechner and Lefroy 2015). Therefore the models will not map biodiversity corridors for specialist fauna that do not use woody vegetation habitat for dispersal. In addition, the connectivity models will likely under predict corridor values in open grasslands and in urban contexts (HCCREMS pers comm 15/7/15). The regional scale models present the relative values across the study area, additional areas may be important within LGAs.

Neither product has had input data on vegetation condition or structure. Therefore relative ranking of habitat quality is purely based on the number and rarity of species that may use it or the number of connections. Applying local knowledge on vegetation condition will enhance understanding of candidate habitat areas and their contribution to regional biodiversity. As far as possible the models have avoided or down weighted use of the Greater Hunter Vegetation mapping due to attribute inaccuracy.

Understanding these limitations and qualifications will assist users to weight the relative input of these data sources with other data used in local applications. The regional layers are useful as indicators of biodiversity values, particularly when paired with other data, and provide the broader regional context particularly cross Council boundaries.

The regional data layers should not be the primary source of information where larger scale mapping is available. The Lower Hunter Biodiversity Planning Workshop hosted at Lake Macquarie (12th March 2015) discussed a range of modelling processes and outcomes. This included the regional SDMs and Connectivity Assessment completed by the two NERPs, similar independent species and connectivity modelling completed by Lake Macquarie City Council and regional biodiversity modelling by OEH. The forum heard how different modelling treatments influence the different outcomes and highlighted that model outputs are a relative likelihood. The workshop cautioned that it is not sensible to directly compare two relative scales (Kujala et al. 2015), however, it was possible to regard geographic areas of overlap as a form of consensus that there are habitat values present that warrant further consideration.

3.4. Decision points when selecting data to use

The following considerations are suggested when selecting and applying data

- Is it adequate to reference likely (predicted) values or does the process require ground-truthed data?
- What relative weighting will be given to the regional biodiversity data versus other decision inputs?
- What alternative data sets are available? Do these support/concur with regional models?
- If applying a specific species distribution model, which geographic locations have the greatest predictive certainty? Can expert opinion supplement decision making in areas of lower confidence?
- If applying the connectivity assessment, consider whether there are other links or habitat patches that are locally significant.
- What are the local habitat conditions e.g relative weed free, not fragmented, structurally intact?
- Document known data limitations (e.g. 'Evidence based on best available information with stated limitations. Recommend field validation.').

3.4.1. WHEN WOULD YOU USE IT

- Does the process require information on likely threatened species habitat distribution? If yes, the regional SDMs map predicted habitat areas. Note it is still important to conduct a BioNET search of point records within a set radius to check for more current information. Document all sources used in rationalising the end decision.
- Habitat investigations to inform survey effort requirements for targeted flora/fauna surveys.
- In practical applications the location of links should be regarded as indicative rather than as positionally accurate.
- Is it useful to reference the regional map of functional connections? Remember that the regional connectivity map delineates a single least-cost pathway, and alternate pathways may exist. How will the regional links work with other local links? Record or digitise alternate pathways identified by aerial imagery.
- If the regional (cross boundary) perspective is required, are there any differences between two (or more) scales of data to be mindful of?

3.4.2. WHEN WOULDN'T YOU USE IT

- As sole source of information for site specific decisions.
- If there is larger scale data, refer to that source first.
- Without understanding the predictive nature of data
- As indicator of habitat occupancy (vs likelihood).
- Without verifying the predicted functional links.

4. Conclusion

The interim biodiversity data provides an information base to consider multiple species and regional connectivity. HCCREMS will continue work on the data and to work with councils towards improved foundational datasets including regional vegetation mapping. The interim biodiversity data provides an excellent opportunity to focus expert investigation, validate or refine the models. The intent of releasing the interim biodiversity data is to share the data and knowledge gained so that it may be used where it is the best available data. HCCREMS welcome further collaborations to improve regional knowledge of biodiversity assets and assist conservation planners.

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