WILDLIFE CORRIDORS FOR CLIMATE CHANGE

Nandewar and New England Tablelands bioregions

Landscape Selection Process

Connectivity for response to Climate Change
VCA Priorities

A report by
The Department of Environment and Climate Change
Information and Assessment Unit
North East Branch

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Karen Caves, Information and Assessment Section, main project officer, produced the spatial layer and final report and brought the project to conclusion.

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1 Introduction

This project was commissioned by the Conservation Partnerships, Parks and Wildlife Division to identify land areas for strategic establishment of Voluntary Conservation Agreements (VCA) and other private land conservation mechanisms to conserve critical areas within a network of large scale climate change corridors in the Northern Tablelands and Nandewar bioregions. The project has strong links to the “Alps to Atherton” (A2A) Climate Change Corridor and can be viewed as a regional interpretation of the A2A concept and function.

2 Scope

The project aims to delineate and map key areas of landscape connectivity that are significant for the movement of fauna. The areas include key habitat and corridors at the landscape scale. The landscape selection aims to provide an identification of areas important to buffer fauna against increases in variability within the climate. Assessment of biodiversity and connectivity values was carried out to illustrate ecological significance of particular areas.

3 Study Area

The Study area is essentially the Nandewar and Northern Tablelands bioregions including a small area in the Parks and Wildlife group’s Hunter Region, north of the Liverpool plains. This area was integrated into the study area to provide landscape context for the Liverpool plains area and its connectivity values. Map 1 in Appendix 1 illustrates the study area.

4 Background

In the last few years an ever increasing volume of literature, reflecting the increasing research, on climate change has been produced. Despite this, projections regarding effects on biodiversity are of a much generalised nature. The range of projections regarding the changes to weather patterns and the resulting effects on biodiversity are constantly being revised as new information becomes available.

The most recent report released in October 2007 from CSIRO, “Climate Change in Australia – Technical Report 2007”, discusses the current and future scenarios for Australia and illustrates some of the regional differences within Australia for climate change impacts. Moisture and precipitation is amongst the more difficult scenarios to predict, however CSIRO (2007) report that there will be regional variation in the climatic changes for rainfall. In terms of extreme rainfall events, the frequency of these events are increasing more significantly than increasing trends in the general mean. Therefore, erosion, flooding, landslide and river course changes may be a significant impact for biodiversity in the short term. Seasonal precipitation will increase or decrease on regional basis throughout Australia. (CSIRO 2007)

There has been an increase in the frequency of warm days and warm nights and a decrease in the frequency of cool days and cool nights. The best estimate of annual warming over Australia by 2030 is approximately 1.0°C, with regional differences indicate there will be less warming in the coastal areas than the inland areas. (CSIRO 2007)

Climate change presents a complex array of impacts to biological and ecological processes due to changes in humidity, solar radiation, wind speed, potential evaporation, sea surface temperature, precipitation, earth surface temperature and the frequency of extreme events in any one or more of those variables. Information is improving for abiotic projections, however, the impact and adaptation strategies that may occur for biodiversity, are still extremely difficult to decipher.

As temperature and rainfall are major factors dictating the distribution of plants and animals it is expected that there will be both direct and indirect effects on species and ecosystems across Australia. Much supporting evidence collected over the last few years indicates that the relatively modest warming that has already occurred has affected a range of plants and animals (Hughes et al 2003). For example, the migration patterns and seasonal cycles of species have changed in accordance with the warmer weather, so migrating birds arrive earlier than they used to, and native trees and shrubs flower and bear fruit earlier than they used to. Additionally, some species of birds, mammals and insects have moved towards cooler latitudes or upwards in altitude in response to shifting climatic zones (Hughes et al 2003 in NSW Biodiversity and Climate Change Adaptation Framework, Department of Environment and Climate Change, 2007)

Wildlife species are capable of adaptation to a changing climate through migration, genetic adaptation and behavioural. Biodiversity has been subject to a changing climate historically. However, climate change is now a much more significant problem than in the past due to the pervasive threats to native species from modification of land and waters by human settlements, pastoralism, and other anthropological factors that result in the fragmentation of natural vegetation (WWF, IUCN, WCPA 2007).

Sutherst, et at (2007) suggest that “in the face of much uncertainty, there is little merit in designing adaptive strategies to track specific climate-change scenarios. Instead we need to manage for increased variability and uncertainty of the climate. Adapting to climate change will involve combined monitoring interpretive studies and adaptive management”. With this in mind it is essential to approach the mapping of significant climate change conservation priorities with an open mind and a broad approach of “no regret” actions such as buffering and protecting existing habitats, increasing the viability of the reserve system through connectivity and boundary rationalisation and allowing for broad opportunities for adaptation and migration rather than focusing too tightly on specific areas and ideas.

The National Biodiversity and Climate Change Action Plan 2004-2007 (NRMMC, 2004) provides a national overview of the impact of climate change and provides strategies and actions to mitigate impacts of climate change on biodiversity based on knowledge complied in 2004. It Identifies ecosystems and species which may be particularly vulnerable to the effects of climate change. These include species and ecosystems which are: - already considered vulnerable such as those in high altitude environments, restricted to small geographic areas, vulnerable to invasive species, dependent on flowering and fruiting, low-lying coastal areas, freshwater wetlands or vulnerable to increased drought and fire.

The 2007/2008 NSW Biodiversity and Climate Change Adaptation Framework was released in 2007. The framework identifies six key action areas:

1. Share knowledge about biodiversity and climate change, and raise awareness of adaptation actions.
2. Research and monitor impacts of, and adaptation to, climate change.
3. Incorporate adaptation strategies that deal with the impacts of climate change on biodiversity into policy and operations.
4. Provide adaptation planning methods and tools to deal with climate change impacts on biodiversity

5. Minimise the impacts of climate change on key ecosystems and species
6. Minimise the increased threat of invasive species on native species that comes with climate change.

The data presented in this study is intended to support the strategies and processes for application of the six key action areas, particularly key action areas four and five.

5 Rationale

The rationale of the project is to provide connectivity of reserves and core areas of key habitats along climatic gradients creating links between threatened landscapes, refugia and fragmented parts of the reserve network.

This project seeks to provide information to support the key action areas as identified in the 2007/2008 NSW Biodiversity and Climate Change Adaptation Framework and will provide a useful tool for progressing action in those areas.

In a recent symposium on protected areas and climate change (sponsored by the Australian Greenhouse Office and the Department of the Environment and Water Resources), the issues of climate change resilience and the role of the National Reserve System were presented. Key directions for enhancing natural resilience were reported as

- Identify and protect climate refugia
- Conserve large-scale migration corridors
- Maintain viable populations to enable adaptation
- Reduce threatening processes at the landscape scale
- Conserve natural processes and connectivity at the landscape scale and
- Special interventions to avert extinctions

(Taylor, M and Figgis, P 2007 in "*Protected Areas: buffering nature against climate change – overview and recommendations*" page 2")

The identification of broad landscape corridors for adaptation to climate change is beginning to gain some attention in the scientific and government areas. The recognition and announcement of the large 'Alps to Atherton Corridor' has established a greater interest and awareness for biodiversity management in relation to the emerging threatening processes from climatic change predictions.

It is now apparent that recognised threatening processes arising from habitat fragmentation such as habitat isolation, habitat degradation, edge effects, predator/prey ratios to name a few, are now compounded by the increased needs for adaptation of wildlife to the potential pressures and threats presented by climate change. The impact of climate change scenarios on biodiversity have been briefly investigated in this report. These investigations of the current ideas and principles surrounding climate change have been integrated to establish a set of working principles and criteria which formed the basis for the design and development of the project outputs.

This approach works from within a theoretical framework that landscape connectivity will play a major role in both the adaptation to climate change effects and the continuation of wildlife ecological processes. This can be achieved by increasing gene flow between different populations of species to maximise their chances of exploiting changed conditions. This approach is consistent with actions identified for "the protection of habitat for terrestrial and marine species or ecosystems vulnerable to climate change" (NRMMC, 2004) and the key elements for enhancing resilience listed below.

The approach also recognises that actions need to be innovative and diverse to achieve conservation outcomes and protection on multiple tenures. This may take the form of incentives, funded community activities, education and practical conservation planning tools.

The recent thinking and scientific advice, discussed in section four of this report, formed much of the basis to the approach and rationale of this project which seeks to identify a preliminary set of areas for connectivity and explore their values for the movement and adaptation of fauna.

A regional project of this type is inevitably subject to limitations and assumptions of many kinds. However, there is an urgent need to consolidate accumulated fauna knowledge and data into a product suitable to inform current and on-going conservation and management for programs (Scotts 2003). This is especially significant for the recent government incentives to act on climate change and biodiversity adaptation now. An interim product that supports planning for ecological adaptation to climate change is an invaluable tool. Detailed species research on questions regarding corridor use by species, dispersal, breeding requirements, population viability, responses to habitat fragmentation and edges and landscape configuration scenarios, is still required to refine and modify the conservation priorities determined more broadly at this regional scale (Scotts 2003).

In summary, the following principles of design formed the basis of the analysis and decision making for corridor delineation.

- Identification of large scale migration corridors across climatic gradients.
- Reduction in edge effects on reserves and existing vegetation.
- Linking threatened landscapes
- Linking formal protected areas
- Linking key habitats
- Incorporating habitat mosaics
- Buffering and/or expansion of protected areas and linking refugia.

6 Methods

6.1 Desktop Data

The process of land selection and mapping was conducted as a rapid desktop assessment using the best available conservation data and remote sensing imagery. The study area contained several sources of conservation data including fauna corridors and key habitats, spatial links analysis outputs, fauna and flora survey records, high quality and relatively up to date (2005) satellite imagery and vegetation community mapping. A systematic process of identifying major corridors was carried out across the landscape using these sources of information in the following order of application.

1. Corridors and Key Habitats data (Andren, 2004 and Scotts and Drielsma, 2003)
2. Key Habitats and Corridors data (Scotts, D and Drielsma, M 2003)
3. Atlas fauna records
4. Broad outputs from the spatial links tool (Dreilsma, M, Manion, G and Ferrier, S. (2007)

5. Vegetation community mapping from the Nandewar and Brigalow Belt WRA process (Department of Environment and Conservation, 2004)
6. SPOT5 satellite imagery

The Key Habitats and Corridors data originated from two previous assessments. In the eastern section of the study area, data was used from the Drielsma and Scotts (2003) Corridors study and Scotts (2003) Key Habitats study. Across the Nandewar bioregion and west of the New England Hwy, Key Habitats and Corridors were mapped as part of the Vertebrate Fauna studies by Andren (2004) (completed for the Nandewar Western Regional Assessment). These data sources were utilised as the primary information source for the delineation of the climate change connectivity areas.

Mapping of the corridors was then refined based on updated extant vegetation coverage (from Spot5 satellite imagery)

6.2 Wildlife Corridors for Climate Change – Stage One

Wildlife Corridors for Climate Change were assessed and mapped across part or whole areas in the South East Qld, NSW North Coast, Sydney Basin and Brigalow Belt South bioregions. This work covered the jurisdiction Northern Rivers Catchment Management Authority (NRCMA) and the Hunter Central Rivers CMA (HCRCMA). The project was commissioned by Conservation Partnerships, Parks and Wildlife Division and funded by the Climate Action Grants program. Part of this work extends over the project study area. The new work, within this study area, recognises any corridors that were delineated as part of the previous project and attempts to 'edge match' to allow for a complete coverage across both study areas. However, an alternative methodology was followed for the Nandewar and Northern Tablelands project resulting in one network of corridors rather than three groups of faunal assemblage corridors (moist, dry and coastal) which was the approach for previous work. The methods, results and outcomes can be reviewed in DEPARTMENT OF ENVIRONMENT AND CONSERVATION (2007).

6.3 Interpretation of Key Habitats and Corridors for Nandewar – M.J. Andren (2004)

The Nandewar and Northern Tablelands bioregions have been subject to considerable land clearing and agricultural use resulting in extensive habitat loss, degradation and fragmentation. Therefore, the objectives for climate change connectivity in these areas were broadened to allow for the inclusion of identified key habitat areas within the climate change connectivity assessment. This was carried out to enable the production of a complete connectivity layer that integrates the values of key habitats and connectivity between them.

Mapped outputs from the Nandewar biodiversity surrogates study on vertebrate Fauna (Andren 2004) were utilised to establish the location of core key habitat areas and potential corridors and connectivity between them. This information was used as a basis for delineation in conjunction with other available spatial data including fauna records, vegetation mapping, flora records, land use, abiotic data, satellite imagery and land tenure

6.4 Initial delineation of Climate Change Corridor Structure for Nandewar and Northern Tablelands bioregions

Corridors and Key Habitats data (Andren, 2004) was used as the primary data set to identify to basic linkages and structure of the corridor system. Additionally, broad outputs from the Spatial Links Tool (Drielsma, M, Manion, G and Ferrier, S. 2007) were used to ensure major areas of connectivity were included. This initial work was also carried out with reference to extant vegetation using SPOT 5 satellite imagery.

6.5 Refinement of Corridor mapping

The initial corridors framework was reviewed and analysed to determine refined boundaries using more recent habitat quality models, vegetation mapping and visual checking using SPOT5 satellite imagery.

An expert workshop was carried out on the "first cut" of areas from the process. This process used expert knowledge to refine the delineations. There was also further evaluation of the "input" map layers which formed the basis of design for proposed corridors such as:

- Corridors and Key Habitats data (Andren, 2004 and Scotts and Drielsma, 2003)
- Faunal assemblage habitat models (Scotts, 2003)
- Recent broad outputs from the Spatial Links Tool (Drielsma, M, Manion, G and Ferrier, S. 2007)
- Analysis of vegetation patterns from Nandewar WRA Assessment (Department of Environment and Conservation, 2004)
- Recent fauna and flora records from NSW Wildlife Atlas throughout and adjoining the study area
- YETI Flora records
- Tenure Layers
- SPOT 5 Satellite Imagery

6.6 Reference species

The expert review process identified reference species that were specifically associated with each corridor. In some cases two reference species were selected to highlight the different fauna groups occurring in the areas. The species nominated for each corridor were species of particular conservation significance that related to each corridor location, habitat and arrangement and are intended for community recognition and awareness rather than a robust scientific indicator species.

The reference species serves as an icon to support community identification, awareness and education. The reference species is not specifically the most vulnerable to climate change effects but a species that may be vulnerable and is known to occur in the area. There is a high level of uncertainty as to the specific long term effects of climate change on specific fauna species, therefore it is impractical to portray these reference species as those that will be the most significantly impacted by climate change.

6.7 Corridor names

Corridors were identified and labelled based on location, landscape features or protected areas in close proximity. This was established to facilitate community identification and "ownership' with the mapped corridors.

6.8 Corridor Priorities

Priorities were selectively assigned to broad conservation criteria. Priorities for conservation actions within the corridor network will vary depending on the type of conservation program, funding source and actions that are proposed. At this stage, priorities were identified primarily for the protection of existing high conservation values through private land voluntary conservation agreements (VCA's) or other protective mechanisms on private land. These priorities are also suitable to inform strategic acquisition priorities for reserve establishment. Further work to identify new area proposals would benefit from the use of the corridor mapping and the selected priorities. The following criteria, in order of importance were used as a guide to identify priority areas;

Criteria – Characteristics of Priorities	Rationale
1 Mapped key habitat linking existing reserves	Linking reserves enhance viability and enable migration between core key habitat areas.
2 Mapped key habitat adjacent to existing reserves	Increased protected areas will provide a buffer to impacts within the core key habitat areas increasing opportunities for these areas to act as refugia
3 Large intact areas of mapped Key Habitat	Protection of core key habitat and high quality habitat to increase viability of protected areas
4 Altitudinal and habitat gradients	Corridors that extend across gradients of altitude, moisture and habitat will be important for buffering species against climate change impacts.
5 Stepping Stone corridors containing mapped key habitat	Protection of existing stepping stone remnants of key habitat is essential to maintain and improve the corridor functions in particular areas.

6.9 Corridor Features

The following features were delineated within the corridors. The features were delineated based on the spatial configuration and condition of the vegetation according to vegetation community mapping and a visual analysis using SPOT 5 satellite imagery (2005). The features were identified with reference to the conservation actions may be required to improve or recover the protection and/or condition of various areas.

Feature Label	Spatial feature	Conservation Action
Stepping Stone	Fragmented vegetation and intact remnants of various condition serving as a viable corridor for a selection of species.	Protection of existing vegetation and strategic re-establishment of vegetation to enhance 'stepping stone" pattern.
Cleared Valley Floor Linkages	Usually cleared and/or highly threatened fertile and productive areas along alluvial flats.	Re-establishment of vegetation either as windbreaks or patches – in a stepping stone strategy.
Key Habitat	Predominantly good condition and vegetated areas within the corridor with a high proportion of mapped key habitats for wildlife.	Protection and rehabilitation of existing vegetation
Low Cover Linkage	Areas of cleared corridor or sparsely vegetated corridor linking key habitat or areas of high corridor value.	Encourage the establishment of native vegetation through various actions including windbreaks, paddock trees etc to begin a basis for future re-vegetation. Strategic re-establishment of stepping stones
Reserve Buffers and Linkages	Areas of vegetated land in good to reasonable condition linking or adjacent to existing formal reserves.	As above with a view to creating strategic "linkages" of protected areas between formal reserves.

7 RESULTS

7.1 Nandewar bioregion

The Nandewar bioregion may have some notable values as refugia for many inland species under climate change pressures. The bioregion is currently considered significant as a drought refuge for many Eyrean species, which normally are found further west (Andren 2004). In general, the western slopes catch slightly more precipitation from weather systems in the west and in times of drought, wildlife species will favour the slopes as suitable habitat. This adaptation pattern may perpetuate and increase as the inland areas are subject to increased dry weather as projected under the currently climate change scenarios. Distribution ranges that currently extend west from the Nandewar bioregion may contract to slopes and/ or species that traditionally use the north west slopes as drought refugia may permanently inhabit these areas in areas of suitable habitat. (Andren pers. Comm. 2008)

7.2 Corridors – Conservation Summaries

7.2.1 Bebo – Bonshaw

The Bebo – Bonshaw Corridor is a large area of intact vegetation and key fauna habitat that extends east from the Dthinna Dthinnawan National Park (NP) to Maroomba State Conservation Area (SCA) west of Bonshaw. The corridor continues north into the Yelabron State Forest (SF) Estate in Queensland (QLD) and although not mapped, the existence of connectivity further north into the large expanse of vegetation in Wheatstone SF in QLD is noted. This corridor links southwards through to the West Macintyre, Mole River – Tenterfield Plateau and the Granite Belt Corridors.

Geology

Geological features include a large mass of sandstone and sandy soils in and around the Dthinnia Dthinnawan NP in the western area of the corridor, graduating into more fertile conglomerates in the east. Granite intrusions feature within the corridor from east to west.

Altitudinal and Climatic gradients.

The altitudinal gradient extends from 200m ASL in the western section to up to 400 and 500 ASL towards the east, linking up into the higher altitudes of the Granite Belt and Tenterfield Plateau subregion. Maximum, Minimum and Average temperature gradients follow the altitudinal shifts also. Maximum and Minimum temperatures of 32.5 and 25 C respectively are recorded in the western section of the corridor towards Dthinna Dthinnawan. These graduations shift towards the east where a cooler max and min temperature are recorded of 30.7 C and 13 C respectively. Mean annual temperatures range from about 18.2 to 17.1 along the altitudinal gradients.

Vegetation

Bebo

Vegetation around the "Bebo" area in and around Dthinna Dthinnawan NP is composed predominantly of two or three major vegetation communities. Black Pine - Narrow-leaved Ironbark resides in the low fertility sandy soils of the Pilliga sand beds with representation of White Pine – Narrow leaved Ironbark in the higher fertility soils around the periphery of a major core of contiguous vegetation in the area. The occurrence of Angophora within the Black Pine – Smooth-barked Apple community is predominant in areas subject to increased moisture and drainage areas.

Atholwood – Bonshaw

Vegetation communities in the south-eastern part of the corridor differ from the low fertility areas in the Bebo sections. Vegetation communities vary from White Pine – Tumbledown Red Gum and White Pine – Silver-leaved Ironbark – Tumbledown Gum to Dirty Gum – White Pine – Smooth-barked Angophora and other White Pine dominated communities.

The geomorphological and geological differences at each end of the Bebo – Bonshaw corridor demonstrate a gradient of habitats from a low fertility, low moisture retention and low altitudinal environment in the north-west to higher altitudinal and site quality in the south-east.

Fauna

Key Habitat

The corridor contains almost the entire extent of the Bebo – Bonshaw key habitat (over 61000ha). This indicates that the corridor traverses a biogeographically distinct fauna sub-region. Known species of concern that occur within these habitats includes the zig zag velvet gecko (*Oedura Rhombifer*), dunmall's snake, turquoise parrot, hooded robin and grey-crowed babbler. The following table taken from Andren (2004) identifies TSC Act listed fauna species that are known, likely or potentially occurring in the key habitats within the Bebo – Bonshaw corridor.

Bebo – Bonshaw Faunal assemblage

Known to occur
Zig Zag Gecko *Oedura rhombifer,* Dunmalls Snake *Furina dunmalli,* square-tailed kite, squatter pigeon, glossy black-cockatoo, turquoise parrot, brown treecreeper, speckled warbler, painted honeyeater, hooded robin, grey-crowned babbler, diamond firetail, koala, squirrel glider, black-striped wallaby, delicate mouse, yellow-bellied sheath-tailed bat *Saccolaimus flaviventris,* little pied bat *Chalinolobus picatus,* eastern bent-winged bat *Miniopterus schreibersii oceanensi,* greater long-eared bat *Nyctophilus timoriensis*, eastern cave bat *Vespadelus troughtoni,* bristle-faced free-tailed bat *Mormopterus* sp.6.
Likely to occur
black-chinned honeyeater
Potentially occurring
Border thick-tailed gecko *Underwoodisaurus sphyrurus,* barking owl, masked owl, spotted-tailed quoll, grey-headed flying-fox *Pteropus poliocephalus,* large-eared pied bat *Chalinolobus dwyeri,* Beccari's free-tailed bat *Mormopterus beccarii*

(Source: Andren, 2004).

Significance for Climate Change

This large block of vegetation is regionally significant as it contains many flora and fauna species which are at the edge of their distribution. Disjunct populations of particular Eucalypt species, which also occur on the NSW North Coast, indicate its significance as climate change refugia in the past. Species such as the squatter pigeon and the bristle-faced free-tail bat are predominately northern or inland species but have been recorded here.

This corridor is particularly significant for the delicate mouse as it provides a link to the nearest known populations of this species in Qld. The *endangered* black-striped wallaby is also likely to benefit from enhancement of this corridor as it prefers habitats with a mosaic of grasses and thick shrubby understorey rather than open grazing land. Both of these species are at their southern limit of distribution and potentially could expand further south due climate change induced habitat changes.

Reference Species: black-striped wallaby and delicate mouse

7.2.2 Bingara - Manilla

The Bingara Manilla Corridor is a complex of east-west and north-south orientated pathways linking the major latitudinal corridors of Kaputar – Melville Range and the Northern Basalts – Woodsreef. The corridor complex creates linkages across some of the most degraded areas in the Peel Valley subregion, however much of the corridor complex is made up of “stepping stones” of fragmented vegetation.

Geology

The majority of the corridor network is located on andesite and siltstone with featuring small areas of basalt and gabbro although these areas are more heavily cleared or fragmented.

Altitudinal and Climatic Gradients

This corridor network essentially links the lower altitude areas of the Peel Valley. The network links the extra-ordinary high altitudes of the Kaputar- Horton Ranges Corridor on the west to the high altitude environments of the tablelands granite belt corridor to the east. High altitude features within the corridor include Mt Hobden at 1096m ASL and Blue Nobby Mountain at 629mASL. The remaining areas contain elevations between 500m and 600n ASL. Minimum temperatures shift from a minimum average reading of 4°C in the north of the corridor to higher minimum readings of 11 – 15°C in a relatively consistent incremental pattern thus creating a latitudinal gradient of minimum temperature readings from the north to the south. Average maximum temperatures vary less than the minimum with readings between 28.5°C (in the higher altitudes) and 32°C at lower elevations.

Vegetation

In the richer soils on the floodplain and basalt, White Box Grassy Open Forest occurs where vegetation has not been cleared for agricultural purposes. This community is listed as the Endangered Ecological Community (EEC) *White Box Yellow Box Blakely's Red Gum Woodland.*

The remaining vegetation is predominantly of high site quality types such as White Box Shrubby Open Forest – Melville Range, White Pine/ White Box Grass/Forb Open

Forest and White Box/White Pine/ Grass Open Forest – central and Grey Box/Blakely's Red Gum/Yellow Box Grassy Open Forest (EEC). The Peel Valley has some rich soils and a high occurrence of Endangered Ecological Communities due to the extensive levels of vegetation clearing.

Fauna

Key Habitat

This corridor links a significant area of the Nandewar key habitats for the Manilla – Cobbadah fauna sub-region (Andren, 2004). The following table lists species known, likely or potentially to occur in this sub-region.

Bingara – Cobbadah faunal subregion

Known to occur
border thick-tailed gecko *Underwoodisaurus sphyrurus,* square-tailed kite, swift parrot, barking owl, turquoise parrot, grey-crowned babbler, speckled warbler, hooded robin, brown treecreeper, black-chinned honeyeater, regent honeyeater, painted honeyeater, diamond firetail, squirrel glider, grey-headed flying-fox *Pteropus poliocephalus*, yellow-bellied sheath-tailed bat *Saccolaimus flaviventris,* large-eared pied bat *Chalinolobus dwyeri,* common bent-winged bat *Miniopterus schreibersii,* greater long-eared bat *Nyctophilus timoriensis*
Likely to occur
koala
Potentially occurring
painted snipe, masked owl, little pied bat *Chalinolobus picatus*, eastern cave bat *Vespadelus troughtoni*

(Source: Andren, 2004).

Significance for Climate Change

Remnant vegetation along river and stream lines and in Travelling Stock Routes (TSR) provide habitat for woodland birds and bats. This corridor complex attempts to link these areas and allow less mobile species such as squirrel gliders to re-establish across a heavily cleared floodplain.

The higher ridges and mountains provide cooler moister habitats which could potentially provide refugia for species vulnerable to climate change particularly Threatened micro-bats which may become disadvantaged as habitat suitability is reduced further west and at lower altitudes as predicted temperatures increase.

Reference Species: Woodland birds

7.2.3 Eastern Tablelands Complex

The eastern tableland corridor is an extensive corridor network that delineates the most inter-connected areas of habitat and vegetation occurring in the highly cleared productive landscapes of the eastern tablelands. This corridor connects landscape features such as the escarpment country of the Great Dividing Range and tablelands edge to the north west slopes and Nandewar bioregion. The network is composed of several arms extending north-south and east-west to interconnect with the broader corridor network.

Geology

The Tingha Plateau section of the corridor network is predominantly a felsic intrusive of monzo-granite geological landscape. The remaining areas to the east are all rich and highly productive landscapes featuring rhyolite and basalt geological formations from volcanic processes.

Altitudinal and Climatic gradients

The Eastern Tablelands Corridor complex transverses a rise in altitude from the mid elevations of the north-west slopes to the extensive area of high altitude environments around the Glenn Innes – Guyra Basalts subregion. Some of the highest altitudes in the study area occur on the Northern Tablelands in the Glenn Innes – Guyra Basalts and Nightcap subregions. Mid-elevations of the north-west slopes vary from 550m ASL to 700m ASL in the western sections of the corridor complex. These areas connect to the highlands relatively gradually and reach altitudes of 1400m around Ben Lomond along the Great Dividing Range. Average minimum temperatures vary considerably throughout the corridor complex. In the mid- elevation areas of the north west slopes minimum temperatures reach around 10°C to 11°C. Higher elevations are measured to have a minimum average of around -2°C in the north and -6°C in the southern sections of the corridor complex. Maximum average temperatures are considerably less variable across the landscape. In this corridor the maximum temperatures consistently decrease with increasing altitudes towards the east with the granite belt on the north west slopes recording maximums of 28.5° C to 30°C and the higher elevation in the east are recorded to experience maximums of 23°C and 24°C.

Vegetation

Towards the west, just off the tablelands, vegetation communities include examples of Yellow-box/Grey-box/Red Gum, Orange Gum/ New England Black Butt/Tumbledown Red Gum, Orange Gum/Tumbledown Red Gum/Apple and Broadleaved Stringy-bark/Apple Box. Higher elevations in the east sample significant areas of Snow Gum/Mountain Manna Gum, Montane Stringybarks, Peppermint-Mountain/manna Gum and Red Gum/Stringybark. In the Tingha Plateau area, vegetation communities include McKie's Stringybark/New England Black-butt/Rough-barked Apple and point occurrences of Howell Shrublands.

Fauna

Key Habitats

The eastern tablelands corridor complex links Nandewar key habitats for, the fauna sub-regions Tingha Plateau and Eastern Highlands (Andren, 2004), and the Dry Granite Tablelands faunal assemblage (Scotts, 2003).

Threatened species identified by Andren (2004) as known, likely or potentially occurring in the Nandewar key habitat, Tingha Plateau, are listed below: -

Tingha Plateau Faunal subregion

Known to occur
border thick-tailed gecko *Underwoodisaurus sphyrurus,* square-tailed kite, glossy black-cockatoo, barking owl, turquoise parrot, brown treecreeper, speckled warbler, regent honeyeater, painted honeyeater, black-chinned honeyeater, hooded robin, grey-crowned babbler, diamond firetail, koala, squirrel glider, yellow-bellied sheath-tailed bat *Saccolaimus flaviventris,* eastern false pipistrelle *Falsistrellus tasmaniensis,* eastern bent-winged bat *Miniopterus schreibersii oceanensis,* greater long-eared bat *Nyctophilus timoriensis,* greater broad-nosed bat *Scoteanax rueppellii*
Potentially occurring
swift parrot, masked owl, spotted-tailed quoll, grey-headed flying-fox *Pteropus poliocephalus,* large-eared pied bat *Chalinolobus dwyeri,* little pied bat *Chalinolobus picatus,* eastern cave bat *Vespadelus troughtoni*

(Source: Andren, 2004)

Further east and north of Tingha Plateau, there is an expanse of key habitat for fauna groups from the eastern highlands fauna sub-region. Threatened species identified by Andren (2004) as known, likely or potentially occurring in the Nandewar key habitat for the fauna sub-region, Eastern Highlands, are listed below:

Eastern Highlands Faunal subregion

Likely to occur
turquoise parrot, brown treecreeper, speckled warbler, black-chinned honeyeater, hooded robin, diamond firetail, koala, squirrel glider, yellow-bellied sheath-tailed bat *Saccolaimus flaviventris,* eastern bent-winged bat *Miniopterus schreibersii oceanensis.*
Potentially occurring
border thick-tailed gecko *Underwoodisaurus sphyrurus,* square-tailed kite, barking owl, masked owl, regent honeyeater, painted honeyeater, grey-crowned babbler, grey-headed flying-fox *Pteropus poliocephalus*, eastern false pipistrelle *Falsistrellus tasmaniensis,* greater long-eared bat *Nyctophilus timoriensis,* greater broad-nosed *Scoteanax rueppellii,* eastern cave bat *Vespadelus troughtoni.*

(Source: Andren, 2004)

Species of conservation concern associated with the key habitat Dry Granite Tablelands faunal assemblage are listed below (Scotts, 2003).

Dry Granite Tablelands Faunal subregion

border thick-tailed Gecko *Underwoodisaurus sphyrurus,* the skink *Ctenotus Eurydice,* turquoise parrot, Edwards lyrebird, chestnut-rumped heathwren, greater broad-nosed bat *Scoteanax rueppelli*, inland broad-nosed bat *Scotorepens balstoni*

(Source: Scotts, 2003).

Significance for Climate Change

The corridor connects remnant habitats across the tablelands which provide an important link from dry habitats in the west to moister forests in the east. This may be significant for adaptation to climate change. Higher temperatures and lower average rainfall is projected for inland areas making some habitats unsuitable for many species. Increased connectivity and improved habitat condition potentially should improve the resilience of wildlife allowing migration and adaptation to changing conditions.

The Tingha Plateau contains a significant intact area of key habitat on the edge of the tablelands. The area is subject to considerable mineral interests and is disadvantaged in terms of reserve establishment. This subregion is subject to low levels of representation within the reserve system. Improving the levels of protection through private land conservation mechanisms is a priority for this area and will lead to increased resilience and viability of the existing HCV key habitats to potentially act as refugia in times of climate stress.

To the south and east the corridor complex covers linear configurations of vegetation and habitat which connect to larger remnants within a heavily cleared landscape. The area is important for woodland birds such as the regent honeyeater. The southern most section provides for connection between several reserves and state forests on the granite dominated central tablelands.

Reference Species: turquoise parrot and squirrel glider

7.2.4 Granite Belt

The Granite Belt corridor is an immense latitudinal corridor extending almost 280km along the north-west slopes from the rocky environment of Kwiambal National Park in the north to Nundle State Forest on the south-eastern edge of the Peel subregion.

Geology

As indicated by the name, the predominant geology is granite bedrock and extrusions with the occurrence of rich basalt between Inverell and Delungra. This changes to a predominately sandstone geology in the south of the corridor near Nundle. The richer basalt soils near Inverell are more heavily cleared areas where the corridor tends to contain “stepping stone” remnants of vegetation. These remnants, although not extensive are important wildlife resources as they provide habitat on the fertile, basalt plains.

Altitudinal and Climatic gradients

Altitudes remain relatively constant throughout the corridor graduating to slightly higher altitudes in the central areas around Inverell. The corridor is located in the intermediary altitudes between the lower slopes and the table lands and is a crucial area of connection from the high altitudes of the northern tablelands to the lower altitudes on the western slopes. Elevation changes from 350m ASL to 900m ASL with gradual shifts across the landscape. Average minimum temperatures are generally 10°C to 11°C in the northern part of the corridor at lower altitudes with a dramatic contrast at higher elevations to -8°C and -10°C. Maximum readings contrast less with the lower altitudes reaching 31.5°C and the higher elevations averaging around 25°C.

Vegetation

Vegetation types and patterns begin to take on more tablelands species and patterns in this part of the corridor network. Major vegetation communities are typical of less fertile soils and outcropping landscapes such as Black Pine Granite Outcrop Shrubby Woodland, Black Pine/Orange Gum/Tumbledown Red Gum Shrubby Open Forest, Orange Gum/Caley's Ironbark/Red Stringybark Shrub/Grass Open Forest – southern tableland edge. Areas subject to increased fertility or deeper soils contain White Box/Silvertop Stringybark/White Pine Shrubby forest, White Pine/Silver-leaved Ironbark/Tumbledown Red Gum Shrubby Open Forest; Kwiambal and Rough-barked Apple/Silvertop Stringybark/Red Stringybark Grassy Open Forest-tableland edge.

Fauna

Key Habitats

Due to the extensive latitudinal length of this corridor, four major fauna sub-regions are sampled. These fauna assemblage groups have some species in common reflecting the nature of the habitats existing there. This may have benefits for the migration of species to more favourable conditions as climate change impacts occur.

The northern section of the corridor is centred on the Kwiambal fauna sub-region. Those threatened species known, likely and potentially occurring are listed below:

Kwiambal Faunal Assemblage

Known to occur
turquoise parrot, brown treecreeper, speckled warbler, hooded robin, grey-crowned babbler, diamond firetail, koala, squirrel glider, yellow-bellied sheath-tailed bat, *Saccolaimus flaviventris,* little pied bat *Chalinolobus picatus,* eastern bent-winged bat *Miniopterus schreibersii oceanensis,* greater long-eared bat *Nyctophilus timoriensis*
Likely to occur
border thick-tailed gecko *Underwoodisaurus sphyrurus,* black-chinned honeyeater
Potentially occurring
square-tailed kite, barking owl, masked owl, painted honeyeater, spotted-tailed quoll, large-eared pied bat *Chalinolobus dwyeri,* eastern cave bat *Vespadelus troughtoni*

(Source: Andren, 2004)

This is an important area for woodland birds and cave dwelling bats with the extensive Ashford Caves system and large areas of foraging habitat.

The higher altitudinal areas in the central section of the corridor are identified as the central granite belt fauna sub-region. Those threatened species that are known, likely and potentially occurring in the key habitats of this area are listed below.

Central Granite Belt Faunal subregion

Known to occur
Border thick-tailed gecko *Underwoodisaurus sphyrurus,* Namoi River turtle *Elseya bellii*, barking owl, masked owl, turquoise parrot, brown treecreeper, speckled warbler, regent honeyeater, black-chinned honeyeater, hooded robin, grey-crowned babbler, diamond firetail, koala, squirrel glider, yellow-bellied sheath-tailed bat *Saccolaimus flaviventris,* eastern false pipistrelle *Falsistrellus tasmaniensis,* eastern bent-winged bat *Miniopterus schreibersii oceanensis,* greater long-eared bat *Nyctophilus timoriensis,* greater broad-nosed bat *Scoteanax rueppellii*
Likely to occur
painted honeyeater
Potentially occurring
square-tailed kite, swift parrot, spotted-tailed quoll, brush-tailed rock-wallaby, grey-headed flying-fox *Pteropus poliocephalus,* large-eared pied bat *Chalinolobus dwyeri,* eastern cave bat *Vespadelus troughtoni*

(Source: Andren, 2004)

The corridor links several reserves and key habitats for woodland birds, squirrel gliders and forest owls. There is extensive habitat for the border –thick tailed gecko.

South of Bendemeer, the corridor samples key habitats of the Nundle-Moonbi fauna sub-region. Threatened species known, likely and potentially occurring are listed below.

Nundle - Moonbi Faunal subregion

Known to occur
booroolong frog *Litoria booroolongensis,* border thick-tailed gecko *Underwoodisaurus sphyrurus,* square-tailed kite, barking owl, masked owl, turquoise parrot, brown treecreeper, speckled warbler, black-chinned honeyeater, hooded robin, diamond firetail, koala, squirrel glider, yellow-bellied sheath-tailed bat *Saccolaimus flaviventris,* large-eared pied bat *Chalinolobus dwyeri,* eastern false pipistrelle *Falsistrellus tasmaniensis,* eastern bent-winged bat *Miniopterus schreibersii,* greater long-eared bat *Nyctophilus timoriensis,* greater broad-nosed bat *Scoteanax rueppellii*
Likely to occur
grey-headed flying-fox Pteropus poliocephalus
Potentially occurring
glossy black-cockatoo, swift parrot, grey-crowned babbler, regent honeyeater, painted honeyeater, spotted-tailed quoll, brush-tailed rock-wallaby

(Source: Andren, 2004)

Key habitats within this subregion comprise a large part of the distribution, with many known populations, of the border thick-tailed gecko. The last known locations of the booroolong frog, in northern NSW, occur here also. Rehabilitation of these sites could play an important role in the recovery of these species.

The Northern Plains key habitat is also widespread through this area and extends across the landscape outside the mapped corridor. The following species are known, likely or potentially occurring throughout this fauna sub-region:

Northern Plains Fauna subregion

Known to occur
Five-clawed Worm Skink *Anomalopus mackayi,* turquoise parrot, brown treecreeper, speckled warbler, painted honeyeater, hooded robin, grey-crowned babbler, diamond firetail, koala, squirrel glider, grey-headed flying-fox *Pteropus poliocephalus*, Yellow-bellied sheath-tailed bat *Saccolaimus flaviventris,* eastern bent-winged bat *Miniopterus schreibersii oceanensis*
Likely to occur
square-tailed kite, black-chinned honeyeater, greater long-eared bat *Nyctophilus timoriensis,* little pied bat *Chalinolobus picatus*
Potentially occurring
squatter pigeon, swift parrot, barking owl, masked owl, regent honeyeater, eastern cave bat *Vespadelus troughtoni*

(Source: Andren, 2004)

The corridor in this area attempts to link remnant koala and squirrel glider populations across the heavily cleared basalt plains.

Significance for Climate Change

The Kwiambal section is the most widely vegetated area and contains two major river systems, the McIntyre and the Severn. Together with steep mountain ranges and the Ashford cave system, this corridor can potentially play a major role as a climate change refugia.

The lower fertility soils and rugged terrain of the granite belt sections of the corridor have resulted in less extensive clearing for agriculture. There are several conservation reserves on the edge of high and moist environments on the tablelands slopes. In these areas, fauna species of drier habitats are at the edge of their eastern limits. Improving the quality and connectivity of habitats along this corridor should benefit fauna of the western slopes whose present habitats may become unviable under a changing climate.

The Nundle – Moonbi corridor section is a wetter and cooler part of the corridor complex. Several of the last known locations of the booroolong frog, in the study area, occur here. The species appears to be extinct across much of its former range in northern NSW. Rehabilitation and protection of these sites could play an important role in the recovery of these species.

The areas of habitat remaining on the fertile northern plains, although degraded, still offer important habitat resources in high productivity sites for fauna. Improving the natural resilience through habitat restoration and pest control will potentially allow resident populations to adapt to climate change more successfully than lower fertility sites where productivity is low.

Reference Species: woodland birds and booroolong frog

7.2.5 Horton – Melville Range Corridor

The Horton – Melville Range Corridor is a major latitudinal corridor that extends along the western edge of the Peel Valley in a north south orientation from Gravesend on the Gwydir River to Quirindi in the southern upper reaches of the

Namoi Catchment. The latitudinal corridor is more than 250km and includes the high altitudinal environments of Mount Kaputar.

Geology

The northern section of the corridor is predominantly made up of geological formations associated with the volcanic activity of the Nandewar Volcano 17 million years ago. Mount Kaputar features the unique geomorphology and geology of the Nandewar Volcanic Field formation including trachyte, rhyolite, basalt and rhyolitic agglomerates and conglomerates. Sandstone and siltstone also features throughout the area. There is a great diversity of soils types and geological features in the Mount Kaputar area. Further south the influence of the volcanic activity reduces and the geology is less varied however there are still areas that contain the soils and lithic formations of past volcanic activity throughout.

Altitudinal and Climatic gradients

The Horton – Melville Range Corridor is a broad latitudinal landscape corridor that traverses variations in elevation throughout its range. The main altitudinal rises are featured at Mount Kaputar where elevations of 1500m are reached with dramatic slopes and deep gullies. South of Kaputar, the corridor traverses a more gentle increase in elevation towards the upper reaches of the Namoi Valley, near Quirindi, where elevation increases from 300m at Carroll to approximately 600m. Higher elevations are evident along the Peel Range such as 1400m at Crawney Mountain and 1100m at Goonoo Goonoo.

Vegetation

The Horton – Melville Ranges Corridor is an extensive latitudinal pathway and contains variations in vegetation types throughout. The northern section of the corridor which adjoins with the Northern Basalts – Woodsreef Corridor, is predominantly vegetated with White Box/White Pine/Silver-leaved Ironbark Shrubby Forest and White Pine/silver-leaved Ironbark/Tumbledown Red Gum Shrubby Open forest on the flats and footslopes, White Pine/Silver-leaved Ironbark Grassy Open Forest and Yellow Box/Blakely's Red Gum Grassy Forest on the lower slopes and drainage areas and River Red Gum in the Riparian areas.

The mid section of the corridor around Mount Kaputar is more heavily influenced in soils, aspect and altitude by the Nandewar Volcano geological processes, making it extremely rich in diversity and contains some significant high altitude stands of Snow Gum, Mountain Gum, Silver-top Stringy-bark and Ribbon gum. Semi-evergreen Vine Thickets more frequently occur. Lower altitudes and the floodplains are vegetated by Narrow-leaved Ironbark/Black Pine Shrubby Forest, White Pine/White Box Shrubby Open Forests and White Box/White Pine/Silver-leaved Ironbark Shrubby Open forests.

The southern section of the corridor contains lower altitudes and is predominantly vegetated with White Box/White Pine Shrubby open Forest, White Box Shrubby Open Forest – Melville Range, White Pine/White Box Grass/ Forb Open Forest and Narrow-leaved Ironbark/Tumbledown Red Gum Shrubby open Forests – Melville Range. Other features include Rusty Fig Dry Rainforest, Mallee Woodland and Brigalow Acacia Woodland.

Fauna

Key Habitat

This corridor features key habitat for two major fauna sub-regions. These include “Kaputar – Horton Range” in the northern half of the corridor and “Melville Range – Southern Plains” south of Mount Kaputar. The corridor encompasses almost the entire extent of key habitats for these two fauna sub-regions.

Threatened fauna species known, likely and potentially occurring in key habitat for these fauna sub-regions are listed below: -

Mount Kaputar – Horton Range Fauna sub-region

Known to occur
border thick-tailed gecko *Underwoodisaurus sphyrurus,* square-tailed kite, glossy black-cockatoo, barking owl, masked owl, turquoise parrot, brown treecreeper, speckled warbler, regent honeyeater, painted honeyeater, hooded robin, grey-crowned babbler, diamond firetail, spotted-tailed quoll, squirrel glider, koala, brush-tailed rock-wallaby, Grey-headed Flying-fox *Pteropus poliocephalus,* yellow-bellied sheath-tailed bat *Saccolaimus flaviventris,* large-eared pied bat *Chalinolobus dwyeri,* little pied bat *Chalinolobus picatus,* eastern bent-winged bat *Miniopterus schreibersii oceanensis, greater long-eared bat Nyctophilus timoriensis*, greater broad-nosed bat *Scoteanax rueppellii,* eastern cave bat *Vespadelus troughtoni*
Likely to occur
black-chinned honeyeater
Potentially occurring
swift parrot, black-striped wallaby

(Source: Andren, 2004).

Melville Range – Southern Plains faunal subregion

Known to occur
border thick-tailed gecko *Underwoodisaurus sphyrurus,* turquoise parrot, brown treecreeper, speckled warbler, black-chinned honeyeater, diamond firetail, koala, squirrel glider, yellow-bellied sheath-tailed bat *Saccolaimus flaviventris,* large-eared pied bat *Chalinolobus dwyeri,* eastern cave bat *Vespadelus troughtoni*
Likely to occur
painted honeyeater, hooded robin, *greater long-eared bat Nyctophilus timoriensis*
Potentially occurring
Booroolong frog, square-tailed kite, swift parrot, barking owl, masked owl, regent honeyeater, grey-crowned babbler, brush-tailed rock-wallaby, grey-headed Flying-fox *Pteropus poliocephalus* eastern bent-winged bat *Miniopterus schreibersii oceanensis.*

(Source: Andren, 2004)

Brush-tailed rock wallabies once occurred throughout the study area but are now restricted to a few records in the Mt Kaputar area. Removal of threatening process and increased connectivity will help maintain and potentially increase this remnant population.

Significance for Climate Change

The Mt Kaputar area appears to have served as climate change refugia in the past due to its ruggedness, high altitude habitats and volcanic soils. Improving connectivity along this Horton – Melville Range corridor to the north and south of this area will provide both altitudinal and latitudinal gradients connecting north-south ranges across substantially cleared floodplain landscapes. This should benefit mobile species in these areas as habitat resources shift and alter as a result of climate change.

The corridor also occurs along an area where more inland western plains fauna overlap with slopes, tablelands and in the south coastal fauna. Many species here are at the edge of their distribution. Conserving many populations of a species across its distribution enables a species to retain its capacity to adapt to a changing climate (Taylor & Figgis, 2007).

Reference Species: woodland birds and brush-tailed rock-wallaby

7.2.6 Mole River – Tenterfield Plateau

The Mole River – Tenterfield Plateau corridor extends east from the Bebo – Bonshaw corridor at Watsons Crossing. The corridor complex contains multiple arms that extend and link to the “Torrington” and “Torrington – Bolivia Hill” to the south, and Timbarra Plateau and Boonoo Boonoo – Bald Rock in the east. This corridor may also potentially extend northwards into Sundown National Park in Queensland west of Stanthorpe.

Geology

The geological formations within the corridor are many and varied. Predominant geological features include large areas of granite, adamellite, conglomerate and alluvial sediments.

Altitudinal and Climatic Gradients.

This corridor continues a pattern of increasing altitude from the eastern section of the Bebo-Bonshaw Corridor further east along the northwest slopes and up onto the New England Tablelands. Altitudes range from around 400 – 500m ASL up to approx1250 at Mount Mackenzie. The increase in altitude is relatively mild averaging approximately an increase of 100m per 10 kilometres. Maximum average temperatures vary from 30°C– 31°C in the west to 25°C – 26°C in the eastern highlands. Minimum average temperatures reach 10°C – 12°C in the north-west to 4°C - 3°C in the southern section of the corridor.

Vegetation

The Mole River - Tenterfield Plateau Corridor is a complex system of corridors across varied landscapes within several subregions. Therefore vegetation communities are many and varied. This provides some significant gradients of vegetation in relation to the changes to altitude, moisture content, fertility and geology. For example the western sections of the corridor are predominantly vegetated with dry sclerophyll forests such as White Pine/Silver-leaved Ironbark/Tumbledown Gum and Silver-leaved Ironbark/Black Pine/White Box Shrubby Open Forest and Tumbledown Red Gum/Caley’s Ironbark Shrubby Forest. The eastern section contains high altitude dry sclerophyll communities such as Dry Open New England Blackbutt, Dry Grassy Stringybark and New England Stringybark – Peppermint.

The changes in vegetation across this corridor reflect a gradient from the low altitude predominately dry environments in the west to the higher altitude, and more reliable rainfall, dry forests of the northern tablelands.

Fauna

Key Habitat

This corridor contains significant areas of key habitat for the Mole River fauna sub-region (Andren, 2004) and the dry granite tablelands fauna assemblage (Scotts, 2003). Approximately 4780ha of key habitat for Threatened species or species of conservation concern is mapped within the corridor.

The following table shows TSC Act listed, fauna species that are known, likely or potentially occurring in the Nandewar key habitat for the fauna sub-region, Mole River.

Mole River Fauna Assemblage

Known to occur
Border thick-tailed gecko *Underwoodisaurus sphyrurus,* glossy black-cockatoo, turquoise parrot, brown treecreeper, speckled warbler, grey-crowned babbler, diamond firetail, koala, eastern bent-winged bat *Miniopterus schreibersii oceanensis, greater long-eared bat Nyctophilus timoriensis,* greater broad-nosed bat *Scoteanax rueppellii,* eastern cave bat *Vespadelus troughtoni*.
Likely to occur
hooded robin, black-chinned honeyeater
Potentially occurring
square-tailed kite, barking owl, masked owl, swift parrot, regent honeyeater, painted honeyeater, black-throated finch, spotted-tailed quoll, squirrel glider, brush-tailed rock-wallaby, yellow-bellied sheath-tailed bat *Saccolaimus flaviventris,* large-eared pied bat *Chalinolobus dwyeri,* eastern false pipistrelle *Falsistrellus tasmaniensis,* Beccari's free-tailed bat *Mormopterus beccarii*

(Source: Andren, 2004)

Species of conservation concern of the Dry Granite Tablelands fauna assemblage are listed below (Scotts, 2003).

Dry Granite Tablelands Fauna Assemblage

border thick-tailed Gecko *Underwoodisaurus sphyrurus,* the skink *Ctenotus Eurydice,* turquoise parrot, Edwards lyrebird, chestnut-rumped heathwren, greater broad-nosed bat *Scoteanax rueppelli*, inland broad-nosed bat *Scotorepens balstoni*

(Source: Scotts, 2003)

Significance for Climate Change

This corridor complex will improve connectivity for isolated populations of greater glider and the common wombat which are at the edge of their ranges in this part of the study area. The northern limit of the distribution of the common wombat is in the

Stanthorpe area about 100 km to the north and it is restricted to environments of high altitude and cool temperatures in the Great Dividing Range. Projected higher mean annual temperatures may place additional pressures on the already fragmented populations. Revegetation and removal of threatening process in this corridor should improve the natural resilience of this iconic species. Greater gliders have limited dispersal ability and are generally limited by a lack of hollow bearing trees required for dens. Planting of suitable Eucalypt trees and nest box establishment programmes, in and around existing habitat, in the eastern section of this corridor complex will benefit this important species.

Reference Species: Brush-tailed Rock-wallaby and Woodland Birds

7.2.7 Northern Basalts – Woodsreef Corridor

The Northern Basalts – Woodsreef Corridor is a latitudinal corridor that extends 180km from Rocky Dam, west of the Macintyre River to the southern limit of the Great Serpentinite Belt at Woodsreef, approx 10km east of Barraba.

Geology

This corridor essentially runs the entire length of the Great Serpentinite Belt of the Woodsreef Melange from Warialda to Woodsreef and the geology of the corridor is significantly influenced by this phenomenon and the geological events that created it. Geology types adjacent the Great Serpentinite Belt include chemical sediments and intermediate extrusives of chert and andesite.

Altitudinal and Climatic gradients

The corridor represents a significant latitudinal transect (180km) and gradient of altitude. Altitudes generally increase towards the south and on the eastern side of the corridor. Altitude gradually and consistently increase from around 300 and 400m in the north to approximately 700-800m ASL in the south.

Maximum, Minimum and Average temperature gradients follow the altitudinal and latitudinal changes. Maximum and minimum temperatures of 32 C and 17 C respectively are recorded in the northern section of the corridor. These graduations shift towards the south where the cooler maximum and minimum average temperatures are recorded of approximately 29.6 C and 3 C respectively. Mean annual temperatures range from about 17.6 in the north to 14.8 and shift incrementally along the altitudinal gradients.

Vegetation

The occurrence of Serpentinite geological formations supports a regionally significant vegetation community referred to as Stringybark/Spinifix Serpentine Woodlands. This highly restricted community contains species such as Spinifex, usually found further west in arid areas, a grass tree *Xanthoreareah glauca* subsp. *angustifolia* which occurs mainly on rocky limestone and trachyte slopes, and the stringy bark *Eucalyptus macrorhyncha*.

Apart from the Serpentinite features, vegetation throughout the corridor maintains similar patterns. Large areas of White Pine and Tumbledown Red Gum Shrubby Forest occur in the Bingara area, Black Pine and Northern Smooth-barked Apple is mapped throughout the Warialda area extending north. Mugga Ironbark communities occur more frequently in the south of the corridor near Barraba. Candidate Endangered Ecological Communities (EEC's) such as White Pine/White Box shrub/ Grass Open Forest and White Pine/silver-leaved Ironbark/White Box Shrub/Grass Open Forests occur between Warialda and Bingara.

Fauna

Key Habitat

This Corridor system spans across four Nandewar key habitat fauna sub-regions. These include a large area of mapped key habitat for the Bingara fauna sub-region and a small area of the Northern Plains fauna sub-region (described in the Granite Belt conservation summary in section 7.1.4). The corridor links the key habitats in the Manilla – Cobbadah fauna sub-region (described in the Bingara – Manilla conservation summary in section7.1.2) to the Warialda – Bunal fauna sub-region.

The tables below describe the known, likely and potentially occurring Threatened species in the key habitats of the Bingara fauna sub-region.

Bingara Fauna subregion

Known to occur
border thick-tailed gecko *Underwoodisaurus sphyrurus,* turquoise parrot, masked owl, brown treecreeper, speckled warbler, black-chinned honeyeater, hooded robin, grey-crowned babbler, diamond firetail, koala, squirrel glider, yellow-bellied sheath-tailed bat *Saccolaimus flaviventris,* little pied bat *Chalinolobus picatus,* greater long-eared bat *Nyctophilus timoriensis.*
Likely to occur
square-tailed kite, painted honeyeater
Potentially occurring
swift parrot, barking owl, regent honeyeater, spotted-tailed quoll*,* black-striped wallaby, grey-headed flying-fox *Pteropus poliocephalus*, large-eared pied bat *Chalinolobus dwyeri,* eastern bent-winged bat *Miniopterus schreibersii oceanensis,* eastern cave bat *Vespadelus troughtoni.*

(Source: Andren, 2004).

Significance for Climate Change

This corridor links vegetated areas which are populated by nectar dependent species such as the regent and black chinned honeyeaters who forage over wide ranges. The presence of large stands of red stringybark, white box and mugga ironbark provide a reliable food supply for honeyeater, flying-foxes and squirrel gliders. Improving the connectivity along this corridor will provide important food and foraging resources for wildlife in the future and will support migration and adaptation into different landscapes.

Reference Species: squirrel glider and woodland birds

7.2.8 Severn River Eastern Highlands

The Severn River Eastern Highlands Corridor complex is situated to the north of the Eastern Tablelands corridor complex. The corridor links areas of the Eastern Tablelands within the Torrington key habitat area and the Granite Belt corridor.

Geology

A large part of the corridor traverses rich geological formations from the Emmaville Volcanics group featuring basalt and rhyolite. This geology supports fertile and productive soils which have been heavily cleared for agricultural purposes. The south east arm of the corridor moves into a geology dominated by granite more typical of the eastern tablelands.

Altitudinal and Climatic Gradients

Altitude increases consistently from the north-west to the south-east of this corridor complex and varies from 450m ASL near Ashford to almost 1300m ASL at Black Mountain. Minimum temperatures follow the elevation with slightly more variation in average minimum temperatures than the maximum temperatures. Average minimum and maximum temperatures are measured at 31 C and 13 C respectively towards the west at lower altitudes and 4 C and 23 C (min and max) in the south east section.

Vegetation

Vegetation communities are generally quite typical of the highly productive landscapes within the north-west slopes and have been subject to significant clearing. There are many vulnerable and endangered communities. The eastern areas of the corridor feature Orange Gum/Ironbark, Red Gum Stringybark, and Peppermint Mountain/Manna Gum. The lower elevations in the west include examples of Orange Gum/Black Pine Shrubby Open Forest; north-east, Black Pine/Tumbledown Red Gum/Narrow-leaved Ironbark Shrubby Open Forest; north-east, Black Pine/Tumbledown Red Gum/Narrow-leaved Ironbark/Red Stringybark Shrub/Grass Open Forest; Severn River and Caley's Ironbark/Orange Gum/Black Pine Shrubby Open Forest; Severn River.

Fauna

Key Habitat

The corridor predominately features key habitat for the Severn River – King’s Plains fauna sub-region (Andren, 2004) with some areas to the east identified as key habitats for the Dry Western Tablelands and Dry Granite Tablelands faunal assemblage (Scotts, 2003).

Threatened species known, likely and potentially occurring in key habitat for the Severn River – Kings Plain fauna sub-region are listed below:

Severn River – King's Plains fauna Sub-region

Known to occur
border thick-tailed gecko *Underwoodisaurus sphyrurus,* square-tailed kite, glossy black-cockatoo, turquoise parrot, brown treecreeper, speckled warbler, black-chinned honeyeater, hooded robin, diamond firetail, spotted-tailed quoll, koala, squirrel glider, eastern bent-winged bat *Miniopterus schreibersii oceanensis.*
Likely to occur
yellow-bellied sheath-tailed bat *Saccolaimus flaviventris.*
Potentially occurring
barking owl, masked owl, swift parrot, grey-crowned babbler, regent honeyeater, painted honeyeater, black-throated finch, brush-tailed rock-wallaby, large-eared pied bat *Chalinolobus dwyeri,* eastern false pipistrelle *Falsistrellus tasmaniensis,* greater long-eared bat *Nyctophilus timoriensis,* greater broad-nosed bat *Scoteanax rueppellii*, eastern cave bat *Vespadelus troughtoni.*

(Source, Andren, 2004)

Priority species identified by Scotts (2003) for the Dry Western Tablelands faunal assemblage are listed below:

Dry Western Tablelands Faunal Assemblage

bush stone-curlew, musk lorikeet, hooded robin, grey crowned babbler, yellow tufted honeyeater, painted honeyeater

(Source: Scotts, 2003)

The eastern regions of the corridor complex contain significant areas of granite geology and key habitat for fauna of the dry granite tablelands faunal assemblage priority species, which are listed below:

Dry Granite Tablelands Faunal Assemblage

border thick-tailed Gecko *Underwoodisaurus sphyrurus,* the skink *Ctenotus Eurydice,* turquoise parrot, Edwards lyrebird, chestnut-rumped heathwren, greater broad-nosed bat *Scoteanax rueppelli*, inland broad-nosed bat *Scotorepens balstoni*

(Source: Scotts, 2003)

Significance for Climate Change

The central section of this corridor provides connectivity between the Torrington SCA, Severn River NR and Kings Plains NP. This large area of mostly contiguous forest provides habitat for squirrel gliders, woodland birds and a regionally significant koala population. This core area of key habitat extends across a wide altitudinal gradient and may potentially provide some ecological resilience against climate change by provision of opportunities for adaptation and migration.

Reference Species: koala and squirrel glider

7.2.9 West Macintyre

The West Macintyre corridor extends south from the most western edge of the Bebo – Bonshaw corridor. The corridor continues along the western side of the Macintyre River and links to the Northern Basalts – Woodsreef Corridor south of Burral Yurrul NP.

Geology

The underlying geology is predominantly composed of Pilliga sandstone formations and forms a latitudinal extension from the core area of similar sandstone communities at Dthinna Dthinnawan. Soils are well drained, low fertility quartz sandy soils.

Altitudinal and Climatic Gradients

The corridor contains both altitudinal and latitudinal gradients from the northern section to the southern section. Altitudes range from 250m ASL at Yetman to approximately 500m ASL in the upper reaches of Simpsons Creek. Latitudinal variation extends over a distance of 40km north – south. Average minimum temperatures vary from 27°C at the northern edge of the corridor to 15°C in the south-east. Maximum average temperatures vary less than that of the minimum temperatures with recordings of 32°C – 33°C in the north and 31°C in the south-east.

Vegetation

In the north of the corridor just west of Yetman, Black Pine/Narrow-leaved Ironbark communities reside in the low fertility sandy soils of the Pilliga sand beds. White Pine/Narrow leaved Ironbark occurs in the higher fertility soils in the alluvial and drainage areas. The occurrence of Angophora within the Black Pine – Smooth-barked Apple community is predominant in areas subject to increased moisture and drainage areas.

Vegetation communities in the south of the corridor contain many similar species although at higher altitudes. These communities consist of predominantly White Pine/Silver-leaved Ironbark Grassy Forests and Narrow-leaved Ironbark/Pine/Brown Bloodwood Shrubby Forests. Other communities featured throughout the area include occurrences of Mugga Ironbark/Black Pine Shrubby Open forest, Black Pine/Northern Smooth-barked Apple Shrubby Open forests, Narrow-leaved Ironbark/Pine/Brown Bloodwood Shrubby/Grass Open Forest and Rough-barked Apple Riparian Forb/Grass Open Forest.

Fauna

Key Habitat

The southern section of the corridor is mapped to contain a large area of key habitat for the Warialda – Bunal (Andren, 2004). The northern section is highly likely to contain similar habitats to the Bebo-Bonshaw fauna assemblage given the occurrence of similar vegetation and geology. However, the area is outside the study area. The following table lists Threatened fauna species known, likely or potentially occurring in the Warialda Bunal fauna sub-region:

Warialda Bunal Fauna Sub-region

Known to occur
zig zag gecko *Oedura rhombifer* , border thick-tailed gecko *Underwoodisaurus sphyrurus,* turquoise parrot, brown treecreeper, speckled warbler, black-chinned honeyeater, hooded robin, grey-crowned babbler, diamond firetail, koala, squirrel glider, yellow-bellied sheath-tailed bat *Saccolaimus flaviventris*, little *pied bat Chalinolobus picatus,* eastern bent-winged bat *Miniopterus schreibersii oceanensis, greater long-eared bat Nyctophilus timoriensis*, eastern cave bat *Vespadelus troughtoni*
Likely to occur
painted honeyeater
Potentially occurring
square-tailed kite, glossy black-cockatoo, painted snipe, barking owl, masked owl, regent honeyeater, black-striped wallaby, delicate mouse, grey-headed flying-fox *Pteropus poliocephalus,* large-eared pied bat *Chalinolobus dwyeri*

(Source: Andren, 2004)

Significance for Climate Change

This well vegetated corridor is poorly surveyed but potentially could provide connectivity for populations of black-striped wallaby and delicate mouse in Dthinna Dthinnawan and reserves to the south. Both species are at the southern edge of their ranges and highly threatened.

Reference Species: black-striped wallaby and delicate mouse

7.3 Priorities for VCA covenants and other private land mechanisms

Priorities were identified through an iterative process of analysis with reference to the following criteria.

1. Significant areas of key habitat for threatened fauna species – either threatened or of conservation concern.
2. Areas adjacent to existing reserves or clear linkages between reserves.
3. Identified as important key habitat areas functioning as a stepping stone corridors.

7.4 Priority Areas

Tenterfield Area

- Key Habitats of the Bebo – Bonshaw fauna subregion adjacent to Dthinna Dthinnawan NP.

- Significant areas of Key Habitat of the Warialda – Bunal fauna subregion linking between Burral Yurrul NP and NR, Taringa NP and Kwiambal NP.

- Key Habitats of the Warialda – Bunal fauna subregion that form links between Kwiambal NP and Maroomba SCA.

- Key Habitats of the Dry Granite Tablelands faunal assemblage adjacent to and/or linking sections of Torrington NP.

- Woodland bird habitats within the Severn River – Kings Plain fauna sub-region between Severn River and Kings Plain NPs

Glen Innes Area

- Woodland Bird Habitats within the Severn River – Kings Plain fauna sub-region between Severn River and Kings Plain NPs

- Key Habitats of the Severn River – Kings Plains fauna sub-region adjacent to and nearby Fladburry SCA.

- Key Habitat of the Tingha Plateau fauna sub-region adjacent to or forming links to Goonoowigal SCA. Tingha Plateau is poorly represented IBRA sub-region and fauna sub-region.

Armidale Area

- Key Habitats of the Kaputar – Horton Range fauna sub-region south of Terry Hie Hie AA forming connectivity towards Horton NP.

- Key Habitats adjacent to Horton NP to increase size and improve viability of this protected area.

- Key Habitats of the Kaputar Horton Range fauna sub-region extending south from Kaputar NP

- Key Habitats of the Central Granite Belt linking up existing reserves.

- Key Habitats of the Tingha Plateau fauna sub-region linking existing reserves and west-wards towards the Granite Belt fauna sub-region.

- Key Habitats adjacent to Stony Batter NR and Linton NR to improve viability of those reserves

- Key Habitats adjacent to Warrabah NP to enhance viability of reserve

- Key Habitats adjacent to Watsons Creek NR to improve size and viability of reserve and form links north to Warrabah NP and south to the Nundle-Moonbi fauna sub-regional key habitat.

Walcha Area

- Key Habitats of the Melville Range – Southern Plains fauna sub-region adjacent to and forming links from Melville Range NR.

- Key Habitats of the Nundle – Moonbi fauna sub-region around Attunga SF.

- Key Habitats of the Nundle – Moonbi fauna sub-region east and southeast of Tamworth.

Upper Hunter Area

- Key Habitats of the Melville Range – Southern Plains fauna sub-region linking from Melville Range NP south towards Wallabadah.

- High Conservation Value vegetation communities and fauna habitats along the Liverpool Ranges. Adjacent to/linking between Coolah Tops and Towarri NP creating connectivity along the Liverpool Ranges.

- Key Habitats adjacent to Wallabadah NR to improve reserve viability

7.5 Recommended Conservation Actions

7.5.1 Key Habitat

The characteristics of this corridor feature are predominantly high levels of vegetated land, presence of high conservation value (HCV) forest and a level of continuity with adjacent areas of vegetation or reserves or other public land. The priorities in these areas would generally be focused on the protection of the existing high conservation value features, or some enhancement of existing vegetation through plantings, weed management and removal threatening processes.

7.5.2 Reserve Buffers and Linkages

These corridor features are predominantly delineated around or linking existing formal reserves and some other public lands. The areas are predominantly vegetated and contain large areas of key habitats and other high conservation value features such as old growth forest, wetlands, rainforest and forest and have often been subject to less disturbance and fragmentation. The focus for conservation action in these areas would be the perpetual protection of HCV values and key habitat directly adjacent to existing reserves or in areas likely to form linkages between reserves, preferably those areas identified as key habitat.

7.5.3 Stepping Stone Key Habitat

These areas are classically fragmented and contain remnant vegetation that may be vulnerable to degradation due to edge effects. The areas are somewhat compromised in terms of viability for acting as wildlife corridors for species which will not disperse large distances over open areas but can be utilised by other species, especially bats and birds. In some instances they are more effective than narrow linear corridors which are dominated by edge loving species and thus represent important priority areas that require consolidation, maintenance and protection. The priorities in these areas would include;

- strategic re-establishment of vegetation,
- rehabilitation - weed management, feral animal removal
- formal protection of existing remnants
- nest boxes.

7.5.4 Valley Floor Linkages

The cleared valley floors of the study area represent major barriers to dispersal for many species. It is recognised that considerable resources would be required to complete these links however their importance should not be ignored. The higher productivity, access and permanent water of the major river systems will make these areas a high priority for conservation activities to address climate change. These have been refugia in past droughts and should be a high priority for future conservation efforts. Projected increased salinity in these areas may mean land becomes available for conservation as farming becomes unviable. Any program of re-vegetaion will be of value in improving the viability of these areas including wind breaks and linear corridors.

8 Limitations

8.1 Isolated vulnerable Habitats

It may not be possible to connect some vulnerable habitats, such as isolated wetlands due to geographic or geological conditions or islands by vegetative corridors. In these instances localised threatening process should be minimised and other conservation strategies explored.

8.2 Remnants and linkages in highly cleared landscapes

In some areas opportunities to establish Floodplain Stepping Stones may arise which are outside delineated corridors. If this occurs in heavily cleared areas it would be prudent to revegetate these areas if no other property is available in the area.

8.3 Riparian corridors

Riparian areas are natural corridors for many species and should be considered a priority to maintain and enhance. Riparian Corridors were not specifically delineated by Scotts (2003) as they are already clearly defined in the landscape.

Although riparian corridors are not extensively mapped in the project outputs, it is essential that these areas receive protection, re-habilitation and even expansion to help complement an overall landscape connectivity approach to climate change. Lindenmayer and Fisher, 2006 state that 'Riparian corridors or stream buffers are a particular type of corridor that can often be particularly effective at maintaining habitat connectivity (Kirchner et al. 2003; Hilty and Merenlender 2004). They provide habitat for large numbers of terrestrial and aquatic fauna and flora (Loyn et al. 1980: Naiman et al. 1993; Spackman and Hughes 1995). In addition, populations of several groups of species are more fecund in riparian areas (Sederquist and Mac Nally 2000), thereby providing more offspring to disperse to the less productive parts of the landscape.'

In terms of connectivity, however, Lindenmayer and Fisher, 2006 go on to state that' while riparian areas are useful for some terrestrial taxa, physical linkages outside the riparian zone are required to maintain landscape connectivity for other taxa (McGarigal and McComb 1992; Claridge and Lindenmayer 1994).

In terms of our recommendations for further corridor and landscape connectivity work, riparian corridors should feature strongly in any mapping of floodplain 'stepping stones' as an essential supplement to the existing broad corridors networks presented by this project.

9 Caveats

Lindenmayer and Fischer 2006 discuss some of the apparent disadvantages with wildlife corridors which should be considered. The discussion states that 'corridors may facilitate the spread of genes that break up co adapted gene complexes in naturally isolated population (Knopf, 1992). They may also exacerbate the spread of weeks, pest animals, diseases, and fires (Forney and Gilpin 1989). Corridors may be dominated by negative edge effects (Sisk and Margules 1993).

These disadvantages should be considered in the allocation of resources for conservation actions. Any re-establishment or rehabilitation of vegetation should also include strategic follow up actions and resources to reduce the impacts of weeds and edge effects and allow for the area to grow spatially and structurally.

10 Recommendations for Further work

- This project provides for the basis broad scale network of vegetated corridors, along climatic gradients linking with the Alps to Atherton continental scale corridor, to assist threatened wildlife populations adjust as projected ecological changes due to climate change occur.

- Further work to delineate stepping stone corridors across and between the most threatened landscapes such as highly cleared productive landscapes floodplains needs to be established as a major incentive to mitigate the increasing pressures of habitat fragmentation on faunal assemblages that rely on these landscapes and their habitat for survival.

- Further refinement is needed to define the corridor network at a local rather than regional scale to increase the effectiveness of the mapping for planning on ground conservation works at a property scale.

- Further research is needed to better understand the effects of climate change on biodiversity in the study region and the ecological processes that are likely to be under most pressure.

- Systematic fauna surveys are needed to determine the value of corridor linkages to different faunal assemblages.

- Research is needed on the population dynamics of vulnerable species in the study area to help improve strategies to maximise gene flow in a way which is of benefit to the species or population. This will assist in determining the effectiveness of different patch sizes for different species,

- Good baseline ecological data, such as current range and distribution, is lacking for the study area. Collecting this data should be a priority so that changes caused by climate change can be recognised. Migratory species are particularly important as changes in their arrival and departure times may signal the onset of dramatic changes.

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EXPERTS

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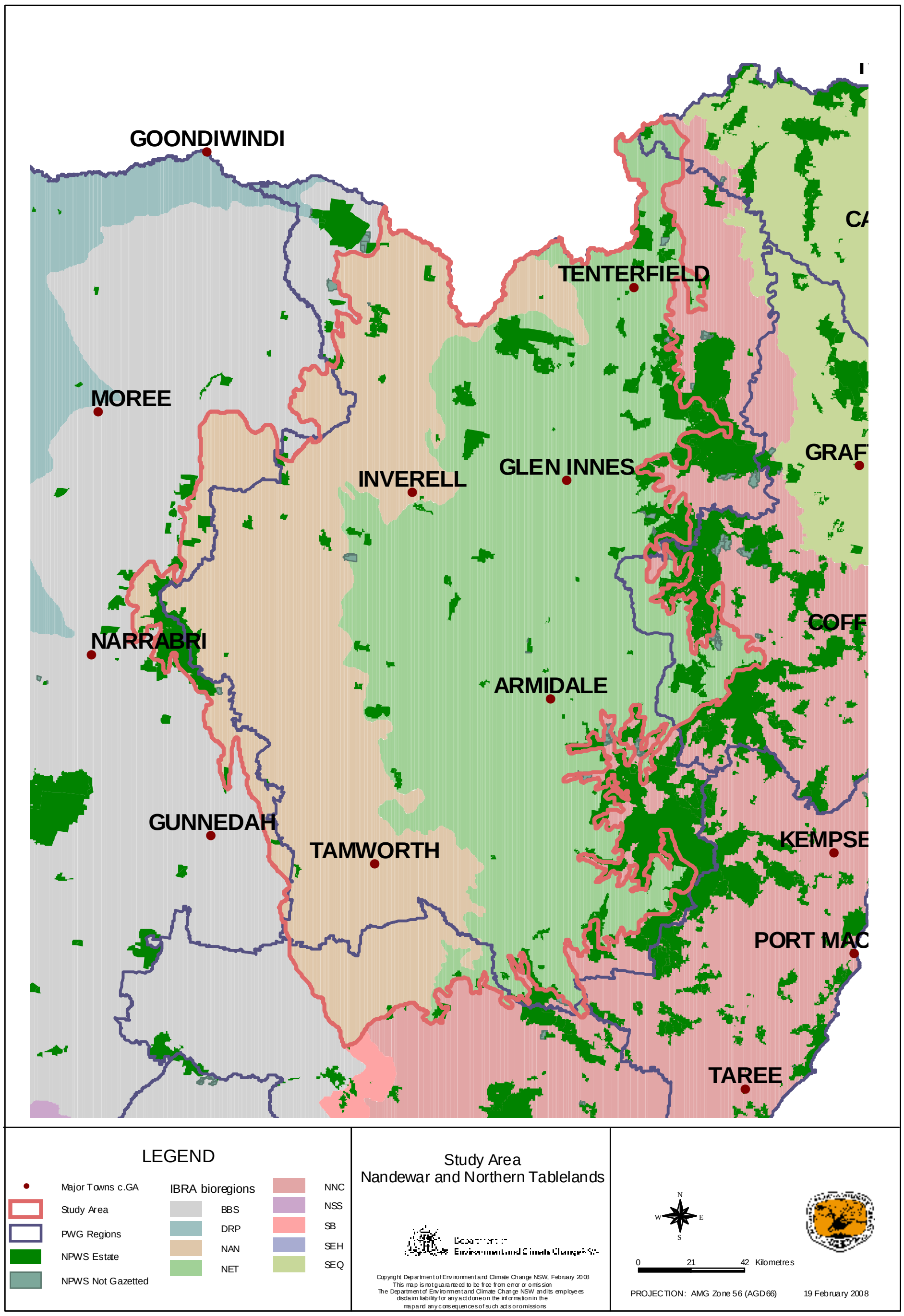
2. Kevin Taylor, Ecologist, Information and Assessment Officer. Dept Environment and Climate Change.

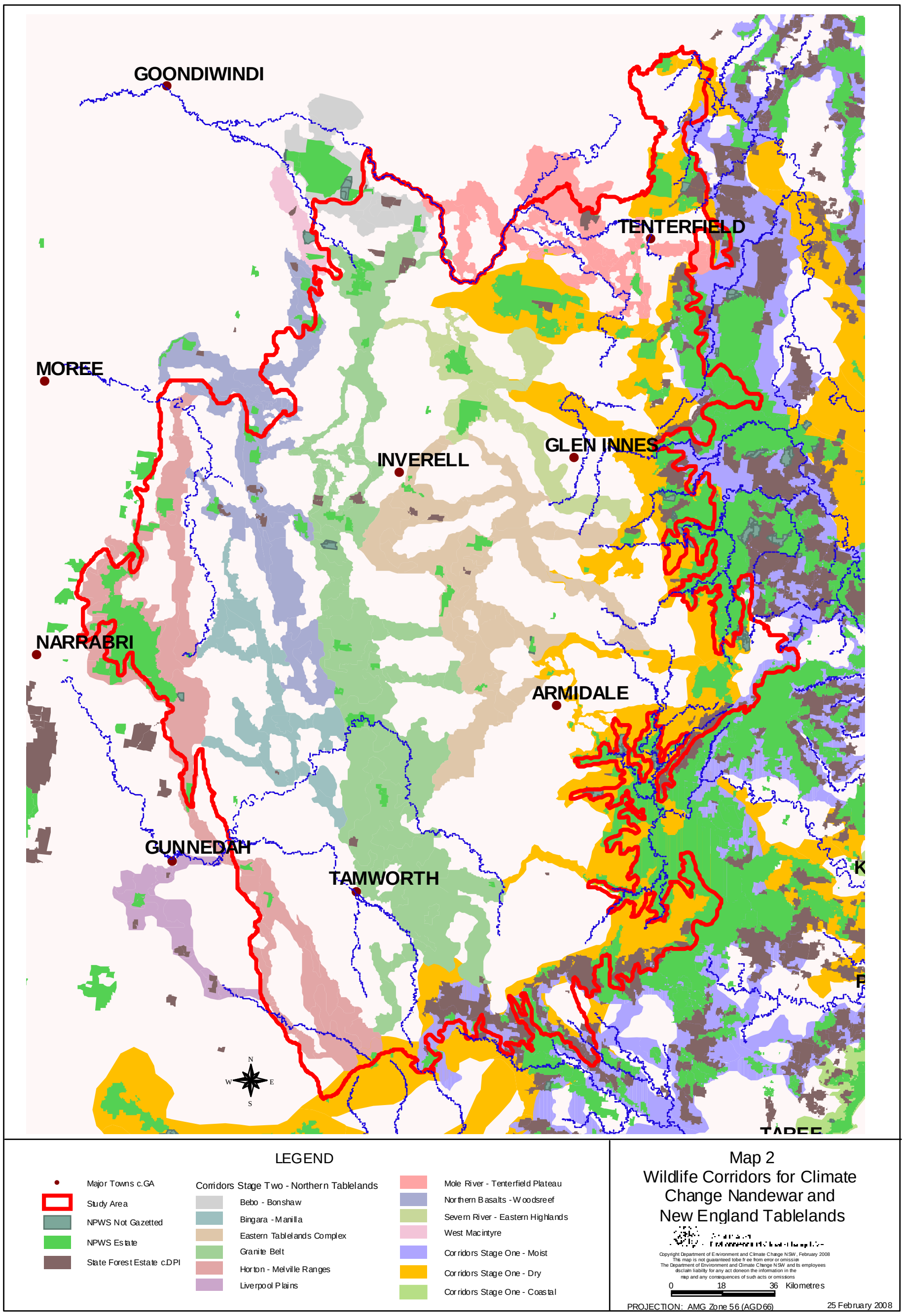
APPENDICIES

APPENDIX A

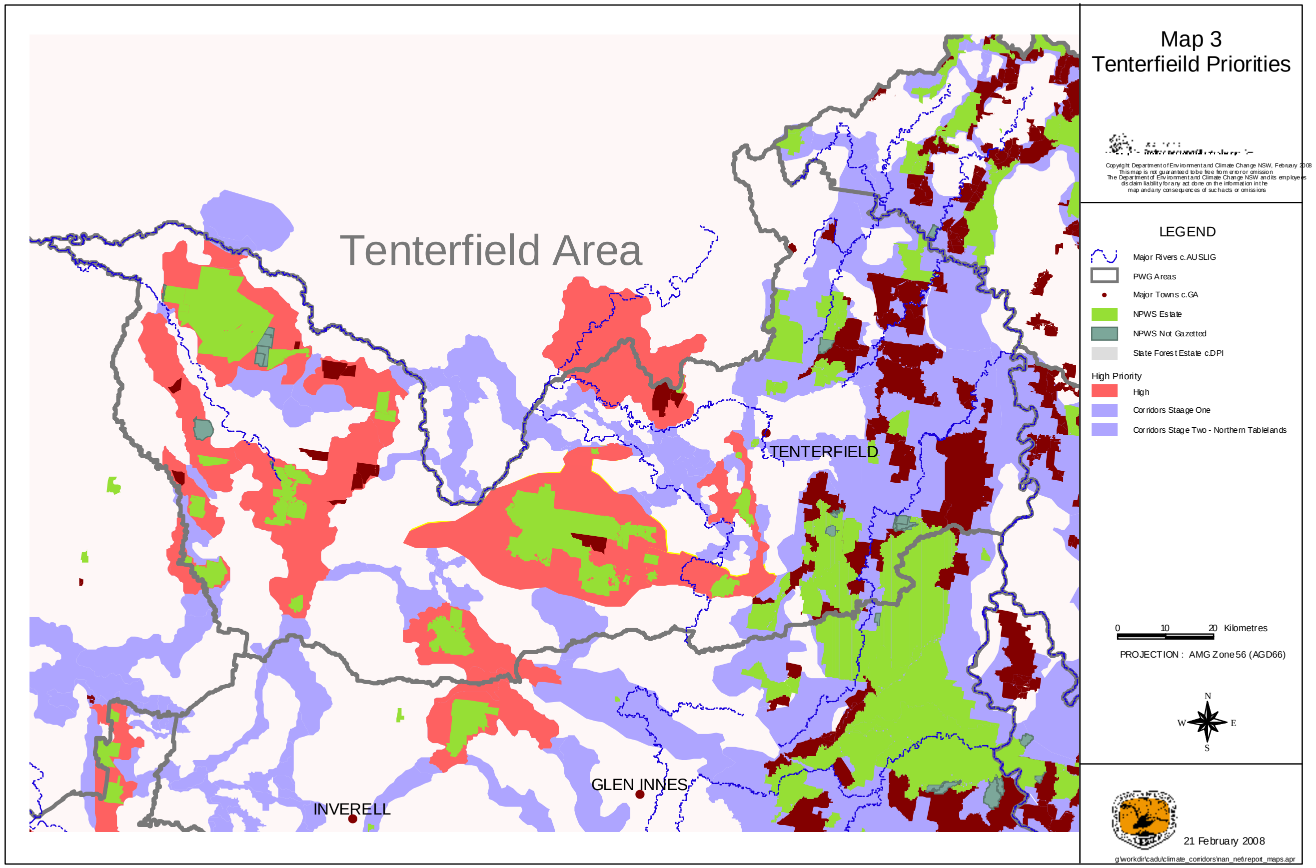
MAP 1: Study Area for Nandewar and New England Tablelands

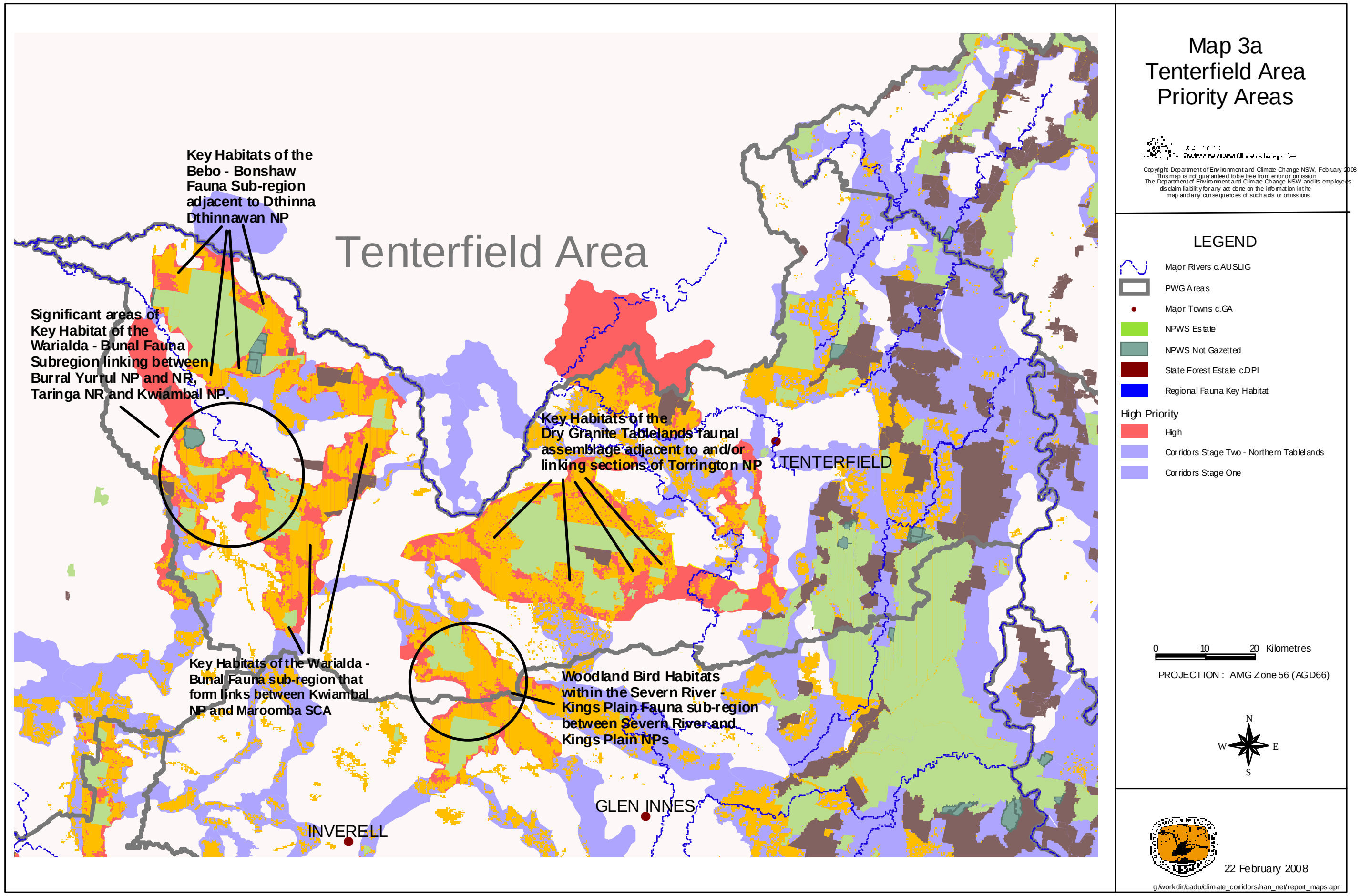


APPENDIX B: ***Map 2 - Climate Change Corridors for Nandewar and Northern Tablelands bioregions – shows linkage to Stage One: Wildlife Corridors for Climate Change***



APPENDIX C***: Maps of each PWG Area and VCA Priorities (Maps 3 – 7)***





Map 3a
Tenterfield Area
Priority Areas
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LEGEND
Major Rivers c.AUSLIG
PWG Areas
Major Towns c.GA
NPWS Estate
NPWS Not Gazetted
State Forest Estate c.DPI
Regional Fauna Key Habitat
High Priority
High
Corridors Stage Two - Northern Tablelands
Corridors Stage One
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PROJECTION : AMG Zone 56 (AGD66)
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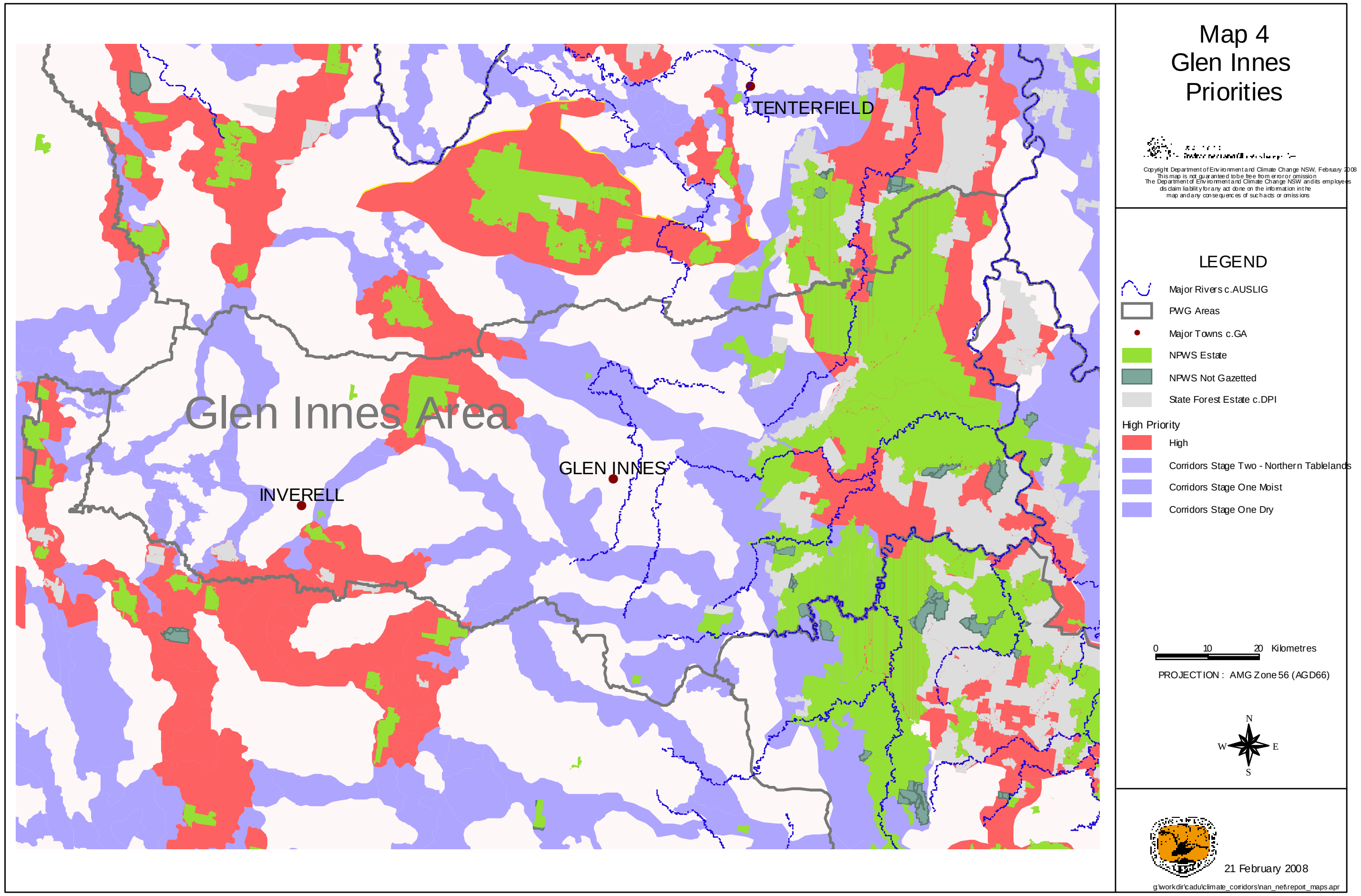
Tenterfield Area
Key Habitats of the Bebo - Bonshaw Fauna Sub-region adjacent to Dthinna Dthinnawan NP
Significant areas of Key Habitat of the Warialda - Bunal Fauna Subregion linking between Burral Yurrul NP and NR, Taringa NR and Kwiambal NP.
Key Habitats of the Dry Granite Tablelands faunal assemblage adjacent to and/or linking sections of Torrington NP
TENTERFIELD
Key Habitats of the Warialda - Bunal Fauna sub-region that form links between Kwiambal NP and Maroomba SCA
Woodland Bird Habitats within the Severn River - Kings Plain Fauna sub-region between Severn River and Kings Plain NPs
GLEN INNES
INVERELL



Map 4
Glen Innes
Priorities
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LEGEND
Major Rivers c.AUSLIG
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Major Towns c.GA
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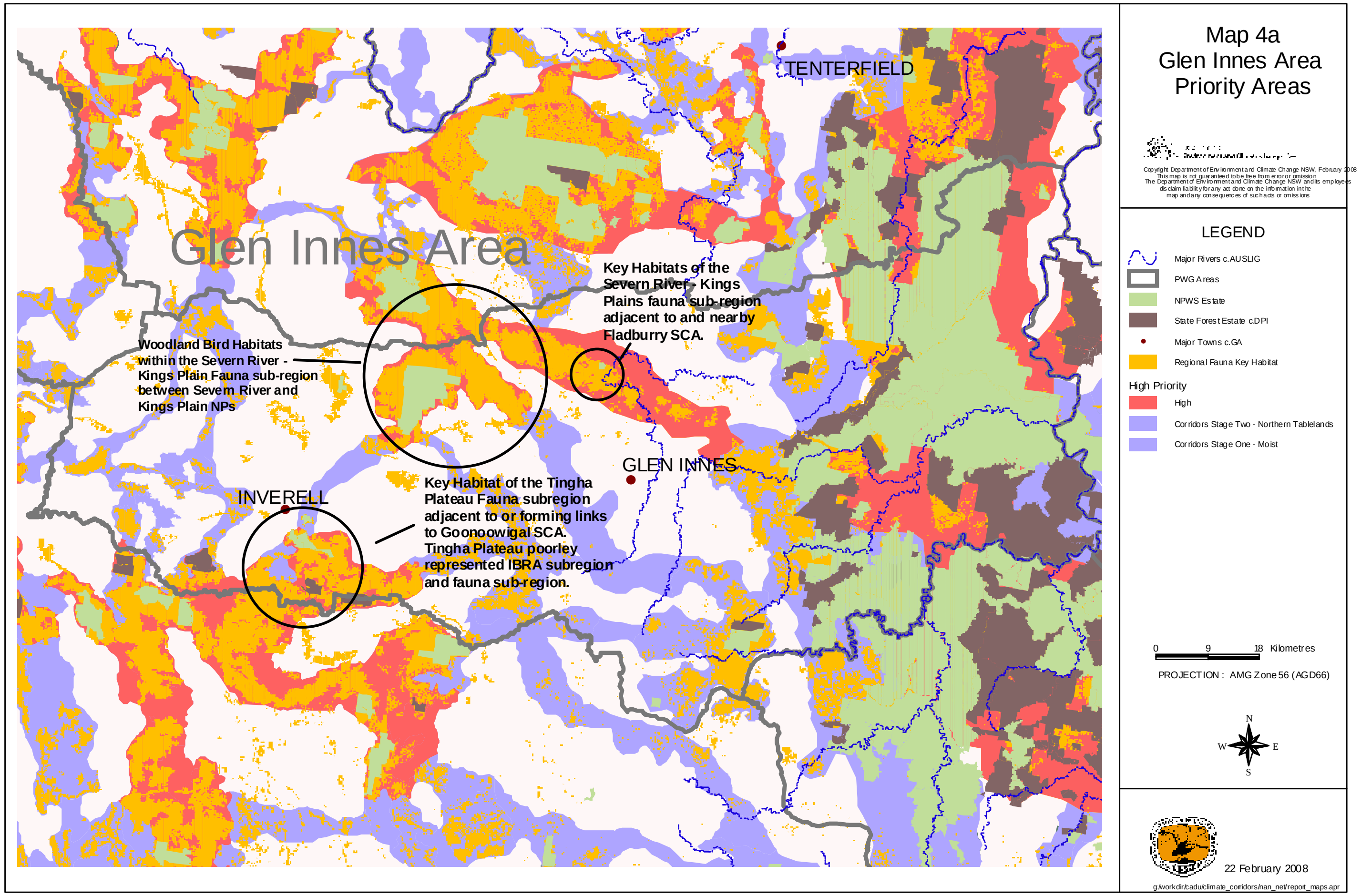

Map 4a
Glen Innes Area
Priority Areas
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State Forest Estate c.DPI
Major Towns c.GA
Regional Fauna Key Habitat
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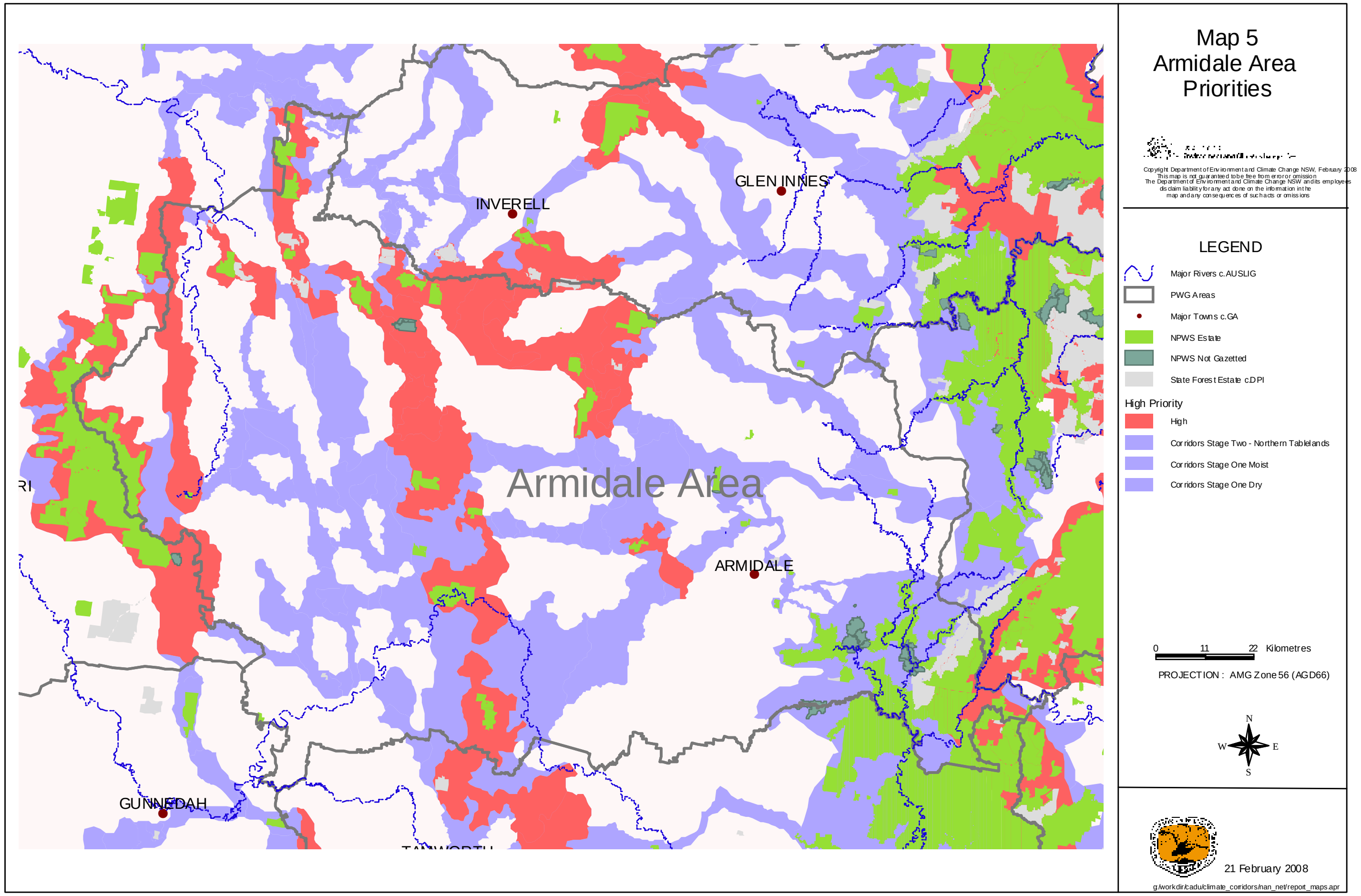
Glen Innes Area
Key Habitats of the Severn River - Kings Plains fauna sub-region adjacent to and nearby Fladburry SCA.
Woodland Bird Habitats within the Severn River - Kings Plain Fauna sub-region between Severn River and Kings Plain NPs
GLEN INNES
INVERELL
Key Habitat of the Tingha Plateau Fauna subregion adjacent to or forming links to Goonoowigal SCA. Tingha Plateau poorley represented IBRA subregion and fauna sub-region.



Map 5
Armidale Area
Priorities
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LEGEND
Major Rivers c.AUSLIG
PWG Areas
Major Towns c.GA
NPWS Estate
NPWS Not Gazetted
State Forest Estate c.DPI
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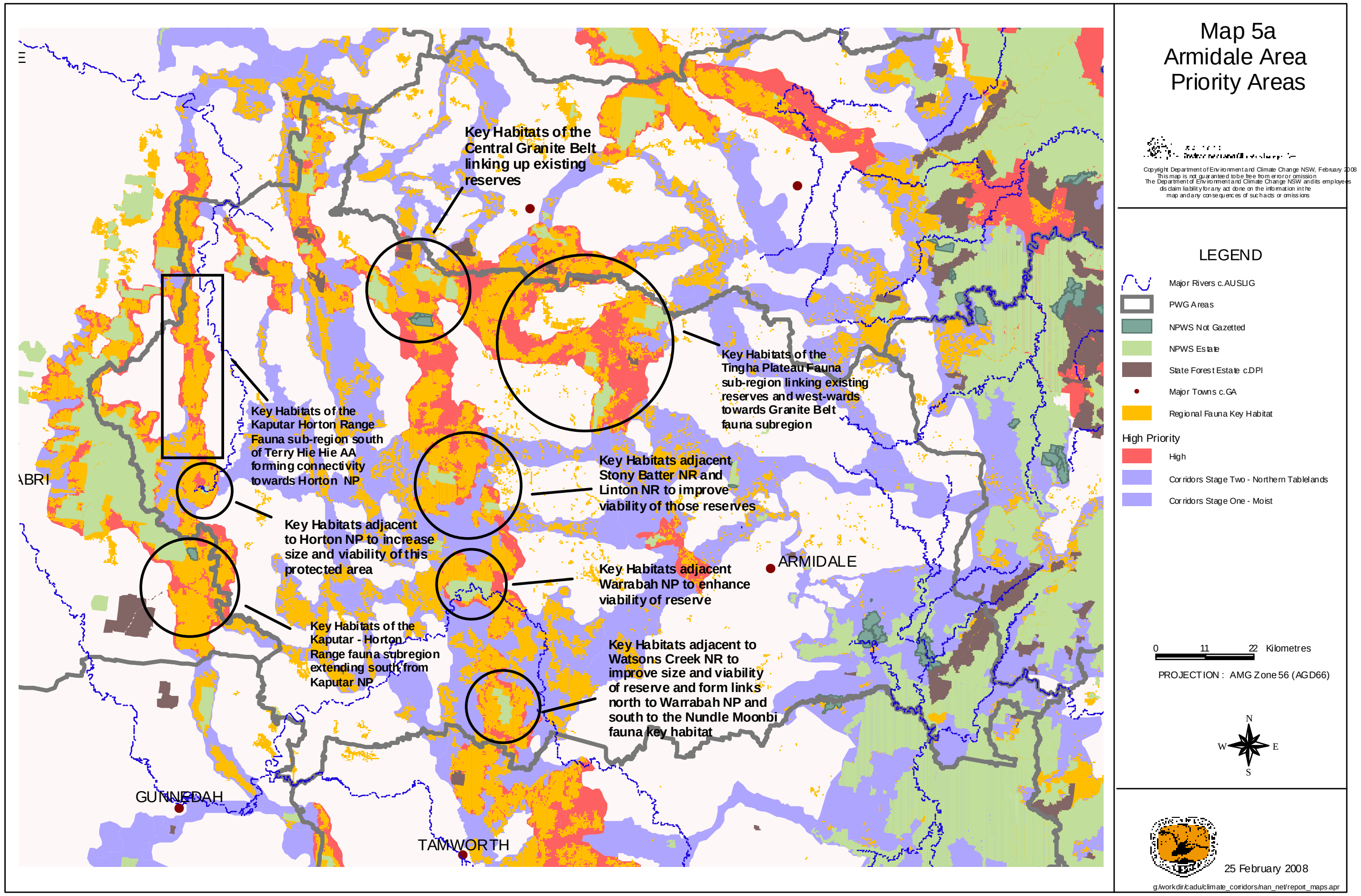

Map 5a
Armidale Area
Priority Areas
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LEGEND
Major Rivers c.AUSLIG
PWG Areas
NPWS Not Gazetted
NPWS Estate
State Forest Estate c.DPI
Major Towns c.GA
Regional Fauna Key Habitat
High Priority
High
Corridors Stage Two - Northern Tablelands
Corridors Stage One - Moist
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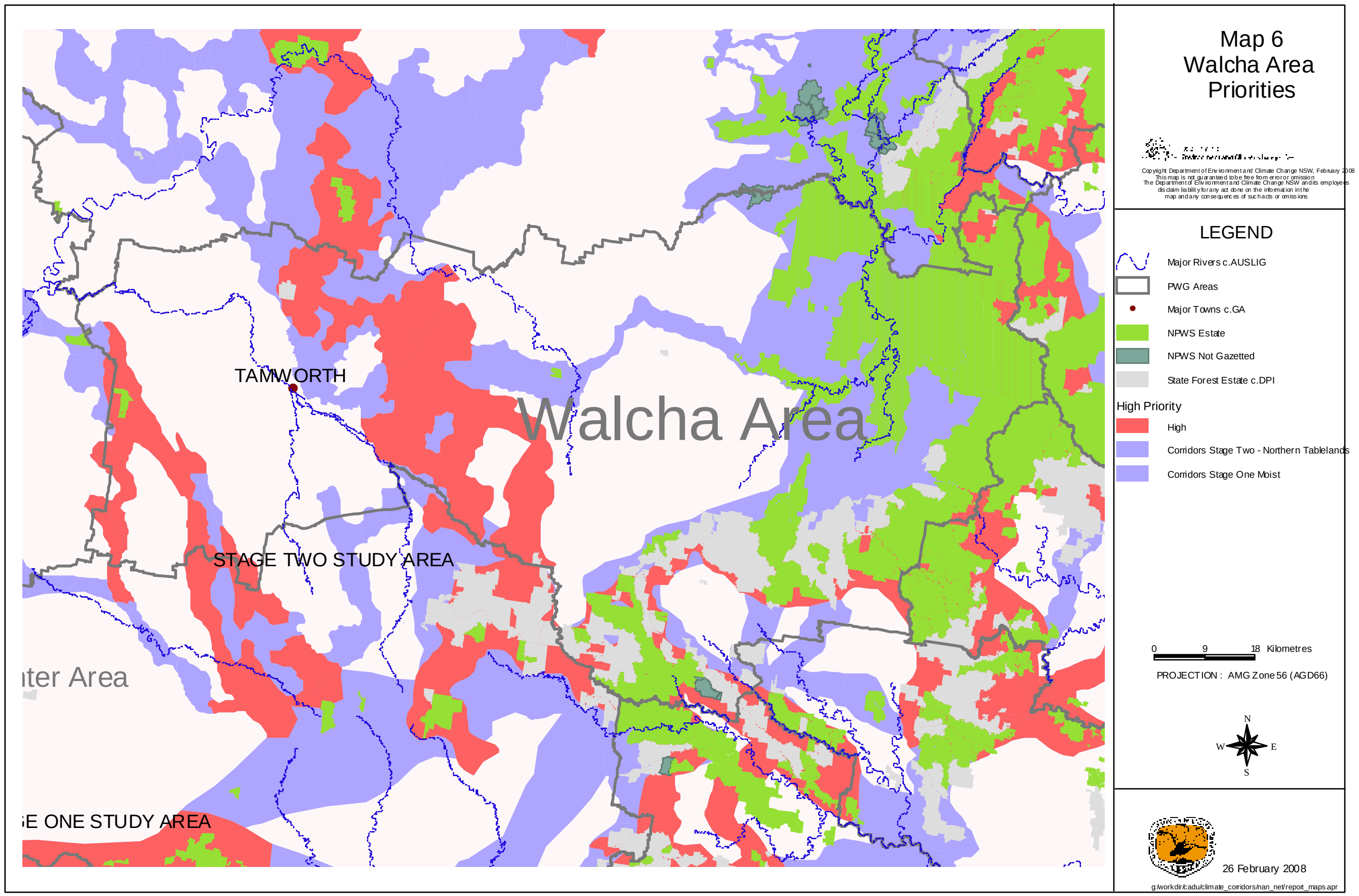
Key Habitats of the Central Granite Belt linking up existing reserves
Key Habitats of the Tingha Plateau Fauna sub-region linking existing reserves and west-wards towards Granite Belt fauna subregion
Key Habitats of the Kaputar Horton Range Fauna sub-region south of Terry Hie Hie AA forming connectivity towards Horton NP
Key Habitats adjacent Stony Batter NR and Linton NR to improve viability of those reserves
Key Habitats adjacent to Horton NP to increase size and viability of this protected area
Key Habitats adjacent Warrabah NP to enhance viability of reserve
ARMIDALE
Key Habitats of the Kaputar - Horton Range fauna subregion extending south from Kaputar NP
Key Habitats adjacent to Watsons Creek NR to improve size and viability of reserve and form links north to Warrabah NP and south to the Nundle Moonbi fauna key habitat
GUNNEDAH
TAMWORTH



Map 6
Walcha Area
Priorities
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map and any consequences of such acts or omissions
LEGEND
Major Rivers c.AUSLIG
PWG Areas
Major Towns c.GA
NPWS Estate
NPWS Not Gazetted
State Forest Estate c.DPI
High Priority
High
Corridors Stage Two - Northern Tablelands
Corridors Stage One Moist
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9
18 Kilometres
PROJECTION : AMG Zone 56 (AGD66)
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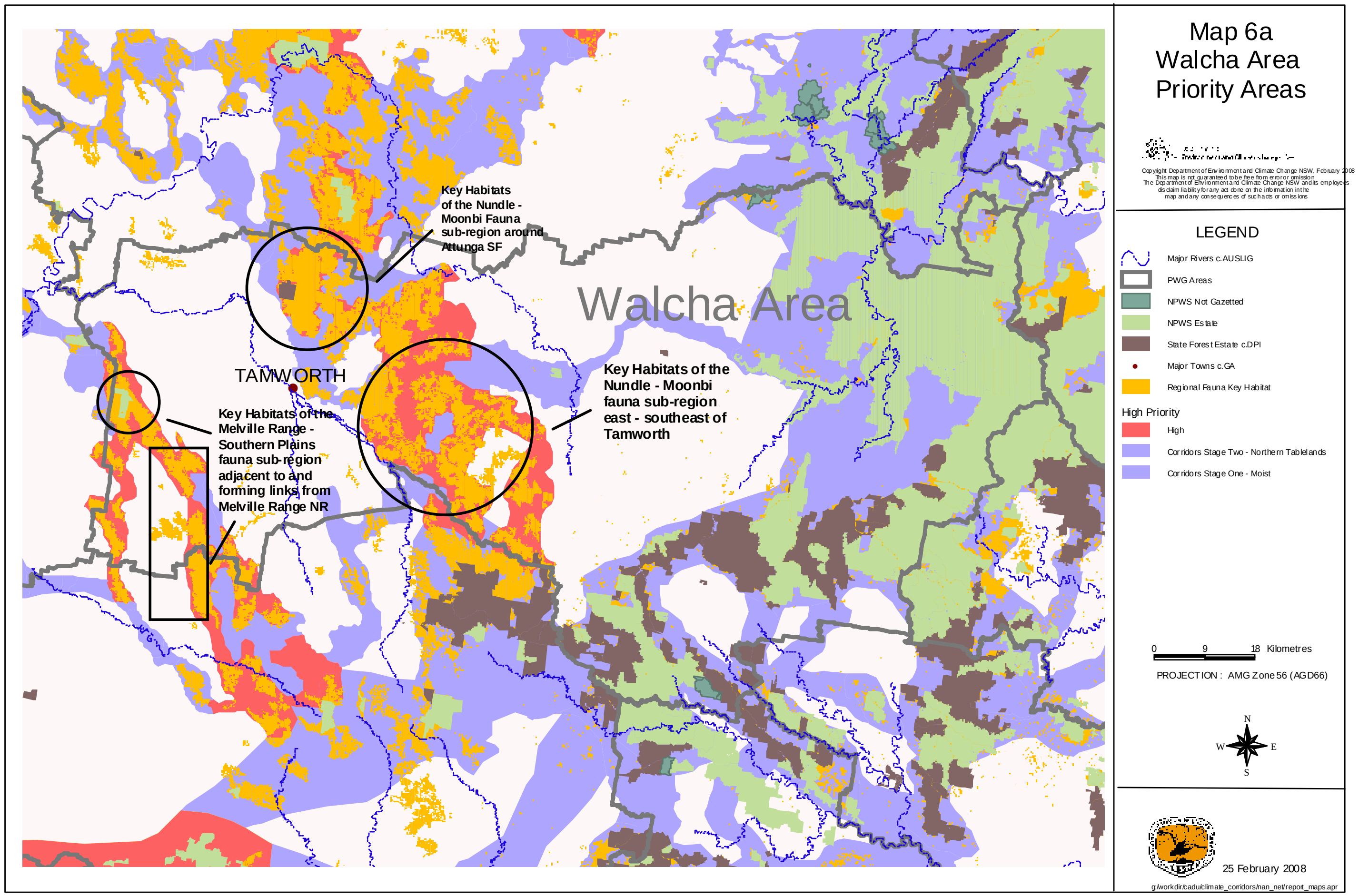
TAMWORTH
Walcha Area
STAGE TWO STUDY AREA
iter Area
E ONE STUDY AREA


Map 6a
Walcha Area
Priority Areas
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LEGEND
Major Rivers c.AUSLIG
PWG Areas
NPWS Not Gazetted
NPWS Estate
State Forest Estate c.DPI
Major Towns c.GA
Regional Fauna Key Habitat
High Priority
High
Corridors Stage Two - Northern Tablelands
Corridors Stage One - Moist
0 9 18 Kilometres
PROJECTION : AMG Zone 56 (AGD66)
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W
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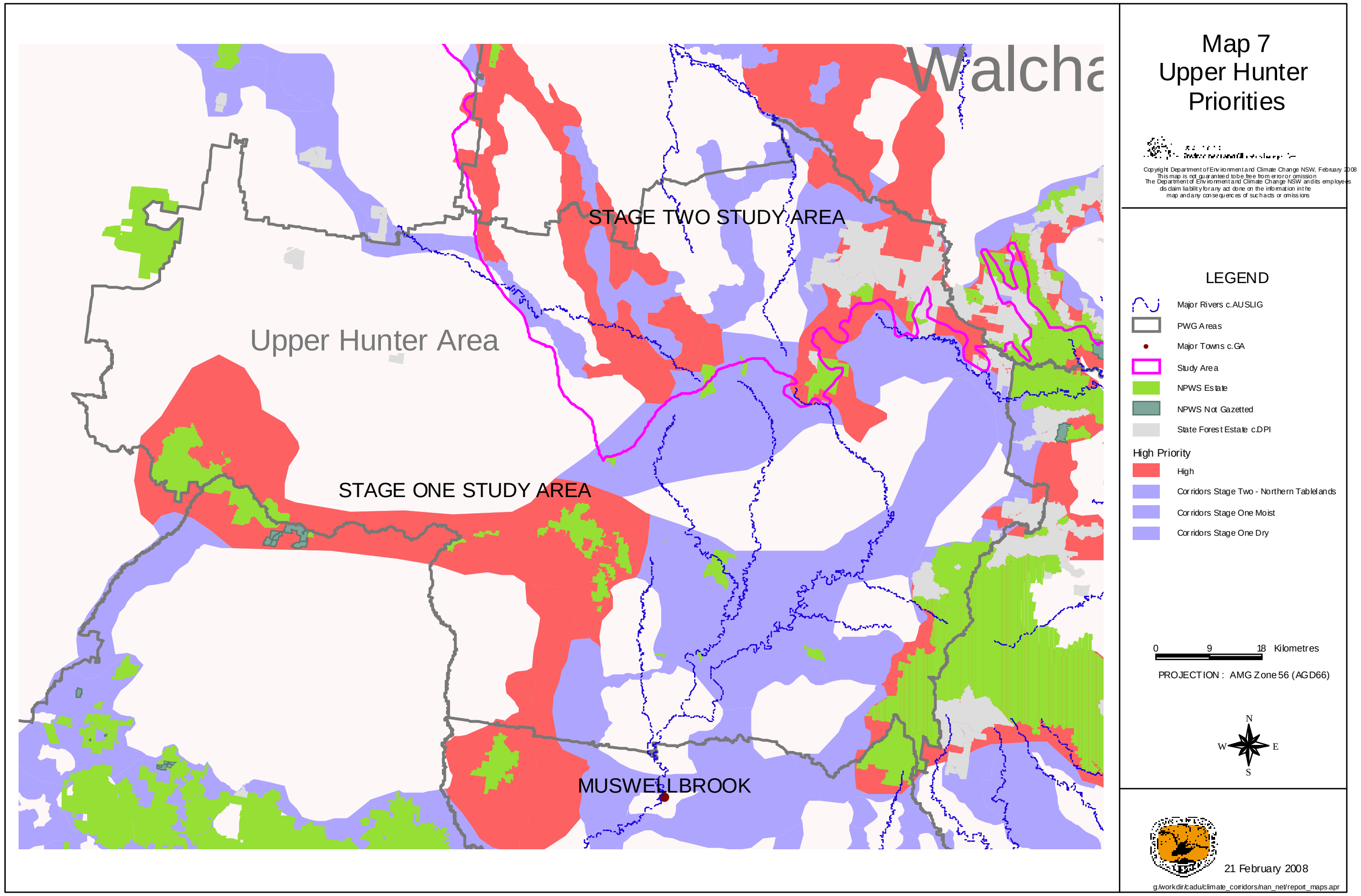
25 February 2008
g:/workdir/cadu/climate_corridors/nan_net/report_maps.apr
Walcha Area
TAMWORTH
Key Habitats of the Nundle - Moonbi Fauna sub-region around Attunga SF
Key Habitats of the Nundle - Moonbi fauna sub-region east - southeast of Tamworth
Key Habitats of the Melville Range - Southern Plains fauna sub-region adjacent to and forming links from Melville Range NR



Map 7
Upper Hunter Priorities
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LEGEND
Major Rivers c.AUSLIG
PWG Areas
Major Towns c.GA
Study Area
NPWS Estate
NPWS Not Gazetted
State Forest Estate c.DPI
High Priority
High
Corridors Stage Two - Northern Tablelands
Corridors Stage One Moist
Corridors Stage One Dry
0 9 18 Kilometres
PROJECTION : AMG Zone 56 (AGD66)
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21 February 2008
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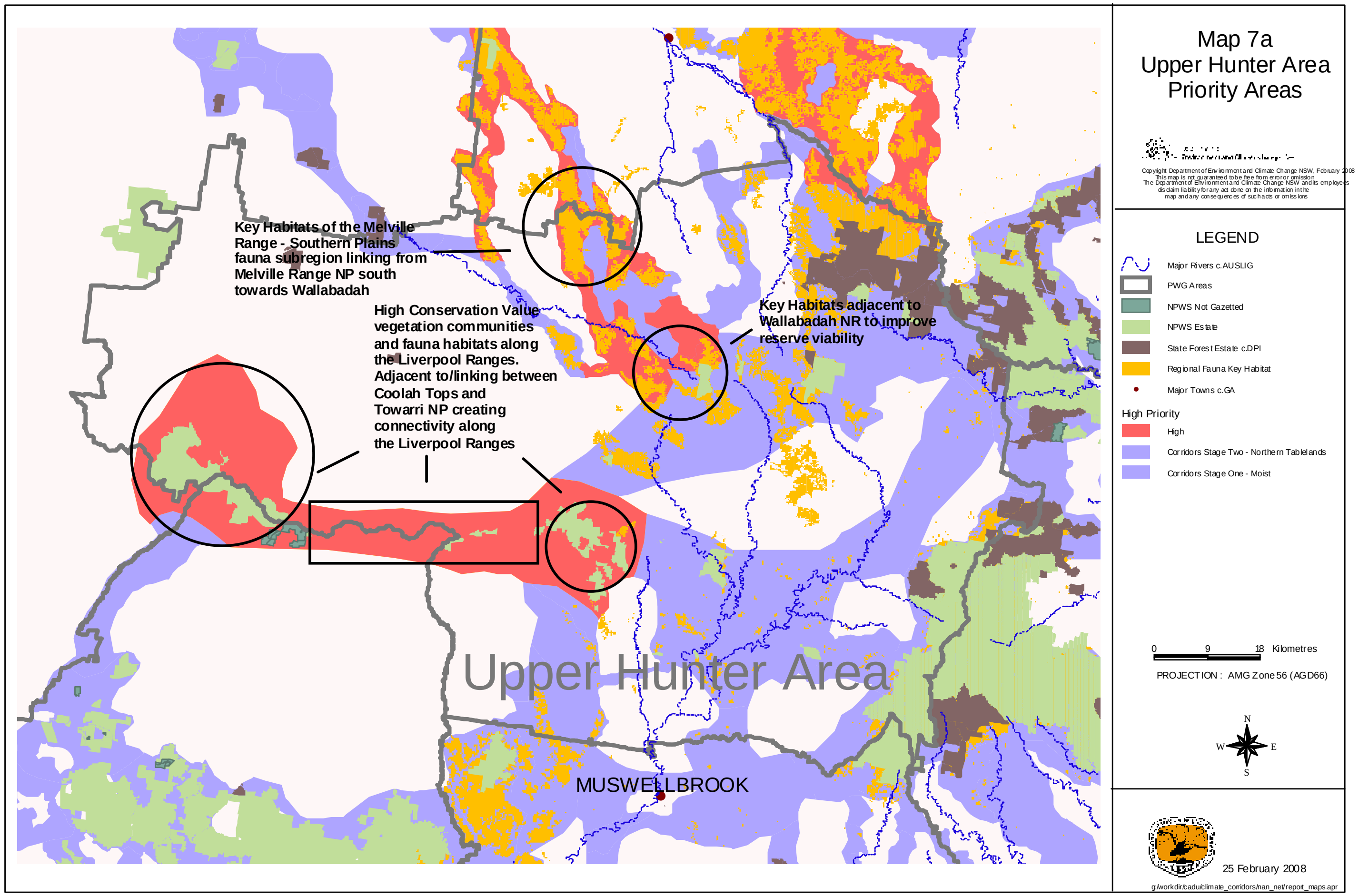
Walcha
STAGE TWO STUDY AREA
Upper Hunter Area
STAGE ONE STUDY AREA
MUSWELLBROOK



Map 7a
Upper Hunter Area
Priority Areas
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LEGEND
Major Rivers c.AUSLIG
PWG Areas
NPWS Not Gazetted
NPWS Estate
State Forest Estate c.DPI
Regional Fauna Key Habitat
Major Towns c.GA
High Priority
High
Corridors Stage Two - Northern Tablelands
Corridors Stage One - Moist
0 9 18 Kilometres
PROJECTION : AMG Zone 56 (AGD66)
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25 February 2008
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Key Habitats of the Melville Range - Southern Plains fauna subregion linking from Melville Range NP south towards Wallabadah
High Conservation Value vegetation communities and fauna habitats along the Liverpool Ranges. Adjacent to/linking between Coolah Tops and Towarri NP creating connectivity along the Liverpool Ranges
Key Habitats adjacent to Wallabadah NR to improve reserve viability
Upper Hunter Area
MUSWELLBROOK