Appendix 15: Threat rankings and information

This appendix needs to be read in conjuction with **Section 4** of the main report. Detailed information on threats operating in the Northern Rivers Region is presented here. Firstly, the regional scale rankings for each of the 79 threat activities is provided. After that, each landscape (coastal plains, midland hills, escarpment ranges and tablelands) is dealt with separately. For each landscape, the ranks for each of the 79 threat activities are provided, followed by a discussion on these threats and how the natural and man-made features of the landscape influence the importance or impact of each threat. While many of these features occur in all landscapes, their particular character, location and circumstance, together with varying levels of use or exploitation by people, has led to different patterns in the occurrence and severity of threats. In many instances, it is the particular interaction of these features, and the landuses they encourage, that leads to the unique set of threats particular to a landscape.

Northern Rivers Region

The regional scale rankings for each threat activity as well as the regional ranking for each broad threat group are shown in **Table 1**.

Table 1 Regionally ranked threat groups and activities

Threat group / Threat activity	Rank
Clearing and fragmentation[1,2]	
Agricultural clearing	Very high
Clearing for urban & industrial development	High
Clearing for plantations	Medium
Rural residential	Medium
Asset protection zones	Medium
Removal of hollow-bearing trees [2]	Medium
Loss and/or degradation of sites used for hill-topping butterflies [2]	Very low
Fire	
Inappropriate fire regimes [2]	Very high
Weeds	
Weed invasion	Very high
Invasion, establishment and spread of *Lantana camara* [2]	High
Invasion of native plant communities by exotic perennial grasses [2]	Medium
Invasion and establishment of exotic vines and scramblers [2]	Medium
Invasion of native plant communities by Bitou Bush & Boneseed [2]	Very Low
Invasion, establishment and spread of Scotch Broom [2]	Very Low
Pests	
Competition and predation by the European Red Fox (*Vulpes vulpes*) [1,2]	Very High
Competition, predation and disease from feral Cats [1,2]	High
Competition, predation, grazing, habitat degradation and disease transmission by feral Pigs (*Sus scrofa*) [1,2]	Medium
Competition, predation and mortality from ingestion of Cane Toad [1,2]	Medium
Competition, grazing and degradation from feral Deers [2]	Medium
Competition, grazing and land degradation from feral Goats [1,2]	Medium

Threat group / Threat activity	Rank
Competition, land degradation and grazing from Rabbits [1, 2]	Medium
Predation by the Plague Minnow (*Gambusia holbrooki*) [2]	Low
Competition and predation from feral fish	Low
Competition from introduced birds	Low
Feral cattle grazing, trampling and competition	Low
Competition, predation and disease from feral Dogs [2]	Very Low
Competition from feral Honey Bees [2]	Very Low
Competition and predation by Red-eared Slider	Very Low
Competition, grazing and degradation from feral Horses	Very Low
Predation by introduced rodents	Very Low
Competition and predation by Pandanus Plant-Hopper	Very Low
Importation of tramp ants into NSW (significant potential threat) [1, 2]	Very Low
Introduction of the Large Earth Bumblebee (*Bombus terrestris*) (significant potential threat) [2]	Very Low
Forestry	
Forestry	Medium
Dieback	
Forest eucalypt dieback associated with over-abundant Bell Miners and psyllids [2]	Medium
Tablelands dieback	Very Low
Dieback from dryland salinity	Very Low
Hydrology and water quality	
Alteration to the natural flow regimes of wetlands from habitat modification and degradation [2]	Low
Alteration to the natural flow regimes of rivers and streams from habitat modification and degradation [2]	Low
Pollution from stormwater	Low
High nutrient loads, sediment loads, contaminant loads and thermal pollution	Low
Alteration to the natural flow regimes of floodplains from habitat modification and degradation [2]	Very Low
Alteration to the natural flow of coastal lakes and estuaries from habitat modification and degradation	Very Low
Siltation/sedimentation	Very Low
Blackwater events	Very Low
Activation of acid sulphate soils	Very Low
Altered groundwater hydrology	Very Low
Diseases and pathogens	
Infection of amphibians with chytrid fungus resulting in chytridiomycosis [1, 2]	Medium
Dieback caused by the root-rot fungus (*Phytophthora cinnamomi*) [1, 2]	Low
Infection by *Psittacine circoviral* (beak & feather) disease affecting endangered psittacine species [1, 2]	Very Low
Exotic fungi—red pored fungi	Very Low
Phelliuis noxious	Very Low
Lethal yellowing	Very Low
Human Interference	
Removal of dead wood and dead trees [2]	Medium
Irresponsible ownership of domestic pets	Medium
Road mortality	Low
Hunting/fishing	Low
Illegal collection	Low
Removal, degradation and disturbance of nests and roosts	Very Low

Threat group / Threat activity	Rank
Human activity by vehicles off road	Very Low
Roadside, track and waterway maintenance	Very Low
Loss or degradation of estuarine nursery habitats	Very Low
Human-induced mortality	Very Low
Impediments to movement of fish	Very Low
Dead wood removal from streams [3]	Very Low
Human activity by visitors	Very Low
Bushrock removal [2]	Very Low
Collection of seed	Very Low
Vandalism	Very Low
Horse recreational use	Very Low
Entanglement in, or ingestion of, anthropogenic debris in marine and estuarine environments [1, 2]	Very Low
Electrocution	Very Low
Boat mortality	Very Low
Livestock	
Domestic livestock grazing, trampling and competition	Medium
Chemicals and waste	
Application and pollution from urban, industrial and rural chemicals	Medium
Poisoning due to pest control	Very Low
Illegal rubbish dumping	Very Low
Rubbish dumping / landfill	Very Low
Demographic effects and small populations	
Demographic effects and small populations	Medium
Genetic contamination/hybridisation	Very Low

Notes: [1] Key Threatening Process listed under EPBC Act 1999.
[2] Key Threatening Process listed under TSC Act 1995.
[3] Key Threatening Process listed under FM Act 1994.

Coastal plains

On the coastal plains, 75 threat activities (representing 11 of the 12 regional threat groups) impact on biodiversity. Of these 75 threat activities, 33 are encompassed by listed key threatening processes (see table). This includes all activities in the 'clearing and fragmentation' group which fall under the clearing of native vegetation key threatening process.

The coastal plains, in comparison to the three other landscapes, has the highest overall number of threat activities and the most number of threats unique to a landscape (15% of the 75 threat activities). The high number of threat activities identified for the coastal plains reflects the relatively high population density and diversity of landuse practices.

Vegetation clearing for rural, urban and industrial development; inappropriate fire regimes; invasion from introduced plant species; the establishment and spread of *Lantana camara*; and competition and predation by the European Red Fox are threat activities having the greatest impact on biodiversity on the coastal plains. The impact on biodiversity from rural residential development in addition to the loss of species from competition, predation and disease by feral Cats and Cane Toads is also of high concern within this landscape.

Coastal plains threat facts

No. of threats: 75

High priority threats:

- Rural clearing
- Clearing for urban and industrial development
- Inappropriate fire regime
- Weed invasion
- Invasion, establishment and spread of *Lantana camara*
- Competition and predation by the European Red fox

Threats unique to the coastal plains:

- Invasion by Bitou Bush & Boneseed
- Alteration to the natural flow regimes of floodplains
- Alteration to the natural flow regime of coastal lakes and estuaries
- Loss or degradation of estuarine nursery habitats
- Activation of acid sulphate soils
- Blackwater events
- Predation by rodents
- Competition and predation by Pandanus plant-hopper
- Lethal yellowing
- Entanglement in, or ingestion of anthropogenic debris in marine and estuarine environments
- Electrocution
- Boat mortality

Table 2 lists each threat activity and rating (very high to very low) based on the geographic extent of the activity and its impact on biodiversity within the coastal plains landscape.

Table 2 Coastal plains threat activities and ranks

Threat group / Threat activity	Rank
Clearing and fragmentation[1,2]	
Agricultural clearing	Very High
Clearing for urban and industrial development	Very High
Rural residential	High
Asset protection zones	Medium
Clearing for plantations	Medium
Removal of hollow bearing trees [2]	Medium
Loss and/or degradation of sites used for hill-topping by butterflies [2]	Very Low
Fire	
Inappropriate fire regime [2]	Very High
Weeds	
Weed invasion	Very High
Invasion, establishment and spread of *Lantana camara* [2]	Very High

Threat group / Threat activity	Rank
Invasion and establishment of exotic vines and scramblers [2]	Medium
Invasion of native plant communities by exotic perennial grasses [2]	Medium
Invasion of native plant communities by Bitou Bush & Boneseed [2]	Medium
Pests	
Competition and predation by the European Red Fox (*Vulpes vulpes*) [1, 2]	Very High
Competition, predation and disease from feral Cats [1, 2]	High
Competition, predation and mortality from ingestion of Cane Toad [1, 2]	High
Competition, predation, grazing, habitat degradation and disease transmission by feral Pigs (*Sus scrofa*) [1, 2]	Medium
Competition, grazing and degradation from feral Deers [2]	Medium
Competition, grazing and land degradation from feral Goats [1, 2]	Low
Predation by the Plague Minnow (*Gambusia holbrooki*) [2]	Low
Competition from introduced birds	Low
Competition, land degradation and grazing from Rabbits [1, 2]	Very Low
Competition and predation from feral fish	Very Low
Feral cattle grazing, trampling and competition	Very Low
Competition, predation and disease from feral Dogs [2]	Very Low
Competition from feral Honey Bees [2]	Very Low
Competition and predation by Red-eared Slider	Very Low
Importation of tramp ants into NSW (significant potential threat) [1, 2]	Very Low
Introduction of the Large Earth Bumblebee (*Bombus terrestris*) (significant potential threat) [2]	Very Low
Competition, grazing and degradation from feral Horses	Very Low
Predation by introduced rodents	Very Low
Competition and predation by Pandanus Plant-Hopper	Very Low
Forestry	
Forestry	Low
Hydrology and water quality	
Alteration to the natural flow regimes of floodplains from habitat modification and degradation [2]	Medium
Alteration to the natural flow regimes of wetlands from habitat modification and degradation [2]	Low
Alteration to the natural flow regimes of rivers and streams from habitat modification and degradation [2]	Low
High nutrient loads, sediment loads, contaminant loads and thermal pollution	Low
Pollution from stormwater	Low
Alteration to the natural flow of coastal lakes and estuaries from habitat modification and degradation	Low
Altered groundwater hydrology	Very Low
Siltation/sedimentation	Very Low
Activation of acid sulphate soils	Medium
Blackwater events	Medium
Diseases and pathogens	
Infection of amphibians with chytrid fungus resulting in chytridiomycosis [1, 2]	Medium
Dieback caused by the root-rot fungus (*Phytophthora cinnamomi*) [1, 2]	Low
Infection by *Psittacine circoviral* (beak & feather) disease affecting endangered psittacine species [1, 2]	Very Low
Exotic fungi—red pored fungi	Very Low
Phelliuis noxious	Very Low
Lethal yellowing	Very Low

Threat group / Threat activity	Rank
Human interference	
Removal of dead wood and dead trees [2]	Medium
Irresponsible ownership of domestic pets	Medium
Road mortality	Low
Hunting/fishing	Low
Illegal collection	Low
Loss or degradation of estuarine nursery habitats	Low
Removal, degradation and disturbance of nests and roosts	Very Low
Human-induced mortality	Very Low
Human activity by vehicles off road	Very Low
Roadside, track and waterway maintenance	Very Low
Impediments to movement of fish	Medium
Dead wood removal from streams [3]	Very Low
Human activity by visitors	Very Low
Bushrock removal [2]	Very Low
Collection of seed	Very Low
Vandalism	Very Low
Horse recreational use	Very Low
Entanglement in, or ingestion of, anthropogenic debris in marine and estuarine environments [1, 2]	Very Low
Electrocution	Very Low
Boat mortality	Very Low
Livestock	
Domestic livestock grazing, trampling and competition	Medium
Chemicals and waste	
Application and pollution from urban, industrial and rural chemicals	Low
Poisoning due to pest control	Very Low
Illegal rubbish dumping	Very Low
Rubbish dumping / landfill	Very Low
Demographic effects and small populations	
Demographic effects and small populations	Medium
Genetic contamination/hybridisation	Very Low

Notes: [1] Key Threatening Process listed under EPBC Act 1999.
[2] Key Threatening Process listed under TSC Act 1995.
[3] Key Threatening Process listed under FM Act 1994.

The coastal plains provide an attractive 'sea change' lifestyle for many people seeking an escape from the pressures of city living. People are attracted to the relaxed lifestyle, less crowds, fewer traffic jams and greater access to the ocean, open spaces and the natural environment. This shift in demographics is placing a vastly increased pressure on the natural environment, leading to further clearing and fragmentation of existing vegetation and habitats to satisfy an increased demand for urban and rural residential land, infrastructure and services. As well, there are increased risks of fires, weed invasion, pollution, predation on wildlife by domestic Cats and Dogs and disease.

Many of these threats are cumulative, caused by a multitude of activities. In some cases they are often exacerbated by, or are a result of, another threat such as the invasion of Bitou Bush which resulted from the rehabilitation of sand mines along the coastal foredunes. Many threats are the result of historic landuses such as dairying, whilst others are from current landuse pressures such as

rural residential expansion. Additionally, there are a number of significant future threats unique to the coastal plains landscape, such as sea level rise due to the impacts associated with climate change.

The broad expanses of fertile, alluvial soils on the floodplains of the major rivers are prime agricultural land. As a consequence, these areas have been heavily cleared for agricultural industries including sugar cane and tea-tree (north of Grafton), rotational cropping, dairying and beef cattle grazing (widespread throughout the landscape), and small areas of other grazing and intensive horticulture and animal production. Threats to biodiversity associated with these industries include further habitat clearing and fragmentation caused by expansion or intensification of agriculture; pollution from chemicals, fertiliser and animal wastes; and impacts on hydrology and water quality.

While the moderate maritime climate is conducive for agriculture and human settlement, predicted climate change and associated sea level rise pose significant threats to biodiversity. Inundation of low-lying areas will fundamentally change the character of the coastline and estuaries, displacing important habitats for shorebirds, estuarine species and littoral rainforest. The ecology of freshwater wetlands is also likely to change dramatically. Increasing stochastic events such as cyclones, storms and floods may alter or destroy much of the habitat in this landscape.

Due to their location in the landscape, riparian areas within the coastal plains are constantly reinvaded by weeds carried downstream during floods. Floods also increase erosion of degraded streambanks. Acid sulphate soils occur in the floodplains. Following rain, low-lying swampy areas, areas that have been drained, or areas where acidic soils are exposed, can discharge acidic waters that result in fish kills. Blackwater events—which most evidence suggests occur naturally—can occur after heavy rain covers vegetation in swampy areas causing the vegetation to die and rot. As this water drains it can result in significant fish kills in adjoining aquatic ecosystems. These events pose a major threat to species such as the threatened Oxleyan Pygmy Perch. The introduced Plague Minnow and Cane Toad are associated with the waterways of the coastal plains, threatening aquatic and terrestrial native animals. Waterways in the coastal plains are also impacted by stormwater run-off and pollution from the many large urban and industrial developments near estuaries and rivers. The expanding population and urban areas also increase pressures on the natural environment from recreational activities such as boating and fishing.

Due to the combined effects of urbanisation, tourism and agricultural developments on private land, many habitats in the coastal plains are highly disturbed and fragmented. This causes genetic isolation of populations and an inability for species to recolonise areas after local extinctions. Where national parks and reserves abut urban or populated rural areas, direct threats include clearing of asset protection zones, arson, weed invasion, predation by domestic pets, rubbish dumping and pollution. Additionally, indirect threats result in disturbances to biodiversity from increased recreation, infrastructure development and servicing, and vandalism. Such threats will continue to be exacerbated by the increasing urbanisation of the coastal plains.

The coastal forests suffer from an ongoing loss and lack of recruitment of hollow-bearing trees. The native vegetation that remains on the coastal plains is now most likely to be part of a threatened ecological community, including all floodplain vegetation. This includes Coastal Subtropical Forest, Swamp Oak Forest and Swamp Sclerophyll Forest, Littoral Rainforest, Coastal Saltmarsh and Freshwater Wetlands, all of which are threatened by the impacts of sea level rise. Littoral Rainforest is also threatened by human interference and weed invasion, while coastal Saltmarsh and Freshwater Wetlands are at risk from hydrological changes and water pollution. The highly restricted Byron Bay Graminoid Clay Heath is under threat from urban development and weed invasion. Other heathlands are particularly vulnerable to too-frequent fire, while the Themeda Headland endangered ecological community is vulnerable to infrequent fires which may lead to the dominance of shrubs and exclusion of grasslands.

Threatened species that occur predominantly on coastal plains habitats are under particular pressure from rapid expansion of urban and rural developments and the likelihood of climate change and sea level rise. Such species include nesting turtles, migratory waders and other shorebirds that are also vulnerable to predation and disturbance from vehicles and humans. Invertebrates such as the Black Grass Dart are threatened by habitat fragmentation, the endangered coastal Emu population is threatened by road mortality and inappropriate fire regimes during its breeding season, while many threatened orchids are susceptible to illegal collection. Koalas and Long-nosed Potoroos, including the endangered population west of Tweed Heads, are threatened by habitat fragmentation, road mortality and predation by domestic Dogs and foxes. Most of the Region's flying-fox camps are on the coastal plains, often within urban areas, making them vulnerable to disturbances and habitat loss.

Midland hills

In the midland hills, 63 threat activities (representing all 12 regional threat groups) impact on biodiversity. Of these 63 threat activities, 32 are encompassed by listed key threatening processes (see table). This includes all activities in the 'clearing and fragmentation' group which fall under the clearing of native vegetation key threatening process.

The number of threat activities in the midland hills is comparable to the escarpment ranges and tablelands, but is less than the coastal plains. Individual threat activity ratings for the midland hills are higher than the ranges and tablelands but lower than the coastal plains. This reflects the relative population growth and pressures from urban, rural residential and industrial development.

Five threats were rated very high and six threats were rated high in terms of their impact on biodiversity in the midland hills. Threats from invasion, establishment and spread of *Lantana camara*; invasion and establishment of exotic vines and scramblers; forestry; dieback associated with over-abundant Bell Miners and psyllids; and clearing for rural residential development generally have a greater impact on this landscape compared to other landscapes in the Region.

Midland hills threat facts

No. of threats: 63

Very high and high priority threats:

- Rural clearing
- Clearing for urban and industrial development
- Inappropriate fire regime
- Weed invasion
- Invasion, establishment and spread of *Lantana camara*
- Competition and predation by the European Red Fox
- Clearing for urban and industrial development
- Rural residential development
- Invasion and establishment of exotic vines and scramblers
- Competition, predation and disease from feral Cats
- Forestry
- Forest eucalypt dieback associated with over-abundant Bell Miner and psyllids

Threats unique to the midland hills:

- None

Threats restricted to midland hills and one other landscape:

- Phelliuis noxious
- Forest eucalypt dieback associated with over-abundant Bell Miner and psyllids

Table 3 lists each threat activity and rating (very high to very low) based on the geographic extent of the activity and its impact on biodiversity within the midland hills landscape.

Table 3 Midland hills threat activities and ranks

Threat group / Threat activity	Rank
Clearing and fragmentation[1,2]	
Agricultural clearing	Very High
Clearing for urban and industrial development	High
Rural residential	High
Asset protection zones	Medium
Clearing for plantations	Medium
Removal of hollow bearing trees [2]	Low
Loss and/or degradation of sites used for hill-topping by butterflies [2]	Very Low
Fire	
Inappropriate fire regime [2]	Very High
Weeds	
Weed invasion	Very High
Invasion, establishment and spread of *Lantana camara* [2]	Very High
Invasion and establishment of exotic vines and scramblers [2]	High

Threat group / Threat activity	Rank
Invasion of native plant communities by exotic perennial grasses [2]	Medium
Pests	
Competition and predation by the European Red Fox (*Vulpes vulpes*) [1, 2]	Very High
Competition, predation and disease from feral Cats [1, 2]	High
Competition, predation, grazing, habitat degradation and disease transmission by feral Pigs (*Sus scrofa*) [1, 2]	Medium
Competition, grazing and land degradation from feral Goats [1,2]	Medium
Competition, predation and mortality from ingestion of Cane Toad [1,2]	Medium
Competition, grazing and degradation from feral Deers [2]	Medium
Competition, land degradation and grazing from Rabbits [1, 2]	Low
Predation by the Plague Minnow (*Gambusia holbrooki*) [2]	Low
Competition and predation from feral fish	Very Low
Feral cattle grazing, trampling and competition	Very Low
Competition, predation and disease from feral Dogs [2]	Very Low
Competition from feral Honey Bees [2]	Very Low
Competition and predation by Red-eared Slider	Very Low
Importation of tramp ants into NSW (significant potential threat) [1, 2]	Very Low
Introduction of the Large Earth Bumblebee (*Bombus terrestris*) (significant potential threat) [2]	Very Low
Competition from introduced birds	Very Low
Forestry	
Forestry	High
Dieback	
Forest eucalypt dieback associated with over-abundant Bell Miners and psyllids [2]	High
Hydrology and water quality	
Alteration to the natural flow regimes of wetlands from habitat modification and degradation [2]	Low
Alteration to the natural flow regimes of rivers and streams from habitat modification and degradation [2]	Low
High nutrient loads, sediment loads, contaminant loads and thermal pollution	Low
Altered groundwater hydrology	Very Low
Siltation/sedimentation	Very Low
Pollution from stormwater	Very Low
Diseases and pathogens	
Infection of amphibians with chytrid fungus resulting in chytridiomycosis [1, 2]	Medium
Dieback caused by the root-rot fungus (*Phytophthora cinnamomi*) [1, 2]	Low
Infection by *Psittacine circoviral* (beak & feather) disease affecting endangered psittacine species [1, 2]	Very Low
Exotic fungi—red pored fungi	Very Low
Phelliuis noxious	Very Low
Human interference	
Removal of dead wood and dead trees [2]	Medium
Irresponsible ownership of domestic pets	Low
Road mortality	Low
Hunting/fishing	Low
Illegal collection	Low
Removal, degradation and disturbance of nests and roosts	Very Low
Human-induced mortality	Very Low
Human activity by vehicles off road	Very Low

Threat group / Threat activity	Rank
Roadside, track and waterway maintenance	Very Low
Impediments to movement of fish	Very Low
Dead wood removal from streams [3]	Very Low
Human activity by visitors	Very Low
Bushrock removal [2]	Very Low
Collection of seed	Very Low
Vandalism	Very Low
Horse recreational use	Very Low
Livestock	
Domestic livestock grazing, trampling and competition	Medium
Chemicals and waste	
Application and pollution from urban, industrial and rural chemicals	Low
Poisoning due to pest control	Very Low
Illegal rubbish dumping	Very Low
Demographic effects and small populations	
Demographic effects and small populations	Medium
Genetic contamination/hybridisation	Very Low

Notes: [1] Key Threatening Process listed under EPBC Act 1999.
[2] Key Threatening Process listed under TSC Act 1995.
[3] Key Threatening Process listed under FM Act 1994.

The midland hills form the backdrop to the coastal plains and consist largely of undulating hills. The hills are most suitable for livestock grazing, with beef cattle predominating. In the north, the midland hills include the fertile krasnozem soils of the Alstonville Plateau where large areas have been cleared for grazing and horticulture (including macadamia, avocado and other tree plantations). The main threat in this landscape is agricultural-based industries.

Another widespread threat associated with livestock grazing is the practice of burning to encourage 'green pick' for stock. This can substantially alter the composition and structure of ground covers and the understorey, and may lead to soil erosion and weed invasion. Grazing also has the potential to threaten aquatic biodiversity through degradation of riparian and in-stream habitats caused by stock. Indirect impacts include changes to hydrology caused by dams and other drainage control structures.

The construction of urban water supply dams typically occurs in the midland hills, resulting in both habitat loss as well as changes in hydrology and water quality. In the north, the mid Clarence Valley is considered to be the stronghold for the endangered Eastern Cod and it is currently threatened by a combination of habitat disturbances including river sedimentation, removal of rivers snags and logs, modifications to river flows, pollution, barriers to migration, and illegal fishing.

As well as livestock grazing, another major widespread landuse with a long history in the midland hills is forestry. Threats associated with this activity occur throughout the landscape with forestry occurring on both Sate forests and private lands. Logging poses threats through ongoing disturbance of forested areas, loss of hollow-bearing trees, and the reduction in key resources for some threatened species. Timber plantation establishment has been undertaken across extensive areas of the midland hills over the past ten years. The area established annually is increasing and, while regulated through the statutory requirements of the *Plantations and Reafforestation Act 1999*, it is a major driver for clearing remnant native vegetation. Firewood collection is an ancillary activity that typically occurs near the larger urban centres and rural residential areas. It results in the

removal of dead wood and dead standing trees that can be important habitat for a variety of native animals.

Like the 'sea change' phenomena of the coastal plains, the midland hills is experiencing an influx of 'tree changers'—people moving to rural residential and larger rural acreages to enjoy the relaxed lifestyle, open spaces and natural environment. Impacts assocated with 'tree changers' include clearing of asset protection zones, increased fire frequency, removal of understorey vegetation, loss of hollow-bearing and dead trees, increases in predation by domestic Cats and Dogs, weed invasion, and livestock competition and trampling. This combination of threats can lead to further degradation of biodiversity through an ongoing process of attrition that only becomes apparent over longer periods of time.

The midland hills contains areas that have special biodiversity values because of their geology. The sandstone escarpments and plateaus of the Coaldale to Glenreagh area north and south of Grafton contain a high level of endemic plants as well as habitat for the endangered Brush-tailed Rock-Wallaby. The limestone areas south of Kempsey contain caves that are maternity sites for threatened bentwing bats and cave-dwelling invertebrate fauna. The granite peaks of the Brother mountains west of Laurieton and the nearby conglomerate ranges also have a number of endemic threatened plants including the critically endangered *Banksia conferta* spp. *conferta*. These areas have high biodiversity significance and are vulnerable to stochastic events, high fire frequency and human-associated activities such as illegal collecting and other disturbances.

While much of the midland hills has been either cleared or highly disturbed, there remains large tracts of native vegetation that form important links between the highly cleared coastal plains and the better-vegetated escarpment ranges. These links function as networks that facilitate the movement of both plants and animals across the landscape. In many places, however, these corridors require expansion to improve connectivity as they are likely to become more significant as pathways for the movement of species adapting to the impacts of climate change.

The dry sclerophyll forests of the mid Clarence Valley are of special fauna significance because they produce large amounts of nectar, a crucial energy-rich resource for many birds and arboreal mammals. These high nectar levels in turn result in high densities of birds and mammals which in turn support high densities of predators such as owls, quolls and raptors. Threats such as clearing and logging, which can reduce the number and diversity of nectar-producing trees and remove trees with hollows, can lead to indirect impacts on these predators by reducing the density and variety of their prey. The mid Clarence is also a stronghold for threatened woodland birds and critical weight range vertebrates, suites of species that are vulnerable to predation and changes in the composition and structure of the understorey.

The dry sclerophyll forest communities typical of the midland hills may be more resilient to some impacts of climate change. However, the typically hot, dry summer climate may intensify resulting in increased fire frequency, threatening many aspects of biodiversity. Other threats from climate change include a potential for increased weed invasion and colonisation due to changes in temperature and rainfall patterns. Currently, Lantana and exotic vines are considered major threats in this landscape and their spread may be exacerbated by future climate changes.

Other vegetation at risk includes rainforest, especially small isolated patches such as the Big Scrub remnants, as weeds have the potential to overwhelm these areas in the mid to long term. Wetlands in the midland hills are relatively uncommon but provide important habitat for threatened species such as migratory birds. Many wetlands, such as those of the Upper Clarence, have been highly degraded by agricultural activities such as grazing, dams and drainage works. These threats to the hydrology and water quality are ongoing.

Bell Miner associated dieback is currently an expanding threat that occurs sporadically in the midland hills. While it is most prevalent in the north around Kyogle, it occurs throughout the Region. It results in extreme degradation of forest ecosystems, major disruption in ecosystem function, reduced diversity and abundance of threatened flora and fauna, and increased weed invasion and associated displacement of native forest species.

Foxes and Cats are currently the most common predator threat of native animals in the midland hills, and the threat from domestic Cats and Dogs is increasing as more people settle in rural residential areas and on larger rural lifestyle acreages. Cane Toads are expanding their range into the midland hills, typically using farms dams and drainage lines as stepping stones to invade new areas. They have the ability to adversely affect biodiversity both by competing with native frogs for habitat and by poisoning predators such as snakes and birds.

Escarpment ranges

In the escarpment ranges, 63 threat activities impact on biodiversity. Of these 63 threat activities, 33 are encompassed by listed key threatening processes (see table). This includes all activities in the 'clearing and fragmentation' group which fall under the clearing of native vegetation key threatening process.

The number of threats impacting on this landscape is comparable to the midland hills and tablelands, however, the threat ratings are generally lower in the escarpment ranges. This reflects the low levels of human settlement, difficulty of the steep terrain for undertaking agriculture and the relatively large area of national parks.

Escarpment ranges threat facts

No. of threats: 63

Very high and high priority threats:
- Rural clearing
- Inappropriate fire regime
- Weed invasion
- Competition and predation by the European Red fox
- Competition, predation and disease from feral Cats
- Forestry
- Forest eucalypt dieback associated with over-abundant Bell Miners and psyllids

Threats unique to the escarpment ranges:
- None

Threats restricted to escarpment ranges and one other landscape:
- Invasion, establishment and spread of Scotch Broom
- Forest eucalypt dieback associated with over-abundant Bell Miners and psyllids
- Competition, grazing and degradation from feral Horses

Six threats have either a very high or high impact on the escarpment ranges, including loss of vegetation due to rural clearing; inappropriate fire regime; competition and predation by the European Red Fox; competition, predation and disease from feral Cats; forestry; and forest eucalypt dieback associated with over-abundant Bell Miners and psyllids. Regional threats considered to be having a higher impact within this landscape in comparison to other landscapes are forestry and forest eucalypt dieback associated with over-abundant Bell Miners and psyllids.

Table 4 lists each threat activity and rating (very high to very low) based on the geographical extent of the activity and its impact on biodiversity within the escarpment ranges landscape.

Table 4 Escarpment ranges threat activities and ranks

Threat group / Threat activity	Rank
Clearing and fragmentation[1,2]	
Agricultural clearing	Very High
Asset protection zones	Medium
Clearing for plantations	Low
Clearing for urban and industrial development	Very Low
Rural residential	Very Low
Removal of hollow bearing trees [2]	Very Low
Loss and/or degradation of sites used for hill-topping by butterflies [2]	Very Low
Fire	
Inappropriate fire regime [2]	Very High
Weeds	
Weed invasion	High
Invasion, establishment and spread of *Lantana camara* [2]	Medium
Invasion and establishment of exotic vines and scramblers [2]	Medium
Invasion of native plant communities by exotic perennial grasses [2]	Low

Threat group / Threat activity	Rank
Invasion, establishment and spread of Scotch Broom [2]	Very Low
Pests	
Competition and predation by the European Red Fox (*Vulpes vulpes*) [1, 2]	High
Competition, predation and disease from feral Cats [1, 2]	High
Competition, predation, grazing, habitat degradation and disease transmission by feral Pigs (*Sus scrofa*) [1, 2]	Medium
Competition, grazing and land degradation from feral Goats [1, 2]	Medium
Competition, predation and mortality from ingestion of Cane Toad [1, 2]	Low
Competition, grazing and degradation from feral Deers [2]	Low
Predation by the Plague Minnow (*Gambusia holbrooki*) [2]	Low
Competition and predation from feral fish	Low
Feral cattle grazing, trampling and competition	Low
Competition, land degradation and grazing from Rabbits [1, 2]	Very Low
Competition, predation and disease from feral Dogs [2]	Very Low
Competition from feral Honey Bees [2]	Very Low
Competition and predation by Red-eared Slider	Very Low
Importation of tramp ants into NSW (significant potential threat) [1, 2]	Very Low
Introduction of the Large Earth Bumblebee (*Bombus terrestris*) (significant potential threat) [2]	Very Low
Competition, grazing and degradation from feral Horses	Very Low
Forestry	
Forestry	High
Dieback	
Forest eucalypt dieback associated with over-abundant Bell Miners and psyllids [2]	High
Hydrology and water quality	
Alteration to the natural flow regimes of wetlands from habitat modification and degradation [2]	Low
Alteration to the natural flow regimes of rivers and streams from habitat modification and degradation [2]	Low
High nutrient loads, sediment loads, contaminant loads and thermal pollution	Very Low
Altered groundwater hydrology	Very Low
Siltation/sedimentation	Very Low
Pollution from stormwater	Very Low
Diseases and pathogens	
Infection of amphibians with chytrid fungus resulting in chytridiomycosis [1, 2]	Medium
Dieback caused by the root-rot fungus (*Phytophthora cinnamomi*) [1, 2]	Low
Infection by *Psittacine circoviral* (beak & feather) disease affecting endangered psittacine species [1, 2]	Very Low
Exotic fungi—red pored fungi	Very Low
Human interference	
Removal of dead wood and dead trees [2]	Medium
Irresponsible ownership of domestic pets	Low
Road mortality	Low
Hunting/fishing	Low
Illegal illegally	Low
Removal, degradation and disturbance of nests and roosts	Very Low
Human-induced mortality	Very Low
Human activity by vehicles off road	Very Low
Roadside, track and waterway maintenance	Very Low

Threat group / Threat activity	Rank
Impediments to movement of fish	Very Low
Dead wood removal from streams [3]	Very Low
Human activity by visitors	Very Low
Bushrock removal [2]	Very Low
Collection of seed	Very Low
Vandalism	Very Low
Horse recreational use	Very Low
Livestock	
Domestic livestock grazing, trampling and competition	Low
Chemicals and waste	
Application and pollution from urban, industrial and rural chemicals	Low
Poisoning due to pest control	Very Low
Illegal rubbish dumping	Very Low
Demographic effects and small populations	
Demographic effects and small populations	Medium
Genetic contamination/hybridisation	Very Low

Notes: [1] Key Threatening Process listed under EPBC Act 1999.
[2] Key Threatening Process listed under TSC Act 1995.
[3] Key Threatening Process listed under FM Act 1994.

The escarpment ranges is a dramatically different landscape to the other landscapes in the Region. The steep, rugged landforms typical of the escarpment ranges have precluded, in most areas, the extensive development of landuses that are major threats to biodiversity in the other landscapes. Nearly 40% is within the National Parks and Wildlife estate, with over half of this declared as wilderness.

Threats to these conservation areas, although much reduced compared to other landuses, are still present and include inappropriate fire regimes as a result of escaped neighbour or prescribed burns and/or lightning strikes. These can result in wildfires that can burn large inaccessible areas, including rainforest under extreme conditions. Inappropriate fire regimes encompass those that are too frequent, or not frequent enough, dependent on the ecosystem. Predation from Foxes, Cats and Dogs can also occur throughout these areas, predominantly in disturbed forest areas, along forest edges and in rural agricultural lands. The gorges and cliffs provide havens for feral Goats whose competition for habitat threatens the Brush-tailed Rock-wallaby. Control is often difficult because of the rugged terrain, poor access and the large areas involved.

While grazing in the escarpment ranges is limited and generally less intensive than other landscapes, it is the major industry across the area. Too-frequent fires may be a problem on some private land where graziers burn annually to control shrubs and promote palatable grasses and seasonal ‘green pick’ for stock. This frequent firing may also lead to increased erosion if it occurs just prior to heavy rainfall events. Such high rainfall events can also cause erosion in areas that are subject to more intensive agriculture such as the Dorrigo and Comboyne plateaus. These areas are also attractive for ‘tree changers’ that bring new threats, such as increased weeds, or exacerbate existing threats, such as clearing, domestic pet predation or livestock grazing and trampling.

Forestry is also a major industry in the escarpment ranges that occurs on both State forests and private land, with potential threats including loss of hollow-bearing trees, increased erosion, inappropriate fire regimes, Bell Miner associated dieback, firewood collection and increased predation and human interference. Plantation establishment also occurs in the escarpment ranges,

although not to the same extent as the midland hills, with most recent plantations being established in the upper Clarence Valley.

Much of the escarpment ranges experiences more rainfall that the other landscapes. Overall, it is more likely to be resilient to the impacts of climate change because of the highly variable topography and the mosaic of vegetation communities. Nevertheless, restricted vegetation communities such as upland wetlands, montane heathlands, rocky outcrops, dry rainforest and cool temperate rainforest are vulnerable to the catastrophic consequences of climate change as a result of extended dry periods or increased storm intensities. Another widespread impact may result from changes to fire frequencies and intensities whereby large areas would be subject to dramatic changes.

Bell Miner associated dieback occurs predominantly in the escarpment ranges in the area north and west of Kyogle. It has the potential to become much more widespread and is regarded as a major threat. Chytrid fungus is a serious threat to the many frogs that inhabit the streams and moist forests throughout the escarpment ranges. Weed invasion is prevalent in the lower altitudes where Lantana and exotic vines are the most widespread. Coolatai Grass is invading new areas, particularly along roadsides and has recently become a serious problem in the Mann River area. It has the potential to spread widely into the midland hills and coastal plains unless monitored and controlled. Pest species such as Foxes, Cats and wild Dogs are widespread and there are populations of wild Horses in the Guy Fawkes and Oxley Wild Rivers areas. Cane Toads are beginning to colonise the escarpment ranges through the upper Tweed, Richmond and Clarence valleys.

The escarpment ranges are the stronghold for many forest-dependent species, including some with highly disjunct and restricted distributions such as the Rufous Scrub-bird. This bird requires dense understorey cover and is threatened by activities which remove this habitat component, such as frequent fires, heavy logging or understorey clearing. The Brush-tailed Rock-wallaby is another species with a disjunct and restricted distribution that has its stronghold in the escarpment ranges. It is particularly vulnerable to predation as well as competition by feral Goats. The Ebor to Point Lookout area is a hotspot for endemic flora, with a variety of rainforest, orchid, mallee and shrub species restricted to this area and therefore vulnerable to localised threats such as clearing, grazing, stochastic events and too-frequent fires.

Tablelands

On the tablelands, 63 threat activities impact on biodiversity. Of these 63 threat activities, 29 are encompassed by listed key threatening processes (see table). This includes all activities in the 'clearing and fragmentation' group which fall under the clearing of native vegetation key threatening process.

Threats in the tablelands are primarily associated with agriculture, often stemming from historical settlement patterns and landuse practices.

The main threat activities impacting on the tablelands include rural clearing; inappropriate fire regime; weed invasion; competition and predation by the European Red Fox; competition, predation and disease from feral Cats; competition, land degradation and grazing from Rabbits; tablelands dieback; and domestic livestock grazing, trampling and competition. Tablelands dieback and dieback from dryland salinity are threats that are restricted to the tablelands. Regional threats considered to be having a higher impact within this landscape in comparison to other landscapes are competition, land degradation and grazing from Rabbits; and domestic livestock grazing, tramping and competition.

Tablelands threat facts

No. of threats: 63

Very high and high priority threats:
- Rural clearing
- Weed invasion
- Competition and predation by the European Red fox
- Inappropriate fire regime
- Competition, predation and disease from feral Cats
- Competition, land degradation and grazing from Rabbits
- Tablelands dieback
- Domestic livestock grazing, trampling and competition

Threats unique to the tablelands:
- Tablelands dieback
- Dieback from dryland salinity

Threats restricted to tablelands and one other Landscape:
- Invasion, establishment and spread of Scotch Broom
- Rubbish dumping/landfill

Table 5 lists each threat activity and rating (very high to very low) based on the geographic extent of the activity and its impact on biodiversity within the tablelands landscape.

Table 5 Tablelands threat activities and ranks

Threat group / Threat activity	Rank
Clearing and fragmentation[1,2]	
Agricultural clearing	Very High
Clearing for urban and industrial development	Medium
Rural residential	Medium
Clearing for plantations	Medium
Removal of hollow bearing trees [2]	Medium
Asset protection zones	Low
Loss and/or degradation of sites used for hill-topping by butterflies [2]	Very Low
Fire	
Inappropriate fire regime [2]	High
Weeds	
Weed invasion	Very High
Invasion of native plant communities by exotic perennial grasses [2]	Medium
Invasion and establishment of exotic vines and scramblers [2]	Very Low
Invasion, establishment and spread of Scotch Broom [2]	Very Low
Pests	
Competition and predation by the European Red Fox (*Vulpes vulpes*) [1, 2]	Very High

Threat group / Threat activity	Rank
Competition, predation and disease from feral Cats [1, 2]	High
Competition, land degradation and grazing from Rabbits [1, 2]	High
Competition, predation, grazing, habitat degradation and disease transmission by feral Pigs (*Sus scrofa*) [1, 2]	Medium
Competition, grazing and land degradation from feral Goats [1, 2]	Medium
Competition, grazing and degradation from feral Deers [2]	Low
Predation by the Plague Minnow (*Gambusia holbrooki*) [2]	Low
Competition from introduced birds	Low
Competition and predation from feral fish	Low
Feral cattle grazing, trampling and competition	Very Low
Competition, predation and disease from feral Dogs [2]	Very Low
Competition from feral Honey Bees [2]	Very Low
Competition and predation by Red-eared Slider	Very Low
Importation of tramp ants into NSW (significant potential threat) [1, 2]	Very Low
Introduction of the Large Earth Bumblebee (*Bombus terrestris*) (significant potential threat) [2]	Very Low
Forestry	
Forestry	Low
Dieback	
Tablelands dieback	High
Dieback from dryland salinity	Very Low
Hydrology and water quality	
Alteration to the natural flow regimes of wetlands from habitat modification and degradation [2]	Low
Alteration to the natural flow regimes of rivers and streams from habitat modification and degradation [2]	Low
High nutrient loads, sediment loads, contaminant loads and thermal pollution	Low
Pollution from stormwater	Very Low
Altered groundwater hydrology	Very Low
Siltation/sedimentation	Very Low
Diseases and pathogens	
Infection of amphibians with chytrid fungus resulting in chytridiomycosis	Medium
Dieback caused by the root-rot fungus (*Phytophthora cinnamomi*) [1, 2]	Low
Infection by *Psittacine circoviral* (beak & feather) disease affecting endangered psittacine species [1, 2]	Very Low
Exotic fungi—red pored fungi	Very Low
Human interference	
Removal of dead wood and dead trees [2]	Medium
Irresponsible ownership of domestic pets	Low
Road mortality	Low
Hunting/fishing	Low
Illegal collection	Low
Removal, degradation and disturbance of nests and roosts	Very Low
Human-induced mortality	Very Low
Human activity by vehicles off road	Very Low
Roadside, track and waterway maintenance	Very Low
Impediments to movement of fish	Very Low
Dead wood removal from stream [3]	Very Low
Human activity by visitors	Very Low

Threat group / Threat activity	Rank
Bushrock removal [2]	Very Low
Collection of seed	Very Low
Vandalism	Very Low
Horse recreational use	Very Low
Livestock	
Domestic livestock grazing, trampling and competition	High
Chemicals and waste	
Application and pollution from urban, industrial and rural chemicals	Medium
Poisoning due to pest control	Very Low
Illegal rubbish dumping	Very Low
Rubbish dumping / landfill	Very Low
Demographic effects and small populations	
Demographic effects and small populations	Medium
Genetic contamination/hybridisation	Very Low

Notes: [1] Key Threatening Process listed under EPBC Act 1999.
[2] Key Threatening Process listed under TSC Act 1995.
[3] Key Threatening Process listed under FM Act 1994.

The tablelands are also quite different to the other landscapes of the Region. This is due to the long history of agriculture, the different landforms and climate, and the highly fragmented and often degraded nature of the remaining vegetation. There are few vegetated corridors linking the escarpment ranges to the north-west slopes, west of the tablelands. This creates barriers to the movement of species between these landscapes. Dryland salinity and tablelands dieback are serious threats to biodiversity that are generally restricted to the tablelands. They have been operating for a number of decades and are typically the result of the cumulative impacts of past agricultural landuse activities that have severely degraded the soil, water, vegetation and general ecological process to a point of virtual ecosystem collapse.

The typically flat topography has resulted in a highly cleared landscape, with many small and disjunct vegetation communities such as upland wetlands, montane peatlands, swamps and lagoons either irrevocably altered or highly degraded. Similarly, many of the rivers and creeks are highly degraded. As these form the headwaters of the Region's rivers, there is a high potential for sedimentation and weed invasion in downstream landscapes.

The tablelands are more likely to experience extended periods of drought, exacerbating other threats to biodiversity as well as inhibiting vegetation regeneration. Climate change is likely to severely impact a range of vegetation communities, with potentially catastrophic impacts to native grasslands and major impacts to montane peatlands and swamps, upland wetlands, grassy woodlands, montane heaths and rocky outcrops.

Only 10% of the tablelands are within conservation reserves and these are widely separated and generally restricted to the poorer granite areas and upper gorges. As such, remnant vegetation on travelling stock reserves is extremely important as the basic framework for corridors across the tablelands. These areas are threatened by grazing, which is widespread throughout the tablelands, as well as invasion by weeds such as Coolatai Grass. Agricultural clearing poses an ongoing high level threat to biodiversity on the tablelands.

The fertile basalt-derived soils that dominant the landscape from Glen Innes to Guyra, and occur sporadically around Armidale to south of Walcha, have been largely cleared of native vegetation for grazing. Vegetation remnants that remain are likely to be a threatened ecological community. The

granite-derived soils north of Guyra and around Cathedral Rocks are especially susceptible to erosion if cleared of vegetation and subject to too-frequent fire regimes. While much of the tablelands is not subject to regular burning, the granite areas and drier, rugged gorges are vulnerable to too-frequent fires.

Firewood collection is widespread but intensifies in close proximity to the larger urban centres. It can directly affect threatened trees and ecological communities and remove habitat for hollow and ground-dwelling animals. Urban expansion and an increasing demand for rural residential lots on the outskirts of urban centres also results in clearing, removal of understorey shrubs, and an increased potential for weed invasion and predation by domestic pets.

The fragmented and highly disturbed nature of much of the remaining vegetation is an ongoing problem as older paddock trees die and there are no younger trees to replace them. These trees often contain hollows and the time for young trees to form hollows is measured in decades, resulting in the loss of many hollow-dwelling animals. Similarly, long-term continuous grazing and trampling by stock within remnant forest and woodland can also prevent tree and shrub regeneration. The absence of understorey shrubs in remnant stands may preclude threatened woodland birds from occupying these areas.

The population of woodland birds on the tablelands has been devastated, while some more opportunistic native and exotic birds have expanded their range and number and often actively exclude other native birds. Threatened woodland birds such as the Brown Treecreeper, Diamond Firetail and Hooded Robin are threatened by clearing and fragmentation of woodland habitat, including the removal of dead timber. Clearing and fragmentation result in increased isolation of populations and individuals, severely impacting on viability and increasing the risks of localised extinctions. Tablelands dieback is a significant contributor to the ongoing tree loss that threatens woodland birds.

Weeds on the tablelands include Coolatai Grass, Willow, Blackberry and Scotch Broom, with Coolatai spreading throughout the tablelands along roads. Willows are prevalent in some creeks and rivers and can adversely alter hydrology and water quality. Outbreaks of Scotch Broom have been reported in the Walcha and Tenterfield areas and have the potential to invade native vegetation, suppress regeneration and reduce native animal densities. As with other landscapes, foxes and feral Cats are serious pest threats. Rabbits are most prevalent in this landscape and pose a threat through competition, land degradation and grazing.