Threatened flora and fauna species and non-threatened vertebrate fauna in the Goulburn Broken Catchment: status, trends and management

Background paper to the Goulburn Broken Catchment Regional Catchment Strategy review process.

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Disclaimer

This report was prepared for the general purpose of assisting with the Goulburn Broken Regional Catchment Strategy review and update. An exhaustive investigation was not appropriate for this purpose. The report is based on the best readily available information. The views expressed in the report are those of the author and do not necessarily represent the views of the GBCMA.

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1. Summary of Recommendations

1.1. Strategic Planning

Recommendation 1.

The GBCMA should instigate a strategic review of the roles and responsibilities of government and non-government agencies in relation to biodiversity management in the catchment, with particular emphasis on threatened species management.

Recommendation 2.

The GBCMA investigate the role of Bioregional Planning and its relationship to other catchment planning processes, particularly Local Area Planning.

Recommendation 3

The GBCMA assist Local Governments to understand their roles and responsibilities in relation to threatened species they management and closely involve Local Government in planning processes such as Bioregional Planning.

Recommendation 5.

An analysis and comparison of the Bioregional Planning approach and other threatened species and reserve design planning processes be undertaken to compare outcomes and adequacy of focal species derived implementation plans.

Recommendation 6.

The potential impacts of salinity on habitat extent and configuration, particularly of important regional riparian corridors, large blocks and local habitat networks be assessed.

Recommendation 7.

The GBCMA in partnership with local government should begin to develop significance overlays for native ecosystems that incorporate current and future need of species given anticipated salinity impacts and tree decline

Recommendation 8.

Investigate options and mechanisms to provide incentives to encourage land holders to conserve scattered trees and allow regeneration on private property. The use of local government rate rebates, communal grazing and commons type arrangements should be investigated

Recommendation 9

Investigate incentives and mechanisms to encourage revegetation of larger individual patches (See Rec. 4)

Recommendation 10.

Investigate 'bundling' natural resource management incentives to create 'sustainable land management packages' based on a partnerships between GBCMA and land owners using a whole farm planning and agreed works program approach.

Recommendation 11.

The GBCMA work with public land managers to reduce the impacts and where feasible remove threatening processes from high value public land blocks and to manage them in a co-ordinated manner as part of a whole of landscape approach.

Recommendation 12.
The GBCMA should continue to support land use decision-making processes such as the Box/Ironbark Investigation and encourage sustainable land use planning by Local Government and other agencies.

1.2. Communication

Recommendation 13.
The GBCMA coordinate and produce a threatened species guide booklet for the catchment.

Recommendation 14.
The GBCMA investigate the feasibility of running a trial observer scheme to begin data collection on particular species or suites of species in the catchment.

1.3. Implementation

Recommendation 15.
The GBCMA adopt mandatory monitoring requirements for all threatened species works funded through its auspices. It should also provide funding to complete follow up management where applicable.

Recommendation 16.

Encourage research into restoration, regeneration and disturbance regimes of grassland and grassy woodlands.

Recommendation 17.

GBCMA should co-ordinate pest plant and animal control (fox baiting, weeds) programs across the catchment to deliver multiple benefits for agriculture and threatened species. The possibility of external funding for a fox baiting program in the Mid-Goulburn with external funders and Local Government should be investigated.

2. Introduction

This report is a background paper for the Goulburn Broken Catchment Management Authority (GBCMA) Regional Catchment Strategy review process. As part of this review process, a number of emerging biodiversity issues have been identified. For each of these issues a brief background paper is being prepared to provide strategic advice to the Authority for future management of these issues. This background paper focuses on emerging issues relating to the conservation and management of flora and fauna, in particular threatened flora and fauna species and non-threatened vertebrate fauna in the Goulburn Broken catchment. These issues have been grouped together in a single background paper because of the many common elements behind the reasons for declines in these groups, their current threats and their future management.

2.1. Aim and scope of this background paper

The aim of this background paper is to provide an overview of threatened flor and fauna species and non-threatened terrestrial fauna in the catchment, provide a general indication of the population status and trends of these groups and to identify conservation threats and pressures to these populations. Finally, the paper outlines key areas for the future conservation management of threatened flora and fauna species and non-threatened fauna in the Goulburn Broken catchment.

The emphasis of the paper is on threatened flora, threatened vertebrate and non-threatened vertebrate fauna of the catchment, excluding fish. Issues relating to fish and invertebrates are covered in other background papers and relevant documents currently being prepared for the catchment review process. Non-threatened flora and remnant vegetation management issues have been dealt with in detail in the Draft Goulburn Broken Native Vegetation Plan (2000) and various background papers prepared for that process.

This background paper does not provide a detailed 'species by species' account of the threatened and non-threatened species in the catchment. Rather the focus is on the status,

trends and management of suites (or groups) of species with similar ecological characteristics or requirements.

The decline of non-threatened fauna species has been identified as a serious issues by the Authority and other stakeholders in recent times. Research and anecdotal evidence from the catchment suggests that many non-threatened species are declining in range and/or abundance. These declines are particularly evident in the intensive agricultural areas of the lower catchment. Without intervention, a number of these species are likely to move into threatened categories, increasing the burden on already limited conservation management resources. This paper identifies some of the ecological characteristics of declining fauna species.

2.2. Decision making and resource allocation in the Goulburn Broken catchment

The task of conserving biodiversity in the Goulburn Broken catchment represents an enormous challenge for the catchment community. Decisions on what actions are taken will ultimately be made in the context of trade offs between the social, economic and environmental needs and aspirations of the catchment community. It is clear that there are no simple solutions for tackling biodiversity conservation. It will require the on going cooperation and commitment from a range of government agencies and the wider community. This paper does not delineate a specific plan of action for individual species, but raises a range of options in 'key areas for actions' to move towards more sustainable landscapes management and in doing so conserve the catchment's ecosystems and the species they contain. The emphasis is deliberately placed on conserving ecosystems and habitat. In the long term the community has little choice but to take an ecosystems approach to biodiversity protection. We simply cannot afford the cost of a site based, species by species approach to conservation. At present there is a drastic short fall between the level of actions required to conserve biodiversity and the resources available from public and private sources to undertake these actions. This situation will only deteriorate as the burgeoning list of declining species move into the formal threatened categories, further increasing competition between species for conservation resources.

The philosophical approach to threatened species management is an important debate that will have to be undertaken by the community at some point. Given the increasing role of Catchment Management Authorities in landscape management, the GBCMA will play a key role in advocating and implementing the outcomes of this debate and so some discussion of these future issues is warranted as part of the RCS review process.

The 'areas for action' outlined here apply not only to the Authority's operations, but also to its partner agencies, major stakeholders and other organisations. This wider emphasis is necessary because of the nature of the issues. Threatened flora and fauna species and non-threatened fauna species occur on all land tenures in the catchment and are impacted by threats arising on-site and from adjacent tenures. The long-term conservation of whole groups depends largely on the appropriate management of habitats and reduction in threats managed by many 'third parties'. As such the Authority has a major advocacy role with its partner agencies and the catchment community and many possible actions outlined here apply to these wider stakeholders.

2.3. Policy and Legislation for the management of Threatened Species and non-threatened fauna in Victoria

A raft of state and federal legislation and policies provides the statutory framework for the protection and management of biodiversity and for the management of natural resources more generally in the catchment. A more detailed discussion of this framework is provided in the State Biodiversity Strategy, the National and State Frameworks for vegetation management and the Draft Goulburn Broken Regional Vegetation Strategy (including Native Vegetation Retention Controls) and will not be duplicated again here in this background paper. The following is a brief summary however of the two key pieces of legislation that have particular relevance for the future management of threatened species in the catchment.

The Flora and Fauna Guarantee Act was introduced in 1988 to ensure that all indigenous species and the ecological communities they form, survive, flourish and retain their potential for evolutionary development in Victoria. The Act provides a framework for formally listing threatened species and communities and the process that threaten their survival. Listing of species is done through a formal nomination process, with nominations considered by an independent Scientific Advisory Committee. Listing of a species ensures that an Action Statement outlining the reasons for the species decline, key threats to its survival and the actions required to conserve the species is prepared and periodically reviewed and updated. These Action Statements form a key mechanism by which threatened species are managed in Victoria. The Act also allows for determination of Key Threatening Processes, the recognition of Critical Habitat for a species or community and the placing on Interim Conservation Orders to protect species or their habitats from adverse consequences of developments or land uses (See Appendix 1 and 2 for listed species).

Additionally the federal Environment Protection and Biodiversity Conservation Act (1999) established a more unified framework for the protection and management of biodiversity at the national scale. The EPBC Act superseded a number of previous pieces of legislation and seeks to provide for a more coordinated and logical approach to biodiversity protection and management. Similar to the state FFG Act, the EPBC Act has provisions for the listing of threatened species and ecological communities, the identification of Key Threatening Processes, identification and conservation of Critical Habitat. Listing of species follows a similar process to that of the FFG Act in Victoria, where by nominations for listing are considered by a Scientific Advisory Committee. Once listed, Recovery and Threat Abatement Plans are produced for each species, setting out future management actions to conserve the species.

Once listed, the management of a threatened species becomes a matter of national environmental significance, with important implications for how the species and its' habitats are managed in the future. Any developments or land uses that are likely to have

significant impact on the species must seek prior approval for the development from the Federal Minister for Environment and Heritage. To obtain approval, the proposal must undergo an environmental impact assessment.

Additionally the EPBC Act incorporates the management of World Heritage Ares, Ramsar Wetland Sites of International Significance, lists migratory species and has provision pertaining to the management of nuclear issues in Australia.

2.4. Understanding conservation status classifications

In order to formulate strategies and set priorities to protect and manage species it is important to understand which species are at risk. Species are classified into various categories according to their distribution across the landscape, their abundance and the general trends in these factors. NRE is progressively moving towards a unified classification system for flora and fauna that follows the International Union for the Conservation of Natures listing classification. In the interim there will be some overlap in terminology. In this paper, fauna are classified using the IUCN Red List categories, while flora are classified using the existing NRE system.

Threatened is a general term to designate species whose survival is at risk. This general term covers a range of categories of species including presumed extinct, endangered (in danger of extinction, survival unlikely if threats to existence continue) and vulnerable (likely to move into the endangered category in the near future if threats continue.

The use of Rare and Threatened classifications have important implications for management and setting priorities for action. Species that occur in naturally low numbers across large areas or occur in reasonable numbers but only in a limited number of locations may be classified as Rare and only plant species have this classification in Victoria. For example, there are many Rare vascular plants in the Victorian Alps and Highlands Northern Fall Bioregions in the catchment. These species, may be locally abundant, but are classified Rare because they occur in habitat types that are naturally very restricted in distribution. Many Rare species are not threatened with extinction

provided current management and tenure of the sites they occur on continues. For Rare species that occur in conservation reserves, their future conservation depends largely on maintaining the *status quo* and ensuring that the ecological processes that provide the conditions suitable for the plant to survive and reproduce are maintained. In contrast rare species populations that are not secure, particularly those that occur on other tenures such as private land may be at serious risk and be classified into one of the threatened categories (ie Vulnerable, Endangered, Critically Endangered). Their small population size and/or restricted distribution mean that rare species are predisposed to disaster from stochastic events such as fire, disturbance from humans or disease.

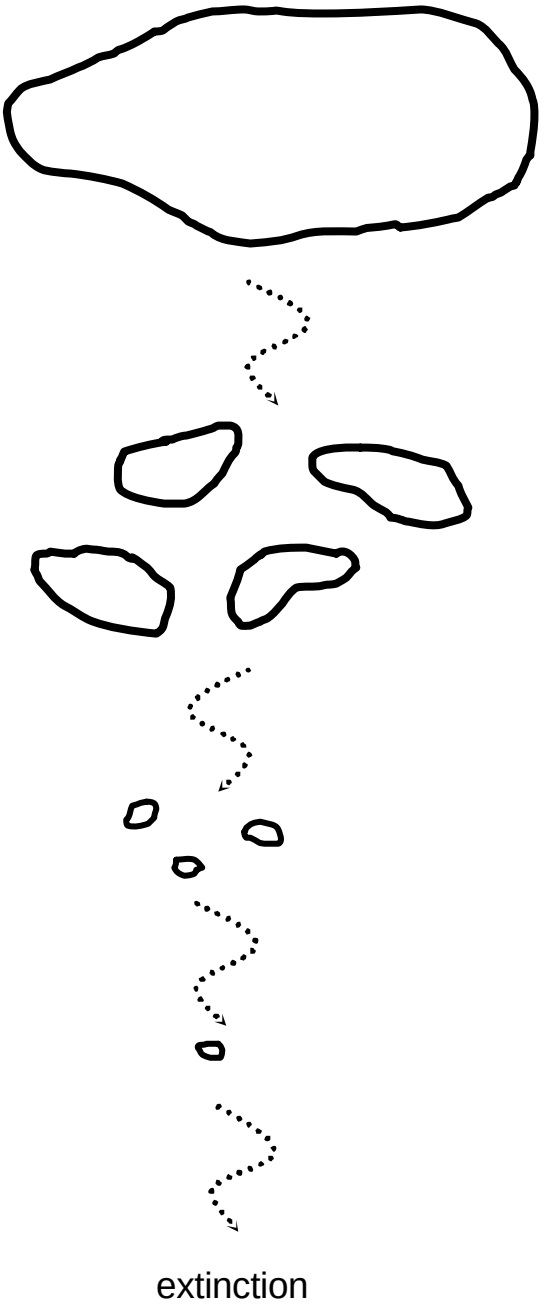
In contrast, threatened species may have had relatively large populations that naturally occurred over broad areas but have suffered declines in range and/or abundance due to threatening processes. Depending on the level of this prior decline and the current trend in the remaining population, the species will be allocated to one of the threatened categories (ie Vulnerable, Endangered and Critically Endangered). Unlike many Rare species whose populations may be small but stable, most threatened species are undergoing active population decline will move into higher extinction risk categories unless the trend can be halted or reversed. As part of its Biodiversity Action Planning process, NRE has developed a system for ranking threatened species based on their distribution, population and occurrence on various tenures. This approach is useful in setting priorities for resource allocation.

2.5. The extinction process

The decline and eventual extinction of species, whether at the local, state or global level is a systematic process. Rarely are species wiped out by a single event. Rather they undergo a series of local population declines and extinctions culminating in total extinction. The extinction process model (Figure 1) is frequently used to explain the extinction process. The model suggests that as large continuous populations are broken up and increasingly isolated, suitable habitat is lost. Once the smaller populations are isolated they are susceptible to other random factors such as stochastic events (disease,

fire or droughts) and population factors such as increased mortality from predation, litter size and biased sex ratios of offspring.

Figure 1 The extinction process model



(Adapted from Clarke *et al.* 1990)

In real world terms, this model is a gross simplification of the extinction process. With increasing understanding about how populations exist and interact with one another in fragmented landscapes, it is clear that the response of different organisms to habitat loss and fragmentation is highly specific. Despite this, the extinction model depicted is conceptually useful to illustrate species decline and to gain insight into the process that many species are currently undergoing in the catchment.

3. General overview of threatened species and non-threatened fauna

The combination of distinct climatic zones and geological formations spanned by the catchment has lead to the development of a complex mosaic of vegetation types across the region. Encompassing vegetation communities as divergent as alpine meadows, tall wet forests, mixed foothill forests, broad riparian floodplains, dry open forests and sparse woodland and grasslands, the Goulburn Broken catchment area contains an enormous diversity of habitat types in a relatively small area. Natural disturbance regimes such as fire, floods and drought, create further floristic and structural diversity and overall habitat 'patchiness'. Approximately 2200 species of native vascular plants and 430 species of native vertebrate animals have been recorded in the catchment. These figures have been derived from the NRE database records and are likely to be underestimates of the total species richness as thorough and systematic inventories have only been undertaken in a subset of habitat types in the catchment. Additionally, because individuals and populations of species vary temporally and spatially, it is virtually impossible to ever compile a complete and definitive list of species for any given area.

Evolution has driven the natural distribution of plants and animals across the catchment over millennia. However, since European settlement, the forces that determine the distribution of plants and animals have been fundamentally altered. Approximately 70% or 1.7 million hectares of native vegetation has been cleared in the catchment since European settlement (Table 1) and all remaining habitats have been disturbed by logging, grazing, exotic species invasions and altered disturbance regimes. Discussion of the

current patterns of plants and animals across the region must be placed in the context of this dramatically altered landscape. The loss of more than two thirds of the total remnant habitat in less than 200 years has set in train a multitude of biological and ecological processes that now dominate the remaining ecosystems and the species they contain. Although broadscale clearing finished decades ago, the rate of change in the quality and quantity of habitats in the catchment mean that species are still adapting (or not adapting) to the 'new' landscape. The plant and animal assemblages of most remnants are still in a state of dynamic flux, with species being lost and gained from sites over time.

In the lower half of the catchment particularly, a syndrome of 'landscape decline' is in process with some entire ecosystems and virtually all of the species dependent on remnant habitats are at future risk. In contrast, a suite of opportunistic, generalist species are rapidly increasing in range and/or abundance by exploiting the new, agricultural habitats that are now available in the catchment. This process is likely to continue as species continue to expand and decline in range and/or abundance in accordance with the amount and quality of their available habitat. It is difficult to predict these changes and how the catchment's flora and fauna communities will look and function in the future beyond generalisations about the types of species likely to decline or increase. For example, the detrimental influence that Noisy Miners are now having on the bird communities of small remnants could not have been envisaged even 20 years ago

3.1. Habitat Loss

The most extensive clearing has been in the GBCMA bioregions most suited for intensive agriculture (Table 1). The Victorian Riverina, Goldfields and the Central Victorian Uplands bioregions have been dramatically altered with more than 92%, 71% and 79% of vegetation cleared respectively. In comparison, 77% vegetation cover or more remains intact in the other four bioregions in the catchment.

Table 1 Extent of Pre-1750 and current native vegetation for each bioregion in the Goulburn Broken Catchment

Bioregion	Pre-1750 extent (ha)	Current Extent (ha)	Current Extent (%)	Cleared (%)
Central Vic.Uplands	490232	101493	20.7	79.3
Goldfields	232747	67071	28.8	71.2
Highlands Nth. Fall	542769	421381	77.6	22.4
Highlands Sth. Fall	20395	20227	99.2	.8
Nth. Inland Slopes	127964	11455	89.2	10.8
Victorian Alps	23741	23674	99.7	.3
Victorian Riverina	966487	70170	7.3	92.7
Total	2404335	715471	29.7	70.3

An increasing number of studies of fauna in fragmented landscapes are suggesting that the total amount of habitat remaining in the landscape may be a more critical factor than the size and configuration of individual patches within the landscape. Simulation models and empirical studies on birds suggest that there may be critical vegetation cover thresholds beyond which changes in faunal species richness occur more quickly. Critical thresholds between 10-30% vegetation cover have been modelled for birds in the Goulburn Broken catchment (Bennett and Ford 1997) and in New South Wales (Reid 1999). These predicted 'critical thresholds' for vegetation cover and species responses may in part explain the dramatic declines in species recorded for the Victorian Riverina, Goldfields and Central Victorian Uplands bioregions.

3.2. Fragmentation

The clearing process not only removes native vegetation but also fragments the remaining areas into smaller patches. The 30% vegetation cover remaining in the catchment is polarised into two categories, larger blocks or very small fragments. Excluding the largest blocks (>5000 ha) which account for 76% of vegetation cover, the two most

disparate size classes (< 5 ha and 1000-5000 ha) account for over half the vegetation cover in the remaining fragment size classes (Table 2).

Table 2 Frequency of remnants in varying size classes for the whole catchment and the percentage vegetation cover of the total within each size class (Wilson and Lowe 2002)

Remnant size class (ha)	Frequency	Frequency (%)	Area (ha)	Area (%)	% of total catchment veg cover
<1	714958	98.5	42518	5.6	1.8
1-5	8864	1.2	17883	2.3	0.7
5-10	1141	0.2	7866	1.0	0.3
10-25	649	0.1	10025	1.3	0.4
25-40	173	0.02	5422	0.7	0.2
40-100	167	0.02	9971	1.3	0.4
100-500	124	0.02	27133	3.6	1.1
500-1000	25	0.003	17456	2.3	0.7
1000-5000	20	0.003	43555	5.7	1.8
>5000	16	0.002	581335	76.2	24.2
Total	726137	100	763164	100	31.7

The data also highlights the skewed size class distribution of remnants; 99.5% of remnants are less than 5 hectares. Data on the number and size classes of remnant vegetation in each bioregion for the catchment indicate a strong correlation between the percentage vegetation cleared and the increasing number of remnants in that bioregion. There is also a negative correlation between the increasing number of remnants and the decreasing average size of remnants in each bioregion. Coupled together, these trends indicate that the more cleared a bioregion is, the more remnants there are likely to be and the average size of those remnants will be smaller than in less cleared bioregions.

Although it is a 'blunt' measure of fragmentation, the average remnant size classes for the catchment and each bioregions also illustrates the degree of habitat fragmentation in the catchment. Excluding the largest blocks (>5000ha), the average remnant size in the catchment is just 0.7ha. The average size of remnants in the four most heavily cleared bioregions, Victorian Riverina, Goldfields, Central Victorian Uplands and the Northern Inland Slopes is less than 0.5 ha; the equivalent of just 5-15 mature trees in the forest and woodland vegetation types that dominant these bioregions.

In short, clearing of native vegetation for agricultural development has fundamentally changed the distribution and configuration of vegetation in the catchment. Arable land has been extensively cleared and remnant vegetation now exists primarily as very small fragments that are not evenly distributed across the landscape. These small remnants are highly modified and are subject to on-going degrading processes from the surrounding landscape that influence the quantity and quality of remnant vegetation. Because of their size and landscape context, these small remnants will require substantial management intervention and habitat restoration if they are to persist in the long term.

In contrast, vegetation on non-arable land mainly persists as large continuous blocks, primarily on public land, with many large conservation reserves. Although subject to a range of threatening processes (eg altered disturbance regimes, grazing, weed invasion, recreation and timber harvesting), the vegetation types in these areas are relatively secure, requiring 'maintenance' management rather than large scale habitat restoration.

3.3. Status of native flora in the Goulburn Broken Catchment

Flora species of conservation concern in the catchment are divided into two key groups, Threatened species and Regionally Significant species. While threatened species are at some risk of extinction in the future, 'Regionally Significant' species may be widespread in the catchment, or across the state. They may be locally depleted, locally uncommon or restricted in distribution or at the limit of their geographic range. Regionally Significant species are at lower risk of extinction, but they do require more attention than common

species to ensure their long-term survival. In particular, regionally significant species at the extremes of their geographic range may be valuable in the future because of the genetic variation they represent within the species.

3.3.1. Threatened Flora

To date, 216 threatened species of vascular plant have been recorded in the catchment (Appendix 1.). This represents approximately 10% of all vascular plants recorded in the catchment. As with other groups, this is likely to be an underestimation of the threatened flora of the catchment as systematic surveys have only been under taken in a few localities and habitat types in the catchment.

As would be expected, threatened plants are most typically associated with the habitats that have been most cleared and disturbed since European settlement. The majority of threatened species, around 40%, are typical of the threatened and depleted grasslands and grassy woodlands Ecological Vegetation Classes of the lower catchment, particularly in the Shepparton Irrigation Region, where the impacts of intensive agriculture on native vegetation have been most severe. These communities are now largely restricted to roadsides, stream frontages and very small blocks on public and private land.

Rare plant species account for approximately 20% of the Goulburn Broken flora. These species typically occur in the highlands, sub-alpine and alpine habitats. Many of these species classified as Rare are naturally restricted in distribution and/or populations. Many of these species occur in conservation reserves on large blocks of public land in the upper catchment. However, grazing and some specific threats associated with recreation pose a threat to the conservation of some of these species.

The remaining threatened plant species (16%) occur in the dry forests of the foothills and lower slopes in the mid catchment. The Box-Ironbark forests contain an important number of threatened plant species (11%), particularly orchids and other ground layer and low shrub species. Despite retention of some large blocks of vegetation on public

land, these forests have been extensively disturbed through grazing, logging and mining operations.

Table 3 Number of vascular flora species in each threat category by lifeform (includes all listed species Threatened and Regionally Significant)

Threat category	Ground-layer	Low shrub	Shrub	Tree	Total
Extinct	1				1
Endangered	23	1	1	5	30
Vulnerable	37	6	3	6	52
Rare	61	16	10	11	98
Poorly known	33	1	0	1	35
Threatened total	**155**	**24**	**14**	**23**	**216**
% of threatened	72	11	6	11	100
Regionally Signf.	6	9	13	10	38
Total all listed spp.	**161**	**33**	**27**	**33**	**254**
% all listed species	63	13	11	13	100

3.3.2. Regionally Significant Species

Along with the 216 species listed as threatened in the catchment, an additional 38 species are listed as Regionally Significant. A number of the Regionally Significant species (Appendix 2), although common elsewhere in the state, are highly depleted in the catchment. For example, species such as Yellow Box (*Eucalyptus melliodora)*, Yellow Gum (*E. leucoxylon)*, White Box (*E. albens)* and White Cypress Pine (*Callitris glaucophylla)* are tree species that often occur on fertile soils and consequently have been heavily cleared. Other species such as River Bottle Brush (*Callistemon seeberi)*, Silver Banksia (*Banksia marginata)* and a number of wattle and pea species have probably been severely impacted by grazing and disruption to natural disturbance regimes such as fire. Many of the species will require active site management and target revegetation programs to augment populations if they are to persist in the catchment.

3.3.3. Life form trends of listed species

Classification of listed species into lifeform groups, reveals that the majority of listed species (Threatened and Regionally Significant) are from one lifeform group; the ground layer. This group accounts for 72% of threatened species and 63% of all listed species. The remaining three lifeform groups (low shrubs, shrubs and trees) are quite evenly represented in the listed species with 13%, 11% and 13% of total listed species occurring in these classifications respectively.

The dominance of ground layer species in the listed flora for the catchment reflects the impact of land use and disturbance in the catchment. The combination of extensive clearing of diverse grasslands and grassy woodlands followed by intensive grazing of virtually all remnants in the lower catchment by domestic stock, kangaroos and rabbits, has removed all but the most resilient ground layer species from remnants on private and public land. Ground layer plant species are particularly susceptible to these types of disturbance. Many species are small, non-woody and not well-adapted to the continual grazing and soil disturbance now typical of small remnants on private and public land. Additionally many species have restricted distributions, specific reproduction and regeneration requirements and have poor dispersal capabilities so are unlikely to recolonise patches following local extinction.

In contrast, larger lifeforms such as trees and shrubs may appear less susceptible to direct disturbances, but as many of these are long lived, the true status of these populations may be masked. Lack of suitable regeneration conditions (eg alteration of fundamental disturbance regimes such as fire) and the lack of recruitment due to grazing is likely to be impacting on many shrub and tree species. For particularly palatable species such as *Allocasurina luehmanii, recruitment opportunities are limited and as such,* a rapid decline in populations of this species can be expected as adult trees die off over time.

3.3.4. Summary of major threats to vascular flora (source Bioregional Network Analysis data)

Although there are numerous threats to the vascular flora of the catchment, three threatening processes in particular represent serious threats to native flora because they are widespread, on-going and have severe impacts on flora species.

Grazing. Grazing by introduced and native herbivores is a major threat to flora in the catchment. Continual grazing changes the composition of vegetation communities, promoting less palatable species while reducing the biomass and recruitment of palatable species. Grazing may also promote invasion of exotic species, particularly annuals, by reducing competition, increasing nutrients and disturbing soil. Individual species responses to grazing vary with the type of grazing (eg sheep or cattle), seasonal conditions and grazing intensity. Studies in grassy woodlands in eastern Australia have identified groups of species that respond differently to grazing, from species sensitive to even light grazing through to species that are favoured by heavy grazing. Robinson and Mann (1996) found that grazing was significantly negatively correlated with the abundance of plant and litter biomass, percentage native ground cover, native grass species composition, the abundance of native shrubs and regeneration of sites along the Broken Boosey Nine Mile Creek system.

Studies on grazing impacts of grazing suggest that there may also be far more subtle impacts.. Declines in litter cover, reduced cryptogam cover, loss of micro-topography, increased soil compaction, modified infiltration rates, increases in erosion rates and changes in microclimatic conditions are all likely to impact on the ecological functioning of sites (Yates *et al*. 2000). Grazing also impacts on the habitat of faunal species with some native ground dwelling vertebrate and invertebrate species particularly impacted by stock grazing.

Weed Invasion Often associated with grazing, weed invasion represents a major threat to vegetation communities throughout the catchment. Invasion of native plant communities

by exotic plant species is considered one of the most serious threats to biodiversity worldwide. Weeds compete with native species for critical resources such as space, light, nutrients and moisture and can influence the composition and structure of vegetation communities. These changes generally result in decreased native species richness and ground layer lifeforms in the catchment are particularly susceptible. Weed invasion is typically severe in small remnants as the edge to area ratio of small sites mean they are predominantly 'edge' and are highly exposed to on-going invasion from the surrounding landscape. Weed invasion may also prevent regeneration and recruitment of native species, further altering species composition and disrupting community succession processes.

Salinity. While there may be other more direct threats, the scale and level of impact of salinity on thousands of small remnants mean that salinity is a prevailing threat to native flora that will out-weigh many minor threats in the catchment. Although salinity does not currently impact on large areas of native vegetation in the catchment, predicted future extents of high water tables in the Victorian Riverina and Goldfields Bioregions will potentially have devastating impacts on threatened flora species due to the overlap between high water tables and depleted EVCs. Aside from the obvious direct impacts of salinity on native vegetaion, there may be more subtle impacts of rising ground water on flora. For example, the loss of overstorey species may change microclimatic conditions in remnants and at the local landscape scale. Salinity is also likely to have disproportionate impacts on the vegetation communities that occur lower in the landscape,. These communities are already severely effected by other threats such as clearing, weed invasion and grazing.

Individually these key threats represent serious risks to native flora in the catchment. What is particularly concerning is that all these threats are operating in unison in many remnants in the lower catchment. Under these circumstances, the proportion of threatened flora in these EVCs is likely to increase, particularly as salinity is more severely expressed in the landscape over time.

3.4. Status of Fauna in the Goulburn Broken Catchment

A total of 457 vertebrate fauna species have been officially recorded in the catchment (see Appendix.3 for full listing). Of this total, 17 are fish species and are not discussed further in this paper as they are being covered in other documents. A further 27 vertebrate fauna species in the catchment are introduced.

3.4.1. The diversity of terrestrial vertebrate faunal groups

Of the 413 native terrestrial vertebrates species recorded in the catchment, birds comprise the vast majority of species with 281 species or 68% of vertebrate species(Table 4). The reptile and mammal groups (57 and 51 species respectively), although significantly less diverse than bird species, are well represented in the catchment. Amphibians are the least diverse terrestrial vertebrate fauna group with only 24 species recorded for the catchment, or 6% of the total terrestrial catchment vertebrate fauna.

Table 4 Summary of the number of species recorded in each terrestrial vertebrate group and the percentage of total species recorded in the Goulburn Broken catchment.

Group	No. species recorded	%of total vertebrate fauna
Birds	281	68
Reptiles	57	14
Mammals	51	12
Amphibians	24	6
Total	**413**	**100**

While the figures presented in Table 4 are a useful indication of the diversity of terrestrial vertebrate fauna in the catchment, they can be misleading in a number of ways. The figures are based only on the recording of a species 'occurrence' in the catchment. It is

important to know whether a species is a resident species, living and breeding in the catchment for its entire lifecycle, or if it is a seasonal visitor that moves into or through the catchment for short periods of time. For example many birds listed for the catchment are *vagrants*, and are recorded as only rare visitors to the catchment.

The dominance of birds in the overall diversity of terrestrial vertebrate fauna in the catchment is not surprising. The pre-European vegetation communities of the catchment were dominated by forests and woodlands vegetation types, with a Eucalypt overstorey and a varying number of lower strata of shrubs and ground layer vegetation. Birds are a diverse group with species capable of exploiting resources from all strata of vegetation, from the ground layer to the canopy and above and utilising a wide range of food, shelter and nesting resources. Further, a large number of bird species recorded in the catchment are typical of wetlands, swamps and riparian habitat areas. These habitat types were common and widespread in the catchment prior to European settlement. The other three terrestrial vertebrate fauna groups (reptiles, mammal and amphibians) are generally less diverse than birds, with many species having very specific habitat requirements. The biology and ecological requirements of amphibians (eg a fully aquatic larval stage) and reptiles (eg poikilothermic or "cold blooded") for example limits the range of habitats that can be utilised and consequently the number of species from these groups is lower.

3.4.2. Current Status of Terrestrial Fauna

The current status of fauna in the catchment presented in this document are derived from a number of sources. The status of threatened fauna is determined by NRE from databases, ecological studies and expert advice (NRE 2000). Detailed studies of populations are only available for a small number of threatened species in the catchment (eg Grey-crowned Babbler and Bush-stone Curlew) or for some species in particular areas of the catchment (eg threatened hollow dependent fauna in the box-ironbark, NRE 1997). The status of non-threatened fauna is 'extrapolated' from fauna records, ecological studies and published accounts of species in the catchment and research in

similar landscapes elsewhere and should be interpreted as general 'trends' in populations of the species rather than a definitive classification.

3.4.3. Threatened Fauna

The list of threatened species presented here (Table 5) is based on catchment records from the NRE Bio-map Database (NRE 2002). The threat categories are those assigned by NRE in the Threatened Vertebrate Fauna listing (NRE 2000) and follow the IUCN classification system. The term 'threatened' is used broadly and includes species that are classed as "Lower risk – near threatened" and "Data deficient". These species do not qualify for a higher risk category but are of conservation concern because insufficient data is available to make accurate assessments on population trends.

Table 5. Summary of the number of species in each fauna group in each threat category, total number of threatened species in each faunal group and the proportion (%) this represents of the species in that group.

Threat categories	Birds	Mammals	Reptiles	Amphibians	Total
Extinct	0	2	0	0	2
Critically endangered	5	1	0	2	8
Endangered	19	5	2	0	26
Vulnerable	17	3	3	2	25
Lower risk *	6	2	1	0	9
Insufficiently known	6	3	1	1	11
Total threatened	**53**	**16**	**7**	**5**	**81**
No. spp. in group	**281**	**51**	**57**	**24**	**413**
% spp. threatened	**19**	**31**	**12**	**21**	**20**

* Lower Risk – near threatened.

The threatened species figures presented in Table 5 provide a grim summary of the status of vertebrate fauna in the Goulburn Broken catchment. Overall, 81 species or 20% of the

catchment's vertebrate fauna (excluding fish) are considered threatened. Of these, 59 species are in the critical categories (Critically endangered, Endangered and Vulnerable) and are at serious risk of extinction unless actions to prevent further declines are taken.

It is important to keep in mind that these classifications are based on the statewide conservation status of the species. The Goulburn Broken may cover only a small part of a species total distribution and as such, are of less concern in terms of the catchment response. For example, threatened species such as the Powerful Owl, Eastern False Pipistrelle, Smoky Mouse and the Fat-tailed Dunnart, occur across large areas of Victoria and their future survival depends on actions undertaken across the State. In contrast for a number of threatened species, the Goulburn Broken catchment forms a large proportion of the species statewide range. For example, the catchment provides critical habitat for the Bush-stone Curlew, Giant Bullfrog, Grey-crowned Babbler, Regent Honeyeater and the Carpet Python. For these species, the catchment is now a stronghold and the actions undertaken in the Goulburn Broken are critical to the long-term survival of these species.

The mammal fauna of the catchment has been particularly effected since European settlement, with approximately one third, or 16 species, now threatened. Of these, 2 species are extinct, while a further 9 species are now of serious conservation concern (ie Critically endangered, Endangered and Vulnerable. Habitat loss and fragmentation through clearing, loss of ground layer habitat through grazing, changes to habitat structure through logging and firewood harvesting and the introduction of predators such as cats and foxes have taken a severe toll on the mammal fauna, particularly the ground-dwelling species. At least 10 of the 16 species listed as threatened spend all or part of their time on the ground.

Amphibians and birds have suffered similar declines with approximately 1 in every five species within these groups now considered threatened. The specific reproductive requirements and limited dispersal capabilities of Amphibians generally mean species within this group are highly susceptible to disturbances such as habitat loss and fragmentation. There is also wide speculation about the impacts of chemical use, climate

change and disease on amphibians worldwide, particularly frogs, although conclusive evidence to support these theories is lacking at this stage.

Threatened birds, account for 19% of threatened vertebrates in the Goulburn Broken catchment and are a conspicuous component of the higher risk threatened fauna categories (Vulnerable, Endangered and Critically Endangered). The prominence of birds in these categories highlights the decline of woodland bird species corresponding to the decline in the extent, continuity and quality of woodland habitats in the lower catchment.

Although relatively few species of reptiles are threatened, it is apparent that many reptile species have declined significantly since European settlement. Studies in the Victorian Riverina and Goldfields indicate that reptiles have declined and are now very patchily distributed across the landscape. Those species now threatened in the catchment are typically associated with the woodland habitats, particularly with ground layer habitats.

3.4.4. Summary of major threats to fauna (source Bioregional Network Analysis data)

Habitat Loss. Although broad scale clearing of vegetation has ceased in the catchment, the on-going incremental loss of habitat and key habitat resources is still a major threat to fauna. Grazing of remnants, salinity, lack of regeneration and recruitment and senescence of scattered trees all reduce the quantity and quality available to fauna at the site, local and landscape scale. Studies on the distribution of fauna in the Victorian Riverina and Goldfields suggest that size and configuration of habitat as well as the total amount of vegetation in the landscape influence the persistence of species dependent of remnant habitats. These studies suggest the on-going incremental loss of vegetation, which will accelerate as salinity impacts increase, is still a major threat to faunal populations under threat. Small remnants and scattered trees make up a significant proportion of the remaining vegetation cover in some landscapes. For example, remnants less than 5 ha account for 31% of total vegetation cover in the Victorian Riverina. The

loss of scattered trees, aside from reducing the total amount of vegetation in the landscape, also reduces critical resources in the landscape such as hollows and nectar. Further the loss of scattered trees and small remnants increases the isolation of remaining remnants.

Habitat degradation. Grazing, weed invasion, rising water tables, soil disturbances and earth works continue to degrade remnants throughout the catchment. These degrading processes decrease the quality of habitat and threaten the long term viability of remnants. These processes degrade habitat quality directly (eg grazing reduces ground layer biomass) and increase the susceptibility of remnants to further degrading processes (eg soil disturbance promoting weed invasion). The issue of on-going habitat degradation has important implications for the long-term management of remnants. If these degrading processes cannot be reversed, remnant vegetation will decline in quality and eventually in extent. The high proportion of fauna species that feed and/or breed on the ground and the proportion of ground layer flora species that are of conservation concern reflects the impact of habitat degradation on biodiversity in the catchment.

Predation. Predation by cats and foxes has been recognised as a major threat to many ground dwelling fauna. Although there are no published figures of population trends of cats and foxes in the catchment, it is clear they are widespread, occurring in most habitats and anecdotal evidence suggests they are increasing in number. Predation by cats and foxes has been implicated in the decline of ground nesting birds, ground dwelling mammals and reptiles. Given that more than 60% of threatened fauna and 40% of declining bird species in the catchment use ground layer habitats for foraging and/or nesting, fox and predation is an important issue for the future conservation of these species. Predation adds additional stress to already fragmented and isolated populations.

3.5. Status of Non-threatened Fauna in the Goulburn Broken Catchment

While agency conservation efforts have traditionally been focused on threatened species, there is now increasing concern about the widespread declines of 'common' species in

the temperate woodlands of southern Australia (Hobbs and Yates, 1999). While many of these species are not yet listed as threatened, there is strong evidence to suggest they are undergoing widespread declines in many landscapes and will move into the threatened categories unless these trends are reversed. Reliable data to ascertain population trends are only available for birds and even then only for some species. The species listed in Table 7 are species recorded in the Goulburn Broken that have been identified by published studies and reviews elsewhere as experiencing declines in agricultural landscapes. Of the 74 species listed, 15 are recorded as declining in 3 or more studies/reviews (Saunders 1989, Robinson 1991, Barrett et al. 1994, Bennett and Ford 1996, Robinson and Traill 1996, Reid 2000, Watson et al. 2000, Freudenberger 2001, Seddon et al. 2001). This suggests these species are undergoing widespread declines in a number of landscapes throughout south eastern Australia. Not surprisingly the list of decliners follows similar patterns to other threatened species in the catchment. The vast majority of species are associated with the grassy woodland and forested habitats of the lower catchment. Many declining species are associated with ground layer or low vegetation habitats (Robinson 1991, Bennett et al. 1998, Robinson and Traill 1996).

The declines recorded in bird species are likely to be symptomatic of much wider population trends of other vertebrate groups. Birds are the only group for which reliable data on a range of species is available. It is widely accepted that birds are useful indicators of biodiversity and ecosystem health. They are now used as focal species for ecosystem restoration projects (Lambeck 1997) with their use in this capacity is based on the premise that the habitat requirements of some bird species encapsulates the habitat needs of many other fauna species. This assumes that the decline of these species indicates that many species, both vertebrates and invertebrates, are undergoing similar declines. Furthermore, given that birds are more mobile, they may be less impacted by fragmentation than less mobile fauna such as small reptiles and amphibians. The declines indicated for birds suggest that the status of some other ‘common‘ vertebrate species may be more critical than currently assumed.

The loss of 70% of native vegetation cover and the fragmentation of the remaining vegetation into thousands of smaller, isolated patches has resulted in substantial changes in faunal populations. The fact that 1 in 5 faunal species in the catchment are threatened with extinction indicates the degree to which species dependent on remnant habitats have suffered since settlement. There is little doubt that most non-threatened fauna species dependent on remnant habitats have also undergone substantial reductions in range and/or abundance since European settlement. Many of these species continue to decline and will undoubtedly move into the threatened categories unless actions are taken to reverse these trends.

Species from all faunal groups appear to be undergoing declines. Recent studies in the Victorian Riverina and the Goldfields suggest that many once common species are in fact now relatively uncommon and with very patchy distributions. For example, research on bird distribution in the Box/Ironbark forests showed that many apparently widespread and common species occurred at just a limited number of sites across the region. Similarly, approximately half of the 113 species recorded by Robinson and Mann (1996) in a survey of the Broken Boosey Nine Mile creek system were recorded at fewer than 5% of the 126 sites. Species considered 'woodland dependent' were rare or absent from much of the creek system despite it being one of the largest remnants left in the eastern Victorian Riverina.

Similarly, surveys of reptiles in the same regions suggest that reptiles are now generally scarce, occurring in low densities with patchy distributions. A survey of 22 grazed and un-grazed sites in the Box/Ironbark recorded only 126 individuals from 6 species despite thorough searching. Robinson and Mann (1996) recorded 72 individuals from 12 species across 126 sites along the Broken Boosey Nine Mile creek system. Bennett *et al.* (1998) also found that most reptile species in the Victorian Riverina occurred in low numbers and few species are found in small remnants.

These studies suggest that although many 'common' species are widespread they occur at low densities and the size of individual populations are probably small. These small

populations, particularly of less mobile groups such as reptiles, are vulnerable to decline and local extinction and recolonisation chances are low.

3.5.1. Which species are likely to decline?

The ratio of declining species to threatened species may be in the order of 2:1, that is, for every threatened species probably another 2 fauna species are undergoing population declines, although there is little hard data to support this assertion. It is obvious that many species are undergoing active population declines (see Case Study). The fact that many less mobile species such as reptiles, amphibians and some mammals and birds species now exist in low numbers and occur in small isolated habitats that are degrading mean these species are in a precarious situation.

The distribution of remnant size classes illustrate the challenges faced by many species. For species with large home ranges (eg Tree Goanna 65ha, Brush-tail Phascogale 40 ha, Powerful Owl 500ha + Bennett et al. 1998) many remnants are simply too small to maintain these species and allow them to survive and reproduce. Individuals of these species are subject to pressures such as finding sufficient food and shelter resources in these degraded habitats and population pressures such as predation, biased sex ratios and increased mortality. These pressures result in declines of populations at the site, local landscape and eventually regional scale. As can be seen from the Case Study, where an average of 1 species disappeared from a single property every 2 years, species declines are occurring rapidly in some areas. It is clear that if current trends continue many 'common' species will become increasingly rare in the catchment. For species that occur in the Victorian Riverina and Goldfields and are subject to similar pressures right across these bioregions there is little doubt that these species will move into threatened categories.

Given that 64% of threatened species and 40% of birds listed as declining in south eastern Australia feed and/or nest on the ground it is clear that ground dwelling species are at risk. Additionally 28% of threatened species utilize hollows for nesting and/or

shelter, while 23% of threatened species rely on vertebrate prey for at least part of their diet. Together these attributes indicate that species that feed or nest on the ground, utilise hollows and/or rely on vertebrate prey are species that are likely to be susceptible to decline. This is especially relevant to species whose habitat range overlaps with the extensively cleared landscapes and/or species with specialist habitat requirements. It is likely that species with these, or combinations of these attributes, are declining. This group includes reptile species such as the Eastern bearded dragon, Common blue-tongue lizard, Stumpy-tailed lizard, Blotched-blue tongue lizard, the large elapid snakes (Tiger, Eastern Brown and Red-bellied Black Snakes). Possible declining mammals including Yellow-footed antechinus, Short-beaked Echidna, Feather-tailed glider, Sugar glider, many micro bat species, and birds including Masked and Banded lapwings, Sacred kingfisher, Flame Robin, Southern boobook, Red-browed Firetail, Singing Bushlark and amphibians such as Sloanes Froglet, Perons tree frog. Although some of these species are clearly secure or increasing in abundance in some areas of the catchment (eg Tiger Snake in the SIR), the attributes of many of these species mean that they will be susceptible to decline at some time in the future.

Table 6 List of bird species recorded as under going population declines in studies in agricultural landscapes in south eastern Australia. * indicates species listed in 3 or more studies.

*Hooded Robin	*Black-chinned	Honeyeater
*Jacky Winter	Honeyeater	Buff-rumped Thornbill
*Crested Shrike-tit	*Brown Treecreeper	Common Bronzewing
*Diamond Firetail	*Emu	Crested Bellbird
*Painted Button-quail	*Gilbert's Whistler	Eastern Yellow Robin
*Varied Sittella	*Red-capped Robin	Grey Butcherbird
*White-browed Babbler	*Southern Whiteface	Grey Currawong
*Australian Owlet-nightjar	*Brown Quail	Little Lorikeet
	Brown-headed	Musk Lorikeet

Restless Flycatcher
Tawny Frogmouth
Western Gerygone
Whistling Kite
White-browed Woodswallow
White-winged Triller
Double-barred Finch
Little Button-quail
Azure Kingfisher
Banded Lapwing
Banded Stilt
Barn Owl
Beautiful Firetail
Black-eared Cuckoo
Blue Bonnet
Blue-faced Honeyeater
Blue-winged Parrot
Brown Falcon
Budgerigar
Buff-banded Rail
Chestnut-rumped Thornbill
Cockatiel
Collared Sparrowhawk
Dollarbird
Dusky Woodswallow
Fan-tailed Cuckoo
Masked Woodswallow
Mistletoebird
Nankeen Kestrel
Pallid Cuckoo
Peaceful Dove
Purple-crowned Lorikeet
Rainbow Lorikeet
Rufous Whistler
Scarlet Robin
Spotted Nightjar
Spotted Quail-thrush
Stubble Quail
Tawny-crowned Honeyeater
Tree Martin
Wedge-tailed Eagle
Weebill
White-backed Swallow
White-bellied Cuckoo-shrike
White-eared Honeyeater
White-fronted Chat
White-naped Honeyeater
White-throated Nightjar
Yellow Thornbill
Zebra Finch

Case Study: Faunal changes at the farm scale

Species decline and eventual extinction is a gradual process involving the accumulation of a series of local extinctions at the individual patch scale. The following case study is an example of the subtle declines in species that are occurring at the farm scale.

'Valarnon' is a 400ha irrigation property north east of Kyabram in the Shepparton Irrigation Region. Historically the property was used for sheep and wheat production, with a small area of horticulture (apricots, fig and peaches). The property is essentially cleared, with more than 99% of native vegetation removed. Only two small remnants of 2ha each remain with a number of scattered trees (approx. 30 in total) spread across the property. One remnant, the house block, is a mixture of box woodland and native grassland that contains about 30 species, including a number of threatened and regionally significant plant species. The remnant was heavily grazed by sheep for short periods in autumn and spring annually for approximately 80 years. The remnant is now intermittently grazed by cattle, primarily during late winter. The other remnant has been heavily grazed by sheep and cattle until 1999 when it was fenced out. Both remnants have dense Eucalypt regeneration. There is little remnant vegetation in the surrounding landscape, the largest areas (i.e. >10 ha) of native vegetation being approximately 10km north along the Goulburn River.

The property was largely undeveloped (Table 7) until 1980 when a program of land forming and irrigation development began. Prior to 1980 approximately 67% or 260 hectares of the property was 'undeveloped' and was only lightly grazed seasonally. Now only 12% of the property is 'undeveloped' but even undeveloped land is now under heavy grazing for a period of the year. The area under intensive management (cropping/sub pasture) has increased from 120 ha to 340 ha, an increase of 55% since the 1980s. A number of individual scattered trees have been removed during land forming and irrigation infrastructure development. Large areas of mixed native and exotic pastures have been replaced with exotic subterranean pasture species and outside remnant areas native plants are scarce, being restricted to paddock margins.

Table 7 Changes in land use on "Valarnon" 1980-2002

Land use	Prior 1980 (ha)	2002 (ha)
Irrigated pasture	8	10
Cropping/ sub pasture	120	340

Undeveloped grazing	260	39
Remnant vegetation	5	4
Plantation	4	3
Other	3	4
Total	400	400

The impact of these changes and developments on native fauna has been significant. Lists and records of fauna sightings on the property have been kept since 1980 and the current owners have been on the property for 3 generations so there is a good knowledge of changes in some faunal groups over that time. Table 2 lists species that have declined or disappeared from the property since 1980. Of the 24 species listed 11 have not been recorded in the last decade and a further 13 species have declined from being considered common to now uncommon. One species, a blind snake (species unknown) now considered uncommon has not been seen for a number of years. Because of its cryptic nature, however, it is difficult to determine if it still occurs on the property or is locally extinct.

Table 8 Changes in status of species on "Valarnon"

Species	Prior 1985	Since 2000
Bearded Dragon	UC	X
Red-bellied Black Snake	UC	X
Eastern Brown Snake	C	UC
Marbled Gecko	C	UC
Blind snake (spp. ?)	C	UC ?
Tree Goanna	C	UC
Common Ring-tail Possum	UC	X
Water Rat	C	UC
White-winged Chough	UC	X
Stubble Quail	C	UC
Zebra Finch	C	X
Bush-stone Curlew (E)	C	X
Red-capped Robin	UC	X
Clamorous Reed Warbler	C	UC
Richards Pipit	C	UC

Purple Swamphen	C	UC
Masked Lapwing	C	UC
Black Falcon	UC	X
Little Eagle	UC	X
Collared Sparrow hawk	UC	X
Golden-headed Cisticola	C	UC
Grey Shrike-thrush	UC	X
Flame Robin	C	UC

As well as these declines, some migrants that have been recorded intermittently over the past 20 years (eg Fan-tailed Cuckoo) have not been recorded for more than 5 years, although they may still occur on or near the property. In contrast 4 bird species (Pied Butcher Bird, Noisy Minor, Eastern Rosella and Crested Pigeon) have become more common since 1980. Three new bird species Grey-crowned Babbler, Banded Plover and Blue-faced Honeyeater were first recorded between 1995-1998. The Grey-crowned Babblers remained in the house garden for 3 months then disappeared and Banded Plovers moved to an adjacent property where they remained for approximately 6 months before disappearing. Blue-faced Honeyeaters are now recorded 2-3 times per year. One mammal species, the Echidna was recorded on the property during 1998 when a single adult was seen and another individual was recorded in a nearby roadside around the same time, but have not been recorded since.

The figures presented are of changes in the fauna on a single property over a 20 year period and present a grim picture for fauna in the intensive agricultural areas of the catchment. As agricultural production has intensified, there has been a corresponding decline in fauna on the property. On average a species has disappeared from the property every 2 years, while a new species was recorded only every 5 years, just one of which continues to be recorded on the property, the others must be considered vagrants. A further 13 species have declined from being considered common to uncommon and if current trends continue many of these species will disappear from the property in the future.

It is interesting to note that during the period these changes in fauna have taken place, remnant vegetation cover declined by 1 hectare primarily through the clearing of scattered trees and 'natural' decline. While this represents 20% of the vegetation cover, the two main remnants on the property remain intact and are more sympathetically managed now than at any time in the past. Of the 24 species that have declined 17 (71%) are associated with ground layer or low vegetation habitats. This corresponds to the greatest change in habitat

resources on the property, the conversion of 'undeveloped' mixed native/exotic pastures to improved sub pastures. Predation rates by cats and foxes have probably remained constant over the period.

The case study provides and insight into the process of faunal declines. Changes in habitat availability at the paddock and property scale result in declines of already small and fragmented populations of fauna. These local declines and extinctions accumulate and result in regional and finally total extinctions. The case study also highlights two interesting patterns of decline of threatened species, the Bush-stone Curlew and Grey-crowned Babbler, both listed as Endangered in Victoria. These two species give an indication of the types of declines that may be occurring with many non-threatened species in the intensive agricultural areas.

The Bush-stone Curlew was historically common on the property, adjacent farms and the surrounding landscape, breeding successfully and gathered in small flocks of sometimes up to 10 individuals. Subtle changes in habitat quality and quantity at the paddock, property and local landscape scale saw the species rapidly decline to be locally extinct within a 20 year period, despite the landscape appearing to be similar in terms of vegetation cover and 'gross' habitat availability. In contrast the Grey-crowned Babbler had not been recorded on the property in living memory and was not observed in the local landscape, the nearest colonies being isolated at least 10-15km away along the Goulburn River. For the Babblers, the local landscape has probably been unsuitable habitat for decades, the species being essentially 'pseudo-extinct' despite being recorded on the property in recent times, as insufficient habitat existed in the landscape for the species to establish breeding territories. These species have sometimes been termed the 'living dead' as essentially the species will die out as there is no recruitment of young to maintain viable populations.

4. Future directions and key areas for actions

A series of recommendations and actions are outlined below. These recommendations stem from the discussion of of the threatened flora and fauna and declining fauna issues outlined in this paper. The recommendations fall into three broad areas for action, Planning, Communication and Implementation.

4.1. Strategic Planning

Recommendation 1.
The GBCMA should instigate a strategic review of the roles and responsibilities of government and non-government agencies in relation to biodiversity management in the catchment, with particular emphasis on threatened species management.

There is an urgent need for a strategic review of roles and responsibilities of government and non-government agencies in relation to biodiversity management in the catchment. The review should include legislative responsibilities, jurisdiction, resources (financial, human, technical, skills capacity etc), identification of gaps and a suggested framework for the coordination, management and delivery of these services.

Recommendation 2.
The GBCMA investigate the role of Bioregional Planning and its relationship to other catchment planning processes, particularly Local Area Planning.

There is a risk of duplication and inefficient use of resources in relation to threatened species and biodiversity planning in the catchment. Planning that includes (or should include) threatened species and wider biodiversity issues is being undertaken by a range of a range of organisations and agencies at various scales. There is some risk of these plans not integrating resulting in missed opportunities for better on-ground outcomes. The role of Bioregional planning and its relationship to other planning processes, particularly Local Area Planning, should be investigated. The role of the Focal Species approach for wider 'conservation planning' should be investigated for other GBCMA programs, with emphasis on developing 'triggers for actions' based on focal species requirements. For example, defining ecological characteristics or site attributes that could be used to identify sites are *likely* to contain threatened or significant plant communities or be important threatened fauna could be used as a 'trigger' in waterway, floodplain and salinity program overlays to ensure appropriate works and consideration for the requirements of these species are included in the works programs of other GBCMA programs.

The aim of the overlays is to trigger prior awareness about the potential presence of threatened species to prevent habitat destruction and ensure the correct response and implementation of appropriate actions at the sites when works are planned and under taken. This has an educative and awareness raising role and well as a practical on-ground role. There are useful lessons in the SIR Environmental Assessment process.

Recommendation 3

The GBCMA assist Local Governments to understand their roles and responsibilities in relation to threatened species they management and closely involve Local Government in planning processes such as Bioregional Planning.

Local Government is a key stakeholder in threatened species management given the proportion of threatened species habitats that occur on land they manage. To date, local governments have generally avoided these issues. However, given the trends in threatened and declining species populations, local government will become a major stakeholder in the long term conservation of many threatened species. Local government are also critical players in natural resource and social planning processes.

Recommendation 5.

An analysis and comparison of the Bioregional Planning approach and other threatened species and reserve design planning processes be undertaken to compare outcomes and adequacy of focal species derived implementation plans.

Bioregional planning in the catchment includes a modified Focal Species approach. This focal species approach is highly 'fauna-centric' which may or may not capture the requirements of threatened flora and even other faunal groups such as reptiles, amphibians and invertebrates. The analysis by Robinson (undated) on reservation requirements for the eastern northern plains of the Victorian Riverina indicated that disparate sets of sites were required to protect threatened plants and animals and that the protection of sites for one group did not necessarily protect other groups. Bioregional planning is currently incorporating more sophisticated landscape design principles (Wilson and Lowe 2002). Before Bioregional Planning is undertaken for

more landscapes, an analysis of the overlap or lack of congruence between planning approaches (eg reserve design approaches) may be useful to ensure that the Bioregional Planning approach captures the full range of sites required to protect populations of threatened animals *and* plants. The analysis could use a test landscape to compare approaches and outcomes. Wilson and Lowe (2002) have commenced this for the mid Goulburn area; it may be useful to use this as a trial site.

Recommendation 6.
The potential impacts of salinity on habitat extent and configuration, particularly of key landscape elements such as regional riparian corridors, large blocks and local habitat networks be assessed.

Salinity represents a major threat to significant vegetation, particularly in the SIR and Mid-Goulburn. The Statewide NAP assets project has commenced this task for the NAP regions; inclusion of more reliable biophysical models may reveal this threat more fully (K. Lowe, pers. comm.). Analysis should be undertaken to determine the likely impacts of salinity on threatened and declining flora and fauna species over the next 50-100 years. Because of the time lags involved in the provision of critical habitat resources such as large old trees with hollows, planning for the provision of habitat connectivity and critical resources needs to begin so these factors can be included in land and water management plans and other strategic documents.

Recommendation 7.
The GBCMA in partnership with local government should begin to develop significance overlays for native ecosystems that incorporate current and future need of species given anticipated salinity impacts and tree decline

The long term goal of doubling production from half the land may offer many opportunities for landscape change. It may also increase the ecological footprint of intensive industries in the catchment. A pro-active planning approach is likely to deliver the best environmental outcomes. Development of tree density overlays and

creation of significance zones that incorporate current and future needs of threatened species is required. This is a key partnership role with NRE.

Recommendation 8.
Investigate options and mechanisms to provide incentives to encourage land holders to conserve scattered trees and allow regeneration on private property. The use of local government rate rebates, communal grazing and commons type arrangements should be investigated

The loss of scattered trees from the catchment's landscape is a major issue. In some areas scattered trees make up a large proportion of the remaining vegetation cover and they provide critical resources such as nectar and hollows for a range of species. They also provide critical ecosystem services such as ground water control, shade and shelter to stock. Similarly, the longer term vegetation succession processes need to be incorporated into habitat planning to ensure adequate successional age classes are present in the landscape and that 'patchiness' is created.

Recommendation 9
Investigate incentives and mechanisms to encourage revegetation of larger individual patches (See Rec. 4)

Most vegetation remnants on private land in the lower catchment are too small to provide habitat for many threatened and declining species. It is also apparent that the total vegetation cover of many landscapes is well below critical thresholds to conserve many sensitive species. Revegetation of small patches perpetuates this situation and creates habitats that are not self-sustaining. The long term value of many of these sites is probably minor from an ecological perspective, although they may fulfil other functions in the landscape. Incentives and mechanisms to encourage revegetation of larger patches, preferably adjacent to existing native vegetation, are desirable. In the long term, the creation of larger blocks may be more cost effective as they are more likely to resist disturbances and create self-sustaining patches.

Recommendation 10.

Investigate 'bundling' natural resource management incentives to create 'sustainable land management packages' based on a partnerships between GBCMA and land owners using a whole farm planning and agreed works program approach.

The conservation of biodiversity and sustainable farming systems and communities are inextricably linked. There is scope to bundle together incentives and other forms of resource assistance to farmers under a single 'sustainable systems' banner to justify stewardship style payments to landowners, even over relatively short time frames (eg 3-5 years). These stewardship style payments could be used to leverage positive land management outcomes on larger areas of land than under the current system. For example, even reduced stocking rates may be sufficient to reduce pressure on native plants below critical thresholds to allow regeneration.

Recommendation 11.

The GBCMA work with public land managers to reduce the impacts and where feasible remove threatening processes from high value public land blocks and to manage them in a co-ordinated manner as part of a whole of landscape approach.

Habitats on public land in the catchment are critical for the long-term survival of many species. These large patches provide the 'excess' individuals of threatened species that move out into the surrounding landscape and recolonise patches where local extinction has occurred or to colonise new patches that have been created through revegetation. The on-going degradation of many of these critical large blocks by continual grazing and logging reduces the population size of species that depend on these resources, reducing the number of 'excess' individuals these large patches produce to disperse and top up patches in the surrounding landscape. As habitats on private land continue to decline, the value of large blocks of habitat on public land as storehouses for species increases. Bioregional networks provide a forum for the co-ordination of this whole of landscape approach.

Recommendation 12.

The GBCMA should continue to support land use decision-making processes such as the Box/Ironbark Investigation and encourage sustainable land use planning by Local Government and other agencies.

4.2. Communication

Recommendation 13.

The GBCMA coordinate and produce a threatened species guide booklet for the catchment.

Public awareness about all but the most charismatic threatened species is very low. A concise summary booklet of threatened species in the catchment would help to raise awareness of threatened species. A simple one page per threatened species with a distribution map, picture, description of the species, its life history, habitat requirements and reasons for its status as well as what can be done to protect the species would be an extremely valuable education and awareness raising tool. New South Wales National Parks and Wildlife Service have an excellent hand book of threatened species for land owners that could be used as a guide. A major community awareness campaign for conservation of native biodiversity is required.

Recommendation 14.

The GBCMA investigate the feasibility of running a trial observer scheme to begin data collection on particular species or suites of species in the catchment.

Knowledge of the distribution of many threatened species is patchy with records often reflecting search effort rather than the true distributions and populations of threatened species. It is difficult to justify redirecting works funds into research or data collection processes. An alternative is to run a community based observer scheme and accept the inherent flaws and weaknesses in this type of sampling. A number of

community based fauna observer schemes have been run in Australia and have provided very valuable information on common and threatened species. These schemes increase awareness and provide valuable information about targeting works programs and priorities. A trial observer scheme could be run using a Landcare group or Land for Wildlife network to ascertain the feasibility and value of such a scheme. Information on running such schemes is available. The process could be operated via email to reduce transaction costs. This could form a major component of a catchment scale monitoring and adaptive management program (see below).

4.3. Implementation

Recommendation 15.
The GBCMA adopt mandatory monitoring requirements for all threatened species works funded through its auspices. It should also provide funding to complete follow up management where applicable.

Significant investment has already been made by government and landowners in the implementation of works for threatened species. Many of these sites are not self-sustaining and require active management (eg weed and rabbit control, replanting etc). Although baseline data has not been collected for many sites, a subset that have photos points or some baseline measure, require brief assessment of the site quality, especially where works have been implemented. This process could yield some very useful information. . The current lack of follow up management of works sites means that the initial investment of time and resources by government and the landowner may be not be maximised in perpetuity. .

Recommendation 16.
Encourage research into restoration, regeneration and disturbance regimes of grassland and grassy woodlands.

Recommendation 17.

GBCMA should co-ordinate pest plant and animal control (fox baiting, weeds) programs across the catchment to deliver multiple benefits for agriculture and threatened species. The possibility of external funding for a fox baiting program in the Mid-Goulburn with external funders and Local Government should be investigated.

There may be a number of cost effective threat reduction strategies that the GBCMA could coordinate at a landscape scale. Fox baiting, for example, may provide protection for ground dwelling and nesting species while also having benefits for landowners. Given the proportion of ground dwelling and nesting species that are threatened and declining it could be argued to funders that a fox baiting position may be justified to 'blitz bait' in areas such as the Woodland and Wildlife area to reduce the net pressure of foxes. A cost-sharing arrangement that reflects the private benefit could be calculated. The cost shared between the GBCMA, local government, Landcare groups and a state or federal government funder may make this a feasible project

5. References

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6. Appendices

6.1. Appendix One: List of Rare and Threatened vascular plants in the Goulburn Broken Catchment.

AROT column (Australian Rare or Threatened), E = Endangered nationally, V= vulnerable nationally, R= rare nationally, K= insufficiently known nationally. VROT column (Victorian Rare or Threatened), x = extinct in Victorian, e = endangered in Victorian, v = vulnerable in Victorian, k = insufficiently known in Victorian, FFG column, L = species is Listed under FFG Act, EPBC column E=Listed under EPBC Act, Action Statement column A= An FFG Action Statement has been prepared.

NAME	COMMONNAME	AROTS	VROTS	FFG	EPBC	ACTION STATEMENT
Calochilus richiae	Bald-tip Beard-orchid	E	e	L	E	A
Eucalyptus crenulata	Buxton Gum	E	e	L	E	A
Cullen parvum	Small Scurf-pea	E	e	L	E	A
Senecio behrianus	Stiff Groundsel	E	e	L	E	A
Sclerolaena napiformis	Turnip Copperburr	E	e	L	E	
Euphrasia collina ssp. muelleri	Purple Eyebright	E	e	L	E	
Euphrasia scabra	Rough Eyebright	K	e	L		A
Amphibromus pithogastrus	Plump Swamp Wallaby-grass	K	e	L		
Brasenia schreberi	Water-shield	R	e	L		
Pterostylis woollsii	Long-tail Greenhood	R	e	L		
Brachyscome muelleroides	Mueller Daisy	V	e	L	V	
Senecio macrocarpus	Large-fruit Fireweed	V	e	L	V	A
Swainsona murrayana	Slender Darling-pea	V	e	L	V	
Swainsona plagiotropis	Red Swainson-pea	V	e	L	V	
Caladenia concolor	Crimson Spider-orchid	V	e	L	V	
Eucalyptus alligatrix ssp. limaensis	Lima Stringybark	V	e		V	
Acacia omalophylla	Yarran Wattle		e	L		
Acacia pendula	Weeping Myall		e	L		A
Dipodium hamiltonianum	Yellow Hyacinth-orchid		e	L		A
Rhodanthe stricta	Slender Sunray		e	L		
Leptorhynchos elongatus	Lanky Buttons		e			
Cullen tenax	Tough Scurf-pea		e	L		
Santalum lanceolatum	Northern Sandalwood		e	L		A
Swainsona adenophylla	Violet Swainson-pea		e			
Swainsona swainsonioides	Downy Swainson-pea		e	L		
Maireana microphylla	Small-leaf Bluebush		e			
Myriophyllum gracile var. lineare	Slender Water-milfoil		e			
Prasophyllum sp. (Nagambie)	Plains Leek-orchid		e	N		
Atriplex spinibractea	Spiny-fruit Saltbush		e			
Aristida jerichoensis var. subspinulifera	Jericho Wire-grass		e			
Craspedia canens	Grey Billy-buttons		e			

Menkea crassa	Fat Spectacles		e	L	
Aristida personata	Purple Wire-grass		e		
Panicum queenslandicum var. queenslandicum	Coolibah Grass		e		
Diuris tricolor	Spotted-throat Cowslip		e	L	
Eucalyptus yarraensis	Yarra Gum	R	k	X	
Amphibromus fluitans	River Swamp Wallaby-grass	V	k	X	V
Prasophyllum validum	Woodland Leek-orchid	V	k		V
Alternanthera nodiflora	Common Joyweed		k		
Callitriche sonderi	Matted Water-starwort		k		
Cardamine tenuifolia	Slender Bitter-cress		k		
Carex chlorantha	Green-top Sedge		k		
Cuscuta tasmanica	Golden Dodder		k		
Cyperus victoriensis	Flat-sedge		k		
Digitaria brownii	Cotton Panic-grass		k		
Eragrostis alveiformis	Granite Love-grass		k		
Fimbristylis aestivalis	Summer Fringe-sedge		k		
Elymus multiflorus	Short-awned Wheat-grass		k		
Hypsela tridens	Hypsela		k		
Isolepis victoriensis	Victorian Club-sedge		k		
Lepidium pseudohyssopifolium	Native Peppercress		k		
Lotus australis	Austral Trefoil		k		
Olearia speciosa	Netted Daisy-bush		k		
Panicum decompositum	Australian Millet		k		
Poa fordeana	Forde Poa		k		
Senecio cunninghamii var. cunninghamii	Branching Groundsel		k		
Atriplex australasica	Native Orache		k		
Brachyscom e cuneifolia	Wedge-leaf Daisy		k		
Baumea planifolia	Rough Twig-sedge		k		
Haloragis glauca f. glauca	Bluish Raspwort		k		
Cynodon dactylon var. pulchellus	Native Couch		k		
Arthropodium sp. 3 (aff. strictum)	Small Chocolate-lily		k		
Caesia parviflora var. vittata	Pale Grass-lily		k		
Austrodanthonia bipartita s.s.	Leafy Wallaby-grass		k		
Desmodium varians	Slender Tick-trefoil		k		
Caladenia vulgaris	Slender Caladenia		k		
Eucalyptus radiata ssp. robertsonii	Monaro Peppermint		k		
Hypoxis vaginata var. brevistigmata	Yellow Star		k		
Eleocharis macbarronii	Grey Spike-sedge		k		
Ranunculus pumilio var. politus	Ferny Small-flower Buttercup		k		
Ranunculus sessiliflorus var. pilulifer	Annual Buttercup		k		
Sclerolaena muricata var. muricata	Black Roly-poly		k		
Sclerolaena muricata var. semiglabra	Dark Roly-poly		k		

Alternanthera sp. 1 (Plains)	Plains Joyweed		k			
Arthropodium sp. 2 (greenish flowers)	Greenish-flower Vanilly-lily		k			
Gratiola pumilo	Dwarf Brooklime	K	r			
Pultenaea williamsonii	Highland Bush-pea	K	r			
Acacia dallachiana	Catkin Wattle	R	r			
Acacia howittii	Sticky Wattle	R	r			
Acacia williamsonii	Williamson's Wattle	R	r	X		
Cystopteris tasmanica	Brittle Bladder-fern	R	r			
Discaria pubescens	Hairy Anchor Plant	R	r	L		A
Eucalyptus froggattii	Kamarooka Mallee	R	r	L		A
Eucalyptus neglecta	Omeo Gum	R	r			
Grevillea repens	Creeping Grevillea	R	r			
Hibbertia humifusa	Rising Star Guinea-flower	R	r			
Oschatzia cuneifolia	Wedge Oschatzia	R	r			
Ranunculus eichlerianus	Eichler's Buttercup	R	r	X		
Austrostipa breviglumis	Cane Spear-grass	R	r			
Chionogentias muelleriana ssp. willisiana	Mt Buller Snow-gentian	R	r			
Eucalyptus alligatrix ssp. alligatrix	Silver Stringybark	R	r			
Hibbertia humifusa ssp. humifusa	Rising Star Guinea-flower	R	r			
Acacia deanei	Deane's Wattle		r			
Acacia flexifolia	Bent-leaf Wattle		r			
Acacia penninervis var. penninervis	Hickory Wattle		r			
Acacia triptera	Spur-wing Wattle		r			
Agrostis muelleriana	Mueller's Bent		r			
Agrostis rudis	Ruddy Bent		r			
Asplenium trichomanes	Common Spleenwort		r			
Astrotricha linearis	Narrow-leaf Star-hair		r			
Atriplex pseudocampanulata	Mealy Saltbush		r			
Bossiaea cordigera	Wiry Bossiaea		r			
Bossiaea riparia	River Leafless Bossiaea		r			
Brachyscome ptychocarpa	Tiny Daisy		r			
Brachyscome readeri	Reader's Daisy		r			
Carex alsophila	Forest Sedge		r			
Choretrum glomeratum	Common Sour-bush		r			
Colobanthus affinis	Alpine Colobanth		r			
Coprosma nivalis	Snow Coprosma		r			
Rytidosperma nivicolum	Snow Wallaby-grass		r			
Deyeuxia crassiuscula	Thick Bent-grass		r			
Leptochloa fusca ssp. fusca	Brown Beetle-grass		r			
Diuris X palachila	Broad-tip Diuris		r			
Dodonaea boroniifolia	Hairy Hop-bush		r			
Epacris microphylla var. rhombifolia	Mountain Coral Heath		r			
Epacris petrophila	Snow Heath		r			

Eremophila gibbifolia	Coccid Emu-bush	r
Eremophila maculata var. maculata	Spotted Emu-bush	r
Eucalyptus alligatrix	Silver Stringybark	r
Eucalyptus perriniana	Spinning Gum	r
Eulalia aurea	Silky Browntop	r
Euphrasia lasianthera	Hairy Eyebright	r
Geranium sessiliflorum ssp. brevicaule	Alpine Cranesbill	r
Euchiton traversii	Mat Cudweed	r
Euchiton umbricola	Cliff Cudweed	r
Goodia medicaginea	Western Golden-tip	r
Grammitis poeppigiana	Alpine Finger-fern	r
Grevillea chrysophaea	Golden Grevillea	r
Grevillea miqueliana	Oval-leaf Grevillea	r
Ozothamnus stirlingii	Ovens Everlasting	r
Hibbertia pedunculata	Stalked Guinea-flower	r
Huperzia australiana	Fir Clubmoss	r
Hybanthus monopetalus	Slender Violet-bush	r
Hydrilla verticillata	Hydrilla	r
Isolepis montivaga	Fog Club-sedge	r
Isolepis wakefieldiana	Tufted Club-sedge	r
Juncus falcatus	Sickle-leaf Rush	r
Juncus psammophilus	Sand Rush	r
Ixiolaena sp. 1	Woolly Buttons	r
Lepyrodia anarthria	Broom Scale-rush	r
Luzula acutifolia ssp. acutifolia	Sharp-leaf Woodrush	r
Luzula alpestris	Tussock Woodrush	r
Lycopodium scariosum	Spreading Clubmoss	r
Minuria integerrima	Smooth Minuria	r
Schizacme montana var. montana	Mountain Mitrewort	r
Myoporum montanum	Waterbush	r
Oxalis magellanica	Snowdrop Wood-sorrel	r
Pimelea biflora	Matted Rice-flower	r
Pomaderris aurea	Golden Pomaderris	r
Prostanthera decussata	Dense Mint-bush	r
Pterostylis boormanii	Sikh's Whiskers	r
Pterostylis hamata	Scaly Greenhood	r
Pultenaea foliolosa	Small-leaf Bush-pea	r
Pultenaea platyphylla	Flat-leaf Bush-pea	r
Pultenaea vrolandii	Cupped Bush-pea	r
Ranunculus collinus	Strawberry Buttercup	r
Ranunculus gunnianus	Gunn's Alpine Buttercup	r
Richea victoriana	Victorian Richea	r
Scleranthus singuliflorus	Mossy Knawel	r
Sida trichopoda	Narrow-leaf Sida	r

Austrostipa gibbosa	Spurred Spear-grass		r			
Austrostipa setacea	Corkscrew Spear-grass		r			
Templetonia stenophylla	Leafy Templetonia		r			
Thelymitra X irregularis	Crested Sun-orchid		r			
Thelymitra luteocilium	Fringed Sun-orchid		r			
Tragus australianus	Small Burr-grass		r			
Tripogon loliiformis	Rye Beetle-grass		r			
Trochocarpa clarkei	Lilac Berry		r			
Wittsteinia vacciniacea	Baw Baw Berry		r			
Wurmbea biglandulosa ssp. biglandulosa	Glandular Early Nancy		r			
Aristida calycina var. calycina	Dark Wire-grass		r			
Brachyscome tadgellii	Tadgell's Daisy		r			
Calochilus imberbis	Naked Beard-orchid		r			
Gynatrix macrophylla	Gippsland Hemp Bush		r			
Pterostylis setifera	Bristly Greenhood		r			
Acacia deanei ssp. paucijuga	Deane's Wattle		r			
Baeckea latifolia	Subalpine Baeckea		r			
Boronia nana var. nana	Dwarf Boronia		r			
Billardiera scandens var. brachyantha	Velvet Apple-berry		r			
Eucalyptus sideroxylon s.s.	Mugga		r			
Chiloglottis jeanesii	Mountain Bird-orchid		r			
Poa sp. aff. gunnii	Avon Tussock-grass		r			
Goodia lotifolia var. pubescens	Silky Golden-tip		r			
Celmisia latifolia	Victorian Snow-daisy		r			
Craspedia sp. 1	Mountain Forest Billy-buttons		r			
Craspedia jamesii	Green Billy-buttons		r			
Phebalium squamulosum ssp. alpinum	Alpine Phebalium		r			
Poa sieberiana var. cyanophylla	Blue-leaf Tussock-grass		r			
Triglochin dubium	Slender Water-ribbons		r			
Acacia lanigera var. lanigera	Woolly Wattle		r			
Pomaderris helianthemifolia ssp. minor	Blunt-leaf Pomaderris		r			
Grevillea victoriae ssp. victoriae	Royal Grevillea		r			
Grevillea monslacana	Lake Mountain Grevillea		r			
Lepyrodon lagurus	Moss		r			
Plagiomnium novaezelandiae	Moss		r			
Hampeella alaris	Moss		r			
Acacia ausfeldii	Ausfeld's Wattle	R	v	X		
Olearia pannosa ssp. cardiophylla	Velvet Daisy-bush	R	v	L		
Phebalium festivum	Dainty Phebalium	R	v	L		
Callitriche cyclocarpa	Western Water-starwort	V	v		V	
Glycine latrobeana	Clover Glycine	V	v	L	V	
Goodenia macbarronii	Narrow Goodenia	V	v	L	V	A
Myriophyllum porcatum	Ridged Water-milfoil	V	v		V	

Pterostylis cucullata	Leafy Greenhood	V	v	L	V	A
Thesium australe	Austral Toad-flax	V	v	L	V	A
Hibbertia humifusa ssp. erigens	Euroa Guinea-flower	V	v	L	V	
Acacia decora	Western Silver Wattle		v			
Acacia loderi	Nealie		v			
Acacia melvillei	Myall		v			
Acacia notabilis	Mallee Golden Wattle		v			
Acacia oswaldii	Umbrella Wattle		v			
Aciphylla glacialis	Snow Aciphyll		v			
Amyema linophylla ssp. orientale	Buloke Mistletoe		v			
Brachyscome debilis	Weak Daisy		v			
Brachyscome gracilis	Dookie Daisy		v	L		
Callitriche umbonata	Winged Water-starwort		v			
Chloris ventricosa	Plump Windmill Grass		v			
Cymbopogon obtectus	Silky-heads		v			
Cyperus bifax	Downs Flat-sedge		v			
Austrodanthonia richardsonii	Straw Wallaby-grass		v			
Digitaria ammophila	Silky Umbrella-grass		v			
Digitaria divaricatissima	Umbrella Grass		v			
Diuris punctata var. punctata	Purple Diuris		v	L		
Eleocharis pallens	Pale Spike-sedge		v			
Eleocharis plana	Flat Spike-sedge		v			
Eragrostis australasica	Cane Grass		v			
Eryngium paludosum	Long Eryngium		v			
Fimbristylis dichotoma	Common Fringe-sedge		v			
Hakea tephrosperma	Hooked Needlewood		v			
Isolepis congrua	Slender Club-sedge		v	L		
Lipocarpha microcephala	Button Rush		v			
Maireana aphylla	Leafless Bluebush		v			
Persoonia arborea	Tree Geebung		v	X		
Pimelea treyvaudii	Grey Rice-flower		v			
Poa labillardierei var. acris	Sharp Mountain Tussock-grass		v			
Poa petrophila	Rock Tussock-grass		v			
Pomaderris vacciniifolia	Round-leaf Pomaderris		v			
Prostanthera rhombea	Sparkling Mint-bush		v			
Pultenaea graveolens	Scented Bush-pea		v	L		
Sida intricata	Twiggy Sida		v			
Sporobolus creber	Western Rat-tail Grass		v			
Thelymitra X chasmogama	Globe-hood Sun-orchid		v			
Thelymitra X macmillanii	Crimson Sun-orchid		v			
Thelymitra circumsepta	Naked Sun-orchid		v			
Brachyscome chrysoglossa	Yellow-tongue Daisy		v	L		
Hypoxis exilis	Swamp Star		v			
Myriophyllum striatum	Striped Water-milfoil		v			

Dianella longifolia var. grandis	Glaucous Flax-lily		v		
Craspedia paludicola	Swamp Billy-buttons		v		
Panicum laevinode	Pepper Grass		v		
Swainsona sericea	Silky Swainson-pea		v		
Cardamine microthrix	Eastern Bitter-cress		v		
Cardamine moirensis	Riverina Bitter-cress		v		
Cardamine papillata	Forest Bitter-cress		v		
Dianella tarda	Late-flower Flax-lily		v		
Hibbertia sp. 1 (Eastern Highlands)	Mt Samaria Guinea-flower		v		
Swainsona recta	Mountain Swainson-pea	E	x	L	E

6.2. Appendix Two: Regionally Significant vascular flora list for the Goulburn Broken Catchment

Common name	Scientific Name
Pale Flax-lily	*Dianella longifolia* var. *grandis*
Pale Flax-lily	*Dianella longifolia*
Sticky Sword-sedge	*Lepidosperma viscidum*
Broughton Pea	*Swainsona procumbens*
Austral Ladies' Tresses	*Spiranthes australis*
Grey Parrot-pea	*Dillwynia cinerescens*
Showy Parrot-pea	*Dillwynia sericea*
Berrigan	*Eremophila longifolia*
Common Eutaxia	*Eutaxia microphylla*
Twiggy Bush-pea	*Pultenaea largiflorens*
Ploughshare Wattle	*Acacia gunnii*
Mitchell's Wattle	*Acacia mitchellii*
Turkey-bush	*Eremophilla deserti*
Curved Rice-flower	*Pimelea curviflora*
Rough-barked Honey-myrtle	*Melaleuca parvistaminea*
Thin-leaf Wattle	*Acacia aculeatissima*
Grey Mulga	*Acacia brachybotrya*
Mallee Wattle	*Acacia montana*
Umbrella Wattle	*Acacia oswaldii*
Wirilda	*Acacia retinodes*
Silver Banksia	*Banksia marginata*
River Bottle-brush	*Callistemon sieberi*
Bitter Cryptandra	*Cryptandra amara*
Hairy Hop-bush	*Dodonea boronifolia*
Cottony Haeckeria	*Haeckeria ozothamnoides*
Weeping Pittosporum	*Pittosporum phillyreoides*
Sweet Bursaria	*Bursaria spinosa*
White Box	*Eucalyptus albens*
Bull Mallee	*Eucalyptus behriana*
Black Box	*Eucalyptus largiflorens*
Yellow Gum	*Eucalyptus leucoxylon*
Yellow Box	*Eucalyptus melliodora*
Blue Mallee	*Eucalyptus polybractea*
Green Mallee	*Eucalyptus viridis*
Black She-oak	*Allocasuarina littoralis*

Drooping She-oak	*Allocasuarina verticillata*
White Cypress-pine	*Calitris glaucophylla*
Swamp Paperbark	*Melaleuca ericifolia*

6.3. Appendix 3. List of fauna (including) excluding fish recorded in the Goulburn Broken Catchment.

EPBC column E=Listed under EPBC Act, Action Statement column, VROT column (Victorian Rare or Threatened), x = extinct in Victorian, e = endangered in Victorian, v = vulnerable in Victorian, k = insufficiently known in Victorian, FFG column, L = species is Listed under FFG Act

NAME	COMMON NAME	EPBC	VROTS	FFG	ANZECC
Xanthomyza phrygia	Regent Honeyeater	E	c	L	CEn
Litoria spenceri	Spotted Tree Frog	E	c	L	CEn
Galaxias fuscus	Barred Galaxias	E	c	L	CEn
Maccullochella macquariensis	Bluenose Cod	E	c	L	CEn
Ardeotis australis	Australian Bustard		c	L	CEn
Ardea intermedia	Intermediate Egret		c	L	CEn
Falco hypoleucos	Grey Falcon		c	L	CEn
Limnodynastes interioris	Giant Bullfrog		c	L	CEn
Bidyanus bidyanus	Silver Perch		c	L	CEn
Egretta garzetta	Little Egret		c		CEn
Macropus robustus robustus	Eastern Wallaroo		c		CEn
Lathamus discolor	Swift Parrot	E	e	L	End
Gymnobelideus leadbeateri	Leadbeater's Possum	E	e	L	End
Burramys parvus	Mountain Pygmy-possum	E	e	L	End
Polytelis swainsonii	Superb Parrot	V	e	L	End
Dasyurus maculatus	Spot-tailed Quoll	V	e	L	End
Delma impar	Striped Legless Lizard	V	e	L	End
Burhinus grallarius	Bush Stone-curlew		e	L	End
Ardea alba	Great Egret		e	L	End
Stictonetta naevosa	Freckled Duck		e	L	End
Haliaeetus leucogaster	White-bellied Sea-Eagle		e	L	End
Ninox connivens	Barking Owl		e	L	End
Ninox strenua	Powerful Owl		e	L	End
Tyto novaehollandiae	Masked Owl		e	L	End
Coracina maxima	Ground Cuckoo-shrike		e	L	End
Pomatostomus temporalis	Grey-crowned Babbler		e	L	End
Petaurus norfolcensis	Squirrel Glider		e	L	End
Morelia spilota variegata	Carpet Python		e	L	End
Macquaria australasica	Macquarie Perch		e	L	End
Acrodipsas myrmecophila	Small Ant Blue		e	L	End
Synemon plana	Golden Sun Moth		e	L	End
Rallus pectoralis	Lewin's Rail		e		End

Sterna nilotica	Gull-billed Tern	e		End
Rostratula benghalensis	Painted Snipe	e		End
Ixobrychus minutus	Little Bittern	e		End
Botaurus poiciloptilus	Australasian Bittern	e		End
Anseranas semipalmata	Magpie Goose	e		End
Lophoictinia isura	Square-tailed Kite	e		End
Falco subniger	Black Falcon	e		End
Pseudomys fumeus	Smoky Mouse	e		End
Galaxias olidus	Mountain Galaxias	i	L	Ins
Melanotaenia fluviatilis	Crimson-spotted Rainbowfish	i	L	Ins
Coturnix ypsilophora	Brown Quail	i		Ins
Turnix velox	Little Button-quail	i		Ins
Hylacola pyrrhopygia	Chestnut-rumped Heathwren	i		Ins
Taeniopygia bichenovii	Double-barred Finch	i		Ins
Calidris subminuta	Long-toed Stint	i		Ins
Calidris melanotos	Pectoral Sandpiper	i		Ins
Sminthopsis murina	Common Dunnart	i		Ins
Sminthopsis crassicaudata	Fat-tailed Dunnart	i		Ins
Canis familiaris dingo	Dingo	i		Ins
Varanus varius	Tree Goanna	i		Ins
Limnodynastes fletcheri	Barking Marsh Frog	i		Ins
Galaxias rostratus	Flat-headed Galaxias	i		Ins
Gadopsis marmoratus	River Blackfish	i		Ins
Euastacus armatus	Murray Spiny Cray	i		Ins
Neophema pulchella	Turquoise Parrot	l	L	LR
Vermicella annulata	Bandy Bandy	l	L	LR
Phalacrocorax varius	Pied Cormorant	l		LR
Chlidonias hybridus	Whiskered Tern	l		LR
Sterna bergii	Crested Tern	l		LR
Numenius madagascariensis	Eastern Curlew	l		LR
Accipiter novaehollandiae	Grey Goshawk	l		LR
Myotis macropus	Southern Myotis	l		LR
Mastacomys fuscus	Broad-toothed Rat	l		LR
Acrodipsas brisbanensis	Large Ant Blue	r	L	R/R
Archaeophylax canarus	Caddisfly (5008)	r	L	R/R
Thaumatoperla robusta	Stonefly (5026)	r		R/R
Grus rubicunda	Brolga	v	L	Vul
Oxyura australis	Blue-billed Duck	v	L	Vul
Tyto tenebricosa	Sooty Owl	v	L	Vul
Grantiella picta	Painted Honeyeater	v	L	Vul

Phascogale tapoatafa	Brush-tailed Phascogale		v	L	Vul
Miniopterus schreibersii	Common Bent-wing Bat		v	L	Vul
Tandanus tandanus	Freshwater Catfish		v	L	Vul
Maccullochella peelii peelii	Murray Cod		v	L	Vul
Thaumatoperla flaveola	Stonefly (5001)		v	L	Vul
Hemiphlebia mirabilis	Damselfly		v	L	Vul
Riekoperla isosceles	Stonefly (5020)		v	L	Vul
Litoria raniformis	Warty Bell Frog	V	v		Vul
Turnix pyrrhothorax	Red-chested Button-quail		v		Vul
Geopelia cuneata	Diamond Dove		v		Vul
Porzana pusilla	Baillon's Crake		v		Vul
Sterna caspia	Caspian Tern		v		Vul
Plegadis falcinellus	Glossy Ibis		v		Vul
Platalea regia	Royal Spoonbill		v		Vul
Nycticorax caledonicus	Nankeen Night Heron		v		Vul
Cereopsis novaehollandiae	Cape Barren Goose		v		Vul
Anas rhynchotis	Australasian Shoveler		v		Vul
Aythya australis	Hardhead		v		Vul
Biziura lobata	Musk Duck		v		Vul
Chthonicola sagittata	Speckled Warbler		v		Vul
Struthidea cinerea	Apostlebird		v		Vul
Pteropus poliocephalus	Grey-headed Flying-fox		v		Vul
Chelodina expansa	Broad-shelled Tortoise		v		Vul
Ramphotyphlops proximus	Woodland Blind Snake		v		Vul
Pseudemoia cryodroma	Alpine Bog Skink		v		Vul
Litoria verreauxii alpina	Alpine Tree Frog		v		Vul
Macquaria ambigua	Golden Perch		v		Vul
Tamasia furcilla	Caddisfly (5022)		v		Vul
Aepyprymnus rufescens	Rufous Bettong		x	L	Ext
Thylogale billardierii	Tasmanian Pademelon		x	L	Ext
Rhinolophus megaphyllus	Eastern Horseshoe Bat			L	
Craterocephalus stercusmuscarum fulvus	Unspecked Hardyhead			L	
Spathula tryssa	Planarian (5052)			L	

Appendix 4. *Environment Protection and Biodiversity Conservation Act 1999* listed communities and migratory species for the Goulburn Broken Catchment (2002).

Threatened ecological communities

Community Name	Status
Buloke Woodlands of the Riverina and Murray-Darling Depression Bioregions	Endangered
Grassy White Box Woodlands	Endangered

Terrestrial species covered by migratory provisions of the Environmental Protection and Biodiversity Conservation Act, 1999

Scientific Name	Common Name
Haliaeetus leucogaster	White-bellied Sea-Eagle
Hirundapus caudacutus	White-throated Needletail
Myiagra cyanoleuca	Satin Flycatcher
Rhipidura rufifrons	Rufous Fantail
Xanthomyza phrygia	Regent Honeyeater
Gallinago hardwickii	Latham's Snipe, Japanese Snipe
Rostratula benghalensis	Painted Snipe

Species covered by marine provisions of the EPBC Act, 1999

Scientific Name	Common Name	Status
Gallinago hardwickii	Latham's Snipe, Japanese Snipe	Overfly**
Haliaeetus leucogaster	White-bellied Sea-Eagle	Listed
Hirundapus caudacutus	White-throated Needletail	Overfly**
Lathamus discolor	Swift Parrot	Overfly**
Myiagra cyanoleuca	Satin Flycatcher	Overfly**
Rhipidura rufifrons	Rufous Fantail	Overfly**
Rostratula benghalensis	Painted Snipe	Overfly**

*Species with a **** *in the status field are predominantly non-marine, however they are known to fly over or occasionally visit the Commonwealth marine area*