# Beyond Bolac

## Biodiversity Blueprint

# Contents

The Beyond Bolac Catchment Action Group (BBCAG) respectfully acknowledges that Indigenous Australians are intrinsically connected to the continent- including the area now known as Victoria. The H11 and H12 catchment area is Djab Wurrung, Watha Wurrung (now known as Wada Wurrung) and Girai Wurrung people country and the Beyond Bolac Catchment Action Group Committee pays their respects to Elders both past and present.

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This document and associated GIS mapping was composed by Jileena Cole under the guidance of the Beyond Bolac Catchment Action Group.

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# Introduction

The protection and enhancement of the natural world is essential so that future generations can enjoy and reap the rewards of a healthy landscape for many years to come. The natural environment within the H11 & H12 sub-catchment is unique, the volcanic origins of the area have created a productive agricultural region containing patches of highly valuable grasslands, grassy woodlands, as well as lakes and wetlands which support a large variety of native plants and animals.

Nevertheless this area is under threat from weeds and vermin, unsustainable farming practices, climate change, pollution, erosion and salinity just to name a few. Agriculture in particular has altered the landscape, replacing large areas of native vegetation with different vegetation communities including introduced pastures, crops and shelterbelt plantings. These introduced species have radically altered the appearance of the landscape, as well as the biodiversity. However, the natural and increased fertility of the soils and generally consistent rainfall has provided favourable conditions for a vigorous living environment; many native species have been able to adapt to these changed landscapes and continue to survive (Weatherly 2016) in some areas.

The dedication of the Beyond Bolac Catchment Action Group has been continuous since it began 2004, as an initiative of Lake Bolac Land Protection Council (Lake Bolac Landcare Group), when locals realised that unless collaborative action was taken, this precious natural environment would be lost.

This Biodiversity Blueprint tells the story of the Beyond Bolac Catchment Action Group and the H11 & H12 sub-catchment. This document will be used by BBCAG to plan and implement vital projects throughout the catchment in collaboration with community member's and stakeholders to restore the beauty and biodiversity of the landscape for posterity.

## The Beyond Bolac Catchment Action Group

**The story so far…**

Beyond Bolac is a community group which was established in 2007 to undertake restoration of the Lake Bolac Catchment, including the Fiery Creek which flows into Lake Bolac and Salt Creek which flows from Lake Bolac to Hexham. Beyond Bolac aims to work with community groups, farmers, industry and government agencies to undertake restoration activities, which include fencing, revegetation, and pest plant and animal control.

It all started in 2004, when a meeting was called by concerned community members from the Lake Bolac Land Care Group and Michelle Calvert from Glenelg Hopkins CMA. The meeting was held in Lake Bolac and included government department representatives, Glenelg Hopkins CMA officers, and local residents. The aim of the meeting was to discuss the drying of and future management of Lake Bolac. Other concerns raised included control of salinity, future flooding and waterways management of the catchment. The major concern at the time was to discuss some means of controlling the overflow of the Lake to assist in salinity management. The GHCMA and its Waterways Implementation Committee, together with local residents, inspected the Lake and catchment to help decide on actions to address these issues.

The GHCMA produced the 'H11 & H12 Catchment Health Report, Lake Bolac, Fiery Creek and Salt Creeks'. The aim of the report was to review existing information on assets, current condition, threats, management options and information gaps. A Standing Committee of local residents and government representatives was appointed by the GHCMA, and this group stayed together long after the report's production to form a grassroots community group – the H11-H12 Catchment Action Group. In 2010 the group decided to change their name to 'Beyond Bolac Catchment Action Group' to assist with communications, as the name would signify a connection to the wider catchment area.


*Bill Sharp and Bill Weatherly at the Eel Festival*

## The Committee of Management

The Beyond Bolac Catchment Action Group nominally comprises around 20 committee members, made up of local landholders, industry groups, environment groups and government agency representatives as well as the Executive Director of The Norman Wettenhall Foundation. The committee is not a closed committee and welcomes any person with an interest in natural resource management and or catchment issues to attend meetings which are held bi-monthly.

The committee has a core executive group who meet regularly with the appointed facilitator to address issues as they arise, outcomes of these meetings are then communicated to other committee members on an as needs basis. On occasion, sub-committees have been formed to address specific issues, outcomes of these sub-committee meetings are then communicated to other committee members at the regular bi-monthly meetings. Government agency staff are always invited to committee meetings, however when specific issues arise the relevant government agency representative is requested to attend to aid valuable discussion on the topic.

The Norman Wettenhall Foundation has been instrumental in Beyond Bolac CAG's ongoing success. Beyond Bolac is one of seven large scale landscape restoration projects The Norman Wettenhall Foundation has invested in and it will provide support and funding to increase the capacity of Beyond Bolac CAG to operate in a strategic way for the long term, enabling the group to successfully communicate and coordinate activities with its stakeholders and gain access to on-ground works funding.

## Stakeholders and Partners

The Beyond Bolac CAG works closely with a number of organisations, including corporate, private and philanthropic; government agencies and community groups across the Catchment.

Key partners include:

- The Norman Wettenhall Foundation
- Glenelg Hopkins Catchment Management Authority
- Landcare Victoria
- Beyond Bolac Catchment Action Group financial members

The group is strongly supported by:

- Victorian State Government, Department of Environment, Land, Water and Planning (DEWLP)
- Australian Government, Department of Environment
- Lake Bolac Development Committee
- Upper Hopkins Land Management Group
- Lake Bolac Foreshore Committee
- Lake Bolac Eel Festival Committee
- Southern Farming Systems
- Parks Victoria
- Southern Rural Water
- Aboriginal Affairs Victoria
- Ararat Rural City Council
- Martang Pty Ltd
- Wathaurung Aboriginal Corporation
- Eastern Marr Aboriginal Corporation
- Trust for Nature
- Environment Protection Agency (EPA)



## Strategic Plan

The Beyond Bolac Catchment Action Group vision

is for a biodiverse, productive, resilient and safe catchment supporting vibrant communities and land managers

The aim of the group is

To engage, enable and assist land managers to implement projects to improve biodiversity in a productive, healthy landscape

Since its inception, Beyond Bolac CAG has been working towards implementing the recommendations from the H11 & H12 Catchment health report, these are outlined below:

- To optimise flows in the Fiery and Salt Creeks
- Identify salinity sources in the catchment and take remedial action
- Undertake salt and water budgets leading to a water management plan
- Conduct further research into water quality, stream flow and salinity
- Hold Community workshops to convey the findings of the report
- Develop a communications plan to keep the community informed
- Obtain further information and research relating to water use
- Audit and identify Aboriginal places of cultural heritage significance
- Continue to revegetate the catchment to combat salinity and restore Ecological Vegetation Classes (EVC)
- Continue to collect and collate existing and new research relevant to the catchment

The priority issues the Beyond Bolac CAG have been tackling across the catchment include

- Waterway health, erosion, sedimentation and pollution
- Sustainable land use and productivity
- Reduced flows throughout waterways and into Lake Bolac and surrounding wetlands
- Wetland development and management
- Protection and enhancement of native vegetation, in particular riparian vegetation
- Biodiversity conservation
- Ground water extraction
- Pest plant and animal management

In March, 2016, the Beyond Bolac CAG reviewed its strategic plan. The Beyond Bolac Catchment Action Group Strategic Plan 2016 – 2021 will provide the strategic direction for the group for the next 5 years, it includes eight key objective for the group to work towards with a number of strategies outlined for each objective to address the issues facing the catchment.

*Table 1. Beyond Bolac Catchment Action Group Strategic Plan 2016 – 2021 summary*

| | Key Objectives for BBCAG | Priority Area | Strategies |
|---|---|---|---|
| 1 | To protect & enhance waterway condition within the catchment | Waterway Health | 1.1 Advocate for increased water flow along Fiery Creek<br>1.2 Provide incentives for land managers to fence off riparian zones<br>1.3 Provide incentives for land managers to undertake native revegetation along waterways<br>1.4 Obtain management agreements for all projects undertaken along waterways |
| 2 | To promote restoration of wetlands across the catchment | Wetlands Restoration | 2.1 Develop education material to increase knowledge and value of wetlands within the catchment<br>2.2 Provide stewardship payments to land managers for restoration and management of wetlands<br>2.3 Obtain management agreements for all projects undertaken for wetlands<br>2.4 Provide incentives for land managers to fence off wetlands |
| 3 | To encourage and support sustainable land use and productivity throughout the catchment | Sustainable Land Use and Productivity | 3.1 Partner with Southern Farming Systems to encourage sustainable farming practices across the catchment<br>3.2 Encourage a reduction in chemical use through the promotion of ICM principals to improve soil and waterway health<br>3.3 Assist land managers to complete whole farm plans with a biodiversity focus<br>3.4 Include where suitable extension officers/services within grant applications |
| 4 | To protect riparian vegetation and enhance biodiversity throughout the catchment | Protect and Enhance Biodiversity | 4.1 To identify priority biodiversity hot spots across the catchment using mapping<br>4.2 Work with landholders to develop site plans for future biodiversity projects<br>4.3 Provide incentives for land managers to fence off remnant native vegetation<br>4.4 Provide incentives for land managers to undertake native revegetation to increase biodiversity across the catchment<br>4.5 Obtain management agreements for projects undertaken for biodiversity values<br>4.6 Provide incentives to land managers to fence and revegetate along Fiery where there are currently gaps in the riparian zone |
| 5 | To reduce the impact of pest plant and animals within the catchment | Pest Plant and Animal Management | 5.1 Seek funding through government programs for weed and vermin management where appropriate<br>5.2 Encourage biological control of weeds and pest throughout the catchment |
| 6 | To engage and empower the community and stakeholders to address environmental issues within the catchment | Community Engagement | 6.1 Facilitate 'communities of interest' within the catchment<br>6.2 Increase use of local media and website to promote events and projects undertaken by BBCAG<br>6.3 Maintain relationships with schools and involve in tree planting projects where suitable<br>6.4 Investigate development of mobile app to provide an interactive educational experience for visitors<br>6.5 Develop annual program of community events, i.e. forums, expert talks on key topics, planting days, field trips, competitions<br>6.6 Provide recognition of Landholders who have made a measurable contribution to enhancing and protecting the catchment i.e. Local awards, profile display at community centre<br>6.7 Provide recognition of Landholders who have made a measurable contribution to enhancing and protecting the catchment i.e. Local awards, profile display at community centre<br>6.8 Engage with the 'CMA upper fiery creek project' participants to continue on-ground works along Fiery Creek |
| 7 | To increase knowledge and share information about the H11 and H12 sub-catchment | Knowledge and Research | 7.1 Contact local universities and develop partnerships to encourage students to undertake research projects within the catchment<br>7.2 Review and update website to enable easy access to all information relating to catchment<br>7.3 Develop easy to use Mobile App tool for landholders to record project information i.e. GPS maps, photos and statistical data (NB: Free online form builder applications available)<br>7.4 Hold a workshop/event/expo for new technologies to assist land holders with sustainable land management<br>7.5 Undertake analysis of salinity data for Fiery Creek each year<br>7.6 Develop easy to use Mobile App tool for community members to record flora and fauna sightings within H11 & H12 sub-catchment and link to larger online databases |

| | Key Objectives for BBCAG | Priority Area | Strategies |
|---|---|---|---|
| 8 | To maintain and build organisational capability to deliver vision | Group Governance | 8.1 Review governance of BBCAG<br>8.2 Develop organisational operational plan for BBCAG<br>8.3 Review BBCAG Strategic Plan<br>8.4 Develop partnerships with GHCMA, Stakeholders and other community groups to value add (funding or in-kind support) to future projects<br>8.5 Attract new members who have an interest in the group by remaining open, honest and welcoming<br>8.6 Encourage active participation from existing members |

## Key Achievements

The Beyond Bolac CAG has been very successful in securing grants from various sources, including Glenelg Hopkins CMA, the Commonwealth Government, Landcare, and The Norman Wettenhall Foundation. The below table provides a summary of the funding received by Beyond Bolac CAG since 2007. In total, the group have secured approximately $837,683 in funding, with just over $400,000 being provided to facilitate and manage the group, with another $434,000 put towards projects.

***Table 2. Summary of funding received by Beyond Bolac CAG***

| | Year provided | Funding provider | Program | Funding received by BBCAG | Matching $ and/or in-kind |
|---|---|---|---|---|---|
| Facilitation | 2010-2012 | Norman Wettenhall Foundation | Research and Facilitation | $53,698 | |
| | 2012 - 2015 | Vic. Government | DEPI Facilitator program | $170,000 | |
| | 2015 - 2018 | Vic. Government | DEWLP Facilitator program | $150,000 | |
| | 2015/2016 | Norman Wettenhall Foundation | Project worker | $30,000 | |
| BBCAG Projects | 2008/09 | Commonwealth Government Water Grant | Comm. Water Grant Project | $50,000 | $20,000 |
| | 2009 | Watershed 2000 | Dr. Williams Research on Salinity. | $6,600 | $3,300 |
| | 2009/10 | Commonwealth Government | GHCMA "HERO" | $90,000 | $45,000 |
| | 2009 /10 | Victorian Government | GHCMA 2nd. Generation Landcare Grant | $45,850 | $22,925 |
| | 2012/13 | Commonwealth Government | Caring for Our Country | $150,000 | $75,000 |
| | 2012/13 | Victorian Government | GHCMA Victorian Landcare Grant | $22,804 | $11,402 |
| | 2014/15 | Victorian Government | GHCMA Victorian Landcare Grant | $18,855 | $9,428 |
| | 2015/16 | Victorian Government | GHCMA Victorian Landcare Grant | $20,000 | $10,000 |
| | 2016/17 | Victorian Government | GHCMA Victorian Landcare Grant | $29,876 | $14,938 |



Several of the projects funded focused on addressing community engagement and education, on-ground works and research & monitoring. Below is snapshot of the projects which have been completed by the group to date.


- Salinity monitoring throughout catchment and particularly Fiery Creek
- Chinaman Swamp study using EM31 technology to detect concentrated salt intrusion into Fiery Creek


- Community workshops to convey findings of the H11 & H12 Catchment Health Report
- Groundwater forum
- Waterway monitoring lecture
- Wetlands workshop
- Floods & Fencing workshop
- Strategic Planning workshops
- Salinity Workshop
- Worshops & presentations at local schools
- Field Trips to neighbouring catchments
- Participation in annual Eel Festival in Lake Bolac
- Regular Newsletter articles
- Networking with stakeholders
- Fire Forum with guest speakers
- Display stands at varius field days thoughout the district


- Fencing off stock from waterways
- Revegetation in riparian zones along waterways
- Wetland rehabilitation
- Wildlife corridors across the landscape

A recent review of the project completed by Beyond Bolac CAG over the last ten years revealed a total of 28 grants were distributed to 20 individuals, totalling $600,000 from investors, with a further $600,000 of in-kind and/or cash being provided by landholders to complete on-ground projects. There have also been a number of landholders who have undertaken fencing and revegetation without having been provided a grant from investors to do so, which has also contributed to improving the catchments health. Without the continued support and investment from the landholders within the Catchment, many of the on-ground works, such as fencing, riparian revegetation and wetland restoration would not be possible. Beyond Bolac CAG is very appreciative for the community support and hope that it can continue well into the future.

# Profile of Catchment

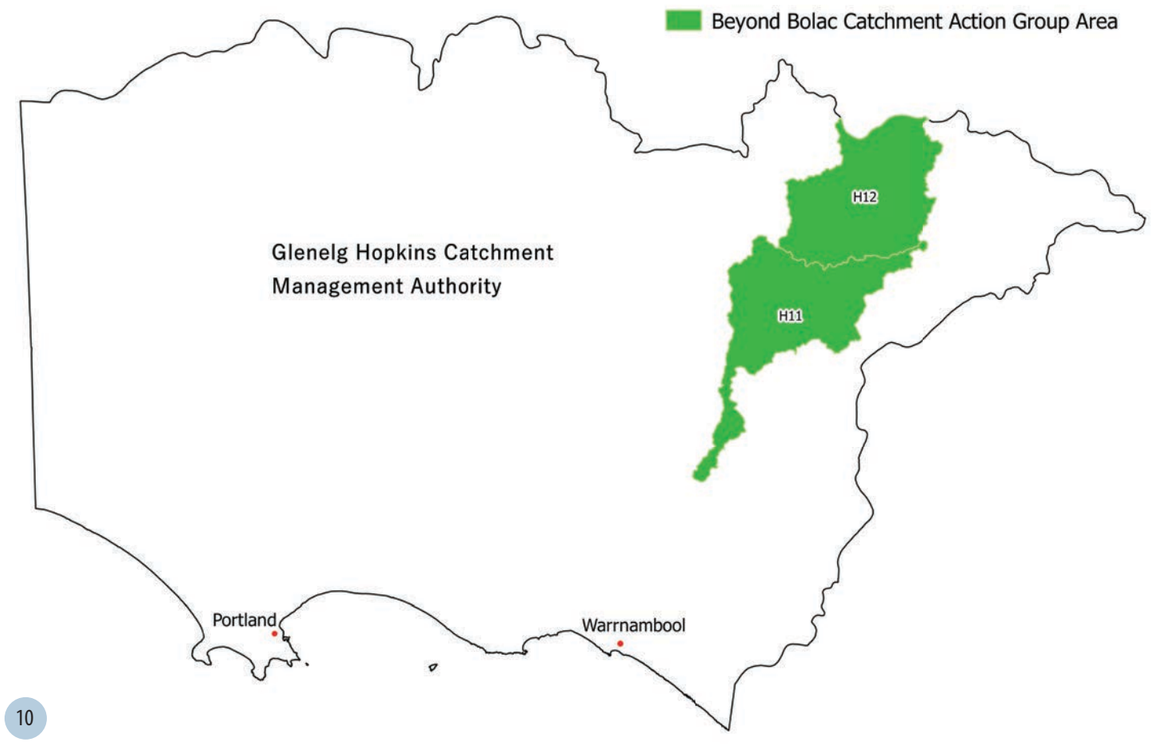
## The H11 H12 Catchment Health Report – Lake Bolac, Fiery & Salt Creeks

The H11 H12 Catchment Health report – Lake Bolac, Fiery & Salt Creeks was prepared in 2006 and the main objective was to review all the information relating to waterway health, land use and management within the Fiery and Salt Creeks as well as Lake Bolac, known as H11 & H12 sub-catchments, to identify knowledge gaps and enable the community and government agencies to coordinate activities that would lead to improved health of the sub-catchment.

The report found that the catchment had experienced many changes to vegetation cover, water quantity and quality and land use. Overall rainfall and rainfall events had decreased while water use had increased. In 2006, when the report was undertaken, the estimated water use across the catchment was more than 11,000 mega litres per annum, and large volume stream flows had not occurred for a number of years resulting in saline water in Lake Bolac not being flushed into Salt Creek. The combined effect of changed rainfall patterns, which decreased runoff and salinity had a dramatic impact on Lake Bolac, and the climate change prediction included lower average rainfall for the region was expected to exacerbate the situation (Gervasi & P&P Design, 2006).

The report concluded that the predicted change in the climate and rainfall patterns would necessitate a cooperative approach to the management of the catchments water resources and provided a number of recommendations in an attempt to achieve this. The Beyond Bolac Catchment Action Group took up the challenge to implement the recommendations from the report; the full report can be downloaded from the Beyond Bolac website at www.beyondbolac.org.

It has been 10 years since the report was undertaken, and there have been many environmental, social and economic changes across the catchment. This Biodiversity Blueprint will provide an update on the health of the catchment to assist its management into the future.






## Indigenous Cultural Heritage

The original custodians of the H11 H12 sub-catchment were the Djab Wurrung people, who occupied the areas west of Fiery Creek, the Watha Wurrung people, who occupied the north east side of Fiery Creek and the Girai Wurrung people who occupied the south east side of Fiery Creek. The Fiery Creek formed the boundary between the Djab Wurrung to the west and the Watha Wurrong and Girai Wurrung people to the east. There were eight clans from the three groups known to exist within the sub-catchment area. There were five Djab Wurrung clans, these included the Buller buller cote gundidj clan at the junction of Salt Creek and the Hopkins River, the Bulukbara clan at Lake Bolac, Peeripar balug clan at Fiery Creek, 32 kilometres south of Mt Cole, Puppellenneerring clan at Fiery Creek, 48 kilometres southwest of Mt Cole and Terrumbehal gundidj clan, between the Hopkins River and Fiery Creek (Clark, 1995).

*In season, eels were a stable food, and the Djab Wurrung people, the Watha Wurrung people and the Girai Wurrung people moved to fishing grounds at Lake Bolac.*

Djab Wurrung country was mostly volcanic plain punctuated with a large number of perennial and intermittent lakes and swamps. The Djab Wurrung people camped along areas of overlap between major vegetation types and along streams, where timber and fuel were more abundant. A common campsite was a constructed earthen mound, usually located on the bank of a stream or on a good vantage point (Clark, 1995).

There was one clan from the Watha Wurrung people which was located at Carranballac, known as the Corrin corrinjer balug, who traded stones and adhesive gum at trade meetings near Lake Terang. There were two clans from the Girai Wurrung people, the Ngalug barar balug clan midway between Mount Shadwell and Lake Bolac near Lake Eyang, and the Flat Top Hill Clan at Flat Topped Hill half between Mt Shadwell and Lake Eyang (Clark, 1995). These clans would meet along Fiery Creek and at Lake Bolac to harvest eels and hunt emus and other game.

In season, eels were a staple food, and the Djab Wurrung people, the Watha Wurrung people and the Girai Wurrung people moved to fishing grounds at Lake Bolac. Lake Buloke (Lake Bolac) was the most celebrated place in the Western District for the fine quality and abundance of eels, in early autumn up to 1,000 people gathered to take advantage of the annual migration of the eels. Eels were captured in great numbers by building stone barriers across rapid streams and diverting the current through an opening into a funnel-mouthed basket pipe, three to four feet long, two inches in diameter and closed at the lower end. When the streams extend over the marshes in times of flood, clay embankments two to three feet high and sometimes three to four hundred yards in length were built across them to confine the current to a narrow opening in which the pipe baskets were placed (Dawson, 1881).

Europeans first arrived in the area in the early 1800s and claimed the fertile lands as their own. There were many clashes in which both parties experienced deaths. Victoria was established as a separate colony in 1851 and government policies regarding Aboriginal people became increasingly intrusive into their lives. Demand for fertile farming land steadily increased and by the 1870s the Aboriginal people had mainly been dispersed to different areas across the region including to established missions (Weir, 2009).

The evidence of Aboriginal occupation in Victoria is present throughout the landscape in the form of Aboriginal cultural heritage places and in the personal, family and community histories of Aboriginal people (GHCMA, 2015). A stone arrangement, north of Lake Bolac, is believed to be a significant Aboriginal ceremonial site. The basalt stones are arranged in lines and are said to resemble a giant eel. Some of these stones were removed to make way for a road, now known as the Glenelg Highway (Wikipedia, 2015). Another site of archaeological significance can be found on the eastern shore of Lake Bolac in a dune complex which extends south of the Fiery Creek. Animal bones, stone tools and charcoal have been found at the site and some of

the remains have been dated back to approximately 12,480±560 before present, with reports referencing the site as far back as 1841. There are erosion issues at the site which has prompted a rock wall to be constructed at the base of the dune to help stabilise the site (Gervasi & P&P Design 2006).

Today, there are three registered Aboriginal Parties (RAPs) who are the voice of Aboriginal people in the management and protection of Aboriginal cultural heritage within the H11 & H12 sub-catchment. The Eastern Maar Aboriginal Corporation, Martang Pty Ltd and Wathaurung Aboriginal Corporation. The local community hosts a festival biannually known as the Lake Bolac Eel Festival which was inspired by the eel harvest gatherings once held by the traditional owners of the land. The Festival has an environmental and reconciliation theme, one of the aims of the festival is to foster reconciliation and mutual respect and understanding between indigenous and non-indigenous peoples, and a key part of the festival has included a Healing Walk.

## Rivers and Creeks

Geographically a catchment is an area of land that drains to a single low point such as a gully, creek or river. A large catchment may be made up of a series of smaller sub-catchments and these are made up of soil, water, air and vegetation. Together these elements support life and make up an ecosystem that within it, has cycling of nutrients and other elements. Each component is linked, so when one changes it has an effect on the other elements. The H11 & H12 sub-catchment is located within the Hopkins River Basin in Western Victoria; the climate of the area is best described as Mediterranean, with hot summers and cool winters. The average rainfall ranges from 537 mm/year at Lake Bolac to up to 572 mm/year in the upper catchment around the headwaters of Fiery Creek at Buangor (BOM, 2015 Rainfall Data).

The major waterway in the H12 sub-catchment is the Fiery Creek, which stretches from the My Cole Range to the confluence of the Fiery Creek and Wongan Creek. Fiery Creek has a number of smaller tributaries of which Wongan Creek is the largest (Gervasi & P&P Design, 2006). The smaller tributaries include Billy Billy Creek, Cave Hill Creek, Challicum Creek, Charleycombe Creek, Dairy Maid Creek, Ditchfield Creek, Middle Creek, Sandy Creek and Wongan Creek. The two major waterways within H11 sub-catchment include the continuation of the Fiery Creek, from the confluence with Wongan Creek, and Salt Creek.

Fiery Creek has a length of approximately 100 kilometres through this sub-catchment and terminates at Lake Bolac. Its overflow becomes Salt Creek which has a length of approximately 25 kilometres. Fiery Creek's headwaters are located between Beaufort and Ararat on the southern slopes of the Great Dividing Range in the H12 sub-catchment. Salt Creek begins at the outlet of Lake Bolac, and flows through low-lying land and is dotted with a large number of wetlands. Historically the wetland areas retained water in the catchment during wetter periods and allowed water to leave the catchment through the year, however the land around Salt Creek appears to have been modified with improved drainage for pasture and crops, with many of the wetlands now drained.

*Fiery creek has a length of approximately 100 km through the sub-catchment and terminates at Lake Bolac.*

The rivers and creeks within the H11 H12 sub-catchment provide many benefits to the region, such as filtering water for agriculture and drinking water supply, as well as supporting unique flora and fauna populations. They also provide a range of social values including fishing, boating, camping, swimming, picnicking and bushwalking. There are a number of threats facing the rivers and creeks within H11 H12 sub-catchment. The value and condition of rivers and creeks are often compromised by erosion and sedimentation, particularly where catchments have been cleared and stock can directly access the waterway.

Increased nutrient loads in waterways as a result of uncontrolled stock access, agricultural fertilisers and urban storm water runoff, can cause blooms of toxic blue-green algae that impact on regional communities and the economy (GHCMA, 2014). Pest plants can significantly reduce waterway values by decreasing river access for recreational activities; pest animals impact native species by direct predation or competing for habitat and food; and climate change, water extraction, land use and river regulation can all alter flow regimes.

## Lakes and Wetlands

Lake Bolac is situated at the centre of the H11 sub-catchment and has a catchment area of approximately 1680km2 (168,000 ha). The lake is primarily fed by flows from the Fiery Creek which discharge into the lake at the southeast corner. The geological history of Lake Bolac area is best described as volcanic in origin, the lake itself is formed in a natural depression and historical information suggests that Lake Bolac was ephemeral in nature and would have dried out completely during extreme dry periods (Gervasi & P&P Design, 2006).

At the outlet of Lake Bolac where Salt Creek begins, an artificial weir has been constructed which is believed to have significantly altered the natural hydrology and water quality of the lake. Historically, it is believed that the mouth of the outlet was blocked by sand, which under certain conditions was breached and allowed part of the water from wetlands to flood downstream. Due to local concern at the time that the sand bar could be washed away permanently and a valuable water resource lost, the outlet was blocked with rock. Various stages of construction upgrades and decommissioning have resulted in the current situation with a concrete spillway with no water level control device (Gervasi & P&P Design, 2006).

There are a large number of wetlands which exist throughout the catchment, most are small and ephemeral (only wet some of the time) and on private, agricultural land, however there are others which are larger. A wetland, as classified by the Ramsar Convention (1971), are areas of marsh, fen (swamp), peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water depth of which low tide does not exceed six meters. In 2006, it was reported that the H12 sub-catchment had 242

*Spillway at entrance to Lake Bolac, February 2011*

wetlands covering an area of 2293 hectares while H11 sub-catchment had 801 wetlands covering an area of 9639 hectares (Gervasi & P&P Design, 2006). These figures are from one point in time, the very nature of wetlands means that drought, heavy rains and the ease of which wetlands can be drained, can decrease or increase the number of wetlands present and the area they occupy.

There is one highly valued wetland in the H11 H12 sub-catchment, the Nerrin Nerrin Wetlands system, which is located 11km east of Lake Bolac and consists of an inlet from Fiery Creek and five wetlands. Three of these wetlands are managed by Parks Victoria and two are located on privately owned land. Overflow from this system flows into Paddy Lake and terminates at Lake Gellie. The Nerrin Nerrin Wetlands are listed in the national directory of Important Wetlands in Australia and are considered a high priority wetland asset in the

*Neerin Nerrin Swamp and homestead*

Glenelg Hopkins Waterway Strategy 2014-2022. They support a rich flora, as well as large numbers of water birds, including nine species listed on international migratory bird agreements and significant occurrences of three threatened water bird species: Freckled Duck, Brolga and Whiskered Tern. The nationally vulnerable Growling Grass Frog also occurs at Nerrin Nerrin Wetlands (GHCMA, 2006).

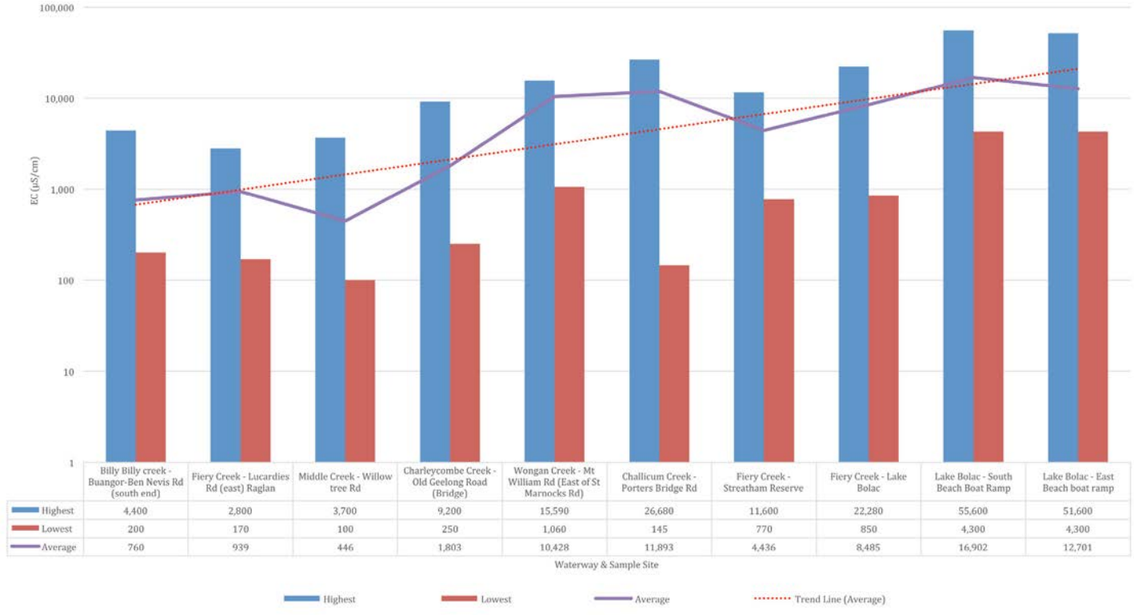
Many of the wetlands within the H11 H12 sub-catchment are located on private agricultural land. Wetlands can provide numerous benefits to agriculture, such as improving water quality, contributing to flood mitigation and the consistency of stream flows. Wetlands also aid soil conservation efforts, and contribute to the sustainability of natural food networks that enhance and protect agriculture animals and crops (Wetland Care Australia, 2016). The value of wetlands in agricultural systems is sometimes underestimated, numerous wetlands have already been lost through drainage and inappropriate management, cropping and more recently, land use and climate change. Reduced rainfall has severely impacted on runoff into wetlands, and as a result, wetlands that were wet every year might only be wet every second or third year (GHCMA, 2016).

Land manager's attitudes towards wetlands is changing, there is increasing recognition of the critical interdependencies between agriculture and healthy wetlands. Management practices are encouraging land managers to retain and restore wetlands. Further research into how to manage particular wetland types within different agricultural systems is needed to ensure that wetlands can be sustainably managed into the future.

## Salinity

Salts occur naturally to some extent within the waterways, lakes and wetlands within the H11 H12 sub-catchment. However, there is evidence to suggest that the salinity within Lake Bolac has been increasing over time, and could be triggered by two separate processes. It is thought that long term increases in salinity could occur where changes in land use and impacts on ground water could be responsible for either salinity runoff or discharges of saline groundwater into surface waters. It is also thought that, in the short term, concentrations of salts and increased salinity levels result from an increase in evaporation and a decrease in precipitation over the hotter months of the year. During periods of low water flow, when Lake Bolac is not spilling into Salt Creek, the Lake acts as a sink for salt from the upper catchment. The moderately saline water which enters Lake Bolac become super saline when evaporation occurs and there is not enough flow to flush water down Salt Creek.

***Figure 2. Salinity levels of waterways based on records from 2000 – 2016 (Allender U, 2016)***

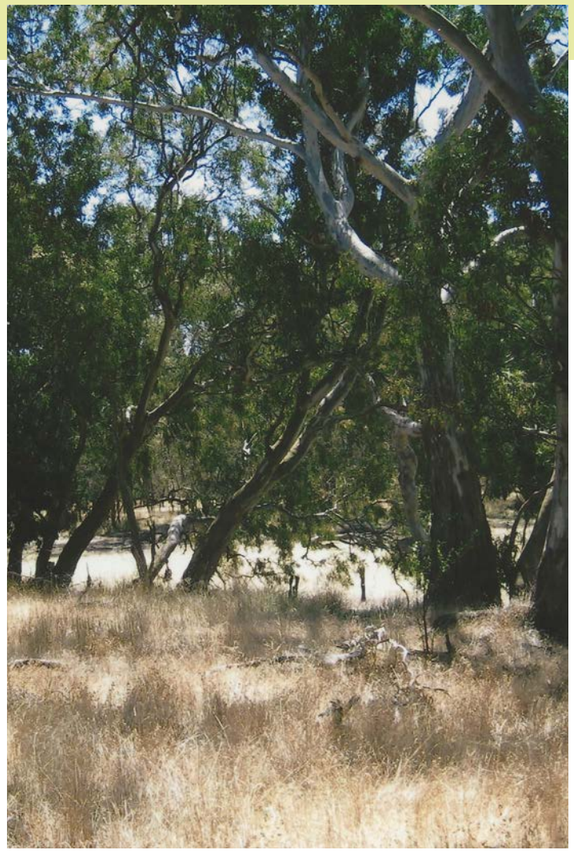



| | Billy Billy creek - Buangor-Ben Nevis Rd (south end) | Fiery Creek - Lucardies Rd (east) Raglan | Middle Creek - Willow tree Rd | Charleycombe Creek - Old Geelong Road (Bridge) | Wongan Creek - Mt William Rd (East of St Marnocks Rd) | Challicum Creek - Porters Bridge Rd | Fiery Creek - Streatham Reserve | Fiery Creek - Lake Bolac | Lake Bolac - South Beach Boat Ramp | Lake Bolac - East Beach boat ramp |
|---|---|---|---|---|---|---|---|---|---|---|
| Highest | 4,400 | 2,800 | 3,700 | 9,200 | 15,590 | 26,680 | 11,600 | 22,280 | 55,600 | 51,600 |
| Lowest | 200 | 170 | 100 | 250 | 1,060 | 145 | 770 | 850 | 4,300 | 4,300 |
| Average | 760 | 939 | 446 | 1,803 | 10,428 | 11,893 | 4,436 | 8,485 | 16,902 | 12,701 |

Measurement of salinity levels along Fiery Creek began back in the year 2000 by local landcare members. Salinity levels are measured when water levels are high enough to get a reasonable sample. In March 2007, salinity levels in Lake Bolac were recorded to be 85,000EC which was up from 27,000EC in September of 2006 (Gervasi & P&P Design, 2006) In March 2016, the salinity level at Lake Bolac's South Beach was 50,000EC and at Lake Bolac East Beach it was 51,600EC, which was well above the 13,200EC which was recoded the same time the year before (Allender U, 2016). The graph below shows the highest, lowest and average salinity for various waterways within the H11 H12 sub-catchment between the year 2000 and 2016. It's important to note that this data represents only a small snapshot in time, and a larger time period would provide a better picture of the salinity levels within the upper catchment. Between the year 2000- 2016 many waterways were dry preventing salinity levels to be measured, however in 2011, the catchment experienced a significant flooding event triggering a flush of the system and good water levels across the catchment. Based on the data collected, the graph indicates that the salinity levels are increasing as the water flows from the upper catchment to Lake Bolac.

## Native Flora

The H11 H12 sub-catchments stretches across four of Victoria's bioregions, the Victorian Volcanic Plains and the Dundas Tablelands in the south and Goldfields and Central Victorian Uplands in the north. Most of the catchment is covered by the Victorian Volcanic Plain Bioregion which is dominated by Cainozoic volcanic deposits which formed extensive flat to undulating basaltic plain with stony rises, old lava flows, numerous volcanic cones and old eruption points and is therefore dotted with shallow lakes both salt and freshwater. The soils are generally grey loams (Weatherly, 2016) with small patches of shallow reddish-brown to black loams and clays which are highly fertile. Wetland formations include inland salt marshes, permanent and intermittent freshwater and saline/brackish lakes, permanent freshwater ponds and marshes and inland, subterranean karst wetlands (DELWP, 2015).



*Eurambeen Redgum and Wetland*

Within the Victorian Volcanic Plain bioregion, the Australian Government has identified the Natural Temperate Grassland, Grassy Eucalypt Woodland and Seasonal Herbaceous Wetlands as critically endangered ecological communities which are protected under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). Temperate grasslands and grassy woodlands are among the most under-represented ecosystems in Australia's conservation estate and are recognised nationally as among the most threatened vegetation types. Both ecological communities were formerly extensive on the Victorian volcanic plain but now comprise mostly small, highly fragmented remnants in a landscape that has been largely cleared for agriculture (DSEWPC, 2011).

Less than five per cent of the original extent of both communities remains, although patches in good condition are likely to constitute less than one per cent. Most known remnants are small – under 10 hectares in size. Many patches of these ecological communities require recovery efforts because they are so degraded, due to weed and feral animal invasion and loss of native biodiversity, that their capacity to maintain ecosystem function is impaired (DSEWPC, 2011)

Seasonal Herbaceous Wetlands are temporary freshwater wetlands that are inundated on a seasonal basis, typically filling after winter-spring rains, and then drying out. The vegetation is generally treeless and dominated by an herbaceous ground layer, often with grasses, sedges and rushes with small flowering plants present. The species present are characteristic of wetter locations and are typically absent or uncommon in any adjoining dryland grasslands and woodlands. The dominant plants present are subject to seasonal and site conditions, and the diversity of the flora may range from relatively species-poor to species-rich composition (Department of Environment, 2016).

The land tenure within which the Seasonal Herbaceous Wetlands ecological community occurs, is primarily private land and the main land use is agriculture, mainly grazing and cropping. The generally flat landscape and fertile soils where Seasonal Herbaceous Wetlands occur are conducive to agriculture. Freshwater Meadows and Shallow Freshwater Marshes are typical wetland types found in the Victorian Volcanic Plains Seasonal Herbaceous Wetlands ecological community, within Glenelg Hopkins CMA area. They are shallow and dry for most of the year and may not be recognised as wetlands, which means that they are easily drained or cropped. At least 70 per cent of freshwater meadows in the Glenelg Hopkins catchment have been drained and many of the smaller wetlands that remain on private land are grazed by domestic animals or cropped during dry years. The greatest threats to these wetlands are ploughing, farm chemicals and sprays, pest plants, vegetation removal and unrestricted grazing (GHCMA, 2016).

Ecological Vegetation Classes (EVC) are the standard unit for classifying vegetation types in Victoria and are based on early approaches to mapping the floristic communities for Victoria's five regional forest agreements in the 1990's. Through the regional forest agreement process and subsequent mapping projects in the non-productive forest regions of the state, the whole of the state of Victoria was mapped with



*Salt Creek near Woorndoo*

EVCs at 1:100,000 scale. EVCs are described through a combination of floristics, lifeforms and ecological characteristics, and through an inferred trustworthiness to particular environmental attributes. Each EVC includes a collection of floristic communities that occur across a biogeographic range, and although differing in species, have similar habitat and ecological processes.

*Within the Victorian Volcanic Plains bioregion, the Australian Government has identified the Natural Temperate Grasslands, Grassy Eucalypt Woodland and Seasonal Herbaceous Wetlands as critically endangered ecological communities.*

Based on the Victorian State Government EVC mapping in 2005, the dominant EVC found within the H11 H12 sub-catchment VVP bioregion area is Plains Grassland, which is characterized by treeless vegetation mostly less than 1 m tall dominated by largely grasses and herb life forms. Species usually found within this EVC include Kangaroo Grass, Wallaby Grass, and herbs such as the iconic Blue Devil, Slender Sun Orchid, Lemon Beauty Heads and Pink Bindweed. This area is also dotted with Plains Grassy Woodland and small patches of Heathy Dry Forest, which normally includes eucalyptus species such as Grey Box, Yellow Box and Yellow Gum, Red Stringybark, Broad-leaved Peppermint and Narrow-leaf Peppermint. Both these EVCs are listed as endangered by the State Government of Victoria.

Along the creek lines, the mapping suggest that the dominant EVC includes Floodplain Riparian Woodland and Creek-line Grassy Woodland, which includes species such as River Red Gums and Swamp Gums with understory species including wattles, grasses, sedges and lilies, these two EVCs are also listed as endangered. The wetland area EVCs include Plains Grassy Wetlands, which is endangered, and Plains Sedgy Wetlands which is listed as vulnerable and characterised by a sparse shrub and ground cover dominated by grasses and small sedges and herbs. The vegetation is typically species-rich on the outer verges but is usually species-poor in the wetter central areas; it has been presumed that these EVCs are now extinct within the catchment (GHCMA, 2006), however there is local evidence to suggest there are some very small pockets in existence.

The Dundas Tablelands covers a small section of the catchment along the western side of Lake Bolac and Salt Creek from Lake Bolac to half way between Woorndoo and Hexham. Dundas Tablelands is predominantly a hard ironstone layer caps the Paleozoic deposits, resisting erosion. Streams have cut deep narrow valleys across the tablelands. The mapping suggests that the dominate EVC in this area is Plains Grassy Woodlands, which is characterised by an open, eucalypt woodland of River Red Gums with an understory which consists of a few sparse shrubs over a species-rich grassy and herbaceous ground layer and listed as endangered.

*H12 sub-catchment landscape*

The headwaters of Fiery Creek flow through the Central Victorian Uplands Bioregion, which is dominated by granitic and sedimentary terrain with metamorphic and old volcanic rocks which have formed steeply sloped peaks and ridges (DELWP 2015). The EVC mapping implies that the three most dominant EVCs within this bioregion include Heathy dry forest, Herb-rich foothill forest and Grassy dry forest. Heathy dry forest grows on shallow, rocky skeletal soils on a variety of geologies and on a range of landforms from gently undulating hills to exposed aspects on ridge tops and steep slopes at a range of elevations. The over-storey is a low, open eucalypt forest to 20m tall and includes species such as Red Stringybark and Broad Leaved Peppermint eucalypts. The understorey is typically dominated by a low, sparse to dense layer of shrubs including the common heath, Golden Bush pea and the iconic Grass tree. Grasses are frequently present in the ground layer, but do not provide much cover (DELWP, 2015).

Grassy dry forest has a similar canopy to the Heathy dry forest however it is characterised by a smaller tree layer including a number of Acacia species. The understorey consists of a sparse shrub layer and ground layer dominated by a high diversity of drought-tolerant grasses and herbs, often including a suite of fern species. Along the easterly and southerly aspects of the lower slopes and in gullies is where the Herb-rich foothill forest thrives. It is characterised by a medium to tall open forest or woodland to 25m tall with a small tree layer over a sparse to dense shrub layer. A high diversity of herbs and grasses in the ground layer characterise this EVC (DEWLP, 2015).

It's important to note that the native vegetation within the H11 H12 sub-catchment has been highly modified and many of the EVC which should exist may no longer be present. There may only be a few key species which survive in any one area, which makes it difficult to determine what existed in the past and therefore what should be re-planted to increase the biodiversity value for the future, especially within a changing climate. Local knowledge suggests that the soils across the catchment are grey/loams, and that Grey Box and Yellow Gums are no longer present. Swamp Gums are limited to Fiery Creek in the upper catchment, along with Candlebark, Messmate, Yellow Box and Scentbark species. The Fiery Creek also supports remnant Red Gums, Tea Trees and Tree Violets, however there are only limited areas where Sheoaks, Banksia's and Bursaria exist today.



The table below list flora species of national or state significance within the H11 H12 sub-catchment. This list was sourced from the Victorian Biodiversity Atlas, which has more than six million records of species distribution and abundance from systematic surveys and general observations for the State of Victoria, and only includes listings from 2005 – 2015. It's important to note that this list is not definitive, and it is likely that some of these species may no longer be present, while other species could be present but not listed below.

***Table 3. Flora of National and State Significance for H11 and H12 Sub-catchment. Source: Victorian Biodiversity Atlas 2016***

| Flora of National and State Significance (2005 – 2015) | |
|---|---|
| **Scientific Name** | **Common Name** |
| *Leucochrysum albicans var. tricolor* | White Sunray |
| *Pimelea spinescens subsp. spinescens* | Spiny Rice-flower |
| *Diuris basaltica* | Small Golden Moths |
| *Rutidosis leptorhynchoides* | Button Wrinklewort |
| *Senecio macrocarpus* | Large-headed Fireweed |
| *Daviesia laevis* | Grampians Bitter-pea |
| *Prasophyllum suaveolens* | Fragrant Leek-orchid |
| *Dianella amoena* | Matted Flax-lily |
| *Ptilotus erubescens* | Hairy Tails |
| *Senecio cunninghamii var. cunninghamii* | Branching Groundsel |
| *Boronia nana var. pubescens* | Dwarf Boronia |
| *Coronidium gunnianum* | Pale Swamp Everlasting |
| *Dianella sp. aff. longifolia (Benambra)* | Arching Flax-lily |
| *Sclerolaena patenticuspis* | Spear-fruit Copperburr |
| *Sida intricata* | Twiggy Sida |
| *Thelymitra gregaria* | Basalt Sun-orchid |
| *Ranunculus diminutus* | Brackish Plains Buttercup |
| *Diuris gregaria* | Clumping Golden Moths |
| *Poa physoclina* | Wind-blown Tussock-grass |
| *Bossiaea cordigera* | Wiry Bossiaea |
| *Comesperma polygaloides* | Small Milkwort |
| *Correa aemula* | Hairy Correa |
| *Diuris behrii* | Golden Cowslips |
| *Eucalyptus yarraensis* | Yarra Gum |
| *Galium curvihirtum* | Tight Bedstraw |

## Native Fauna

The H11 H12 sub-catchment is home to a vast array of native wildlife. The Short Finned Eel (Anguilla Australis) is the most familiar species linked to Lake Bolac due to its significance in the Indigenous cultural heritage of the area. The Eel commences an extraordinary journey from where they spawn near Vanuatu, undertaking metamorphosis from larvae to a juvenile eel, prior to arriving in the freshwater estuaries of Australia and New Zealand.

In Victoria, juvenile eels begin their upstream migration between the months of March and October. Adult eels live in Lake Bolac and surrounding wetlands until the eels reach sexual maturity, around the age of 10, when they return to their birthplace to spawn and die. The Short Finned Eel is widespread and common in coastal river systems in southern Queensland, New South Wales, Victoria, Tasmania and the larger Bass Straight islands as well as the islands found in the south-western Pacific.

The H11 H12 sub-catchment is also home to a number of rare, threatened and endangered native species which are protected either under Victoria's Flora and Fauna Guarantee Act 1988 or the Australian Government's Environment Protection and Biodiversity Act 1999. A list of national or state significant species is provided in table 3. This list was sourced from the Victorian Biodiversity Atlas, which has more than six million records of species distribution and abundance from systematic surveys and general observations for the State of Victoria, and only includes listings from 2005 – 2015. It's important to note that this list is not definitive, and it is likely that some of these species may no longer be present, while other species could be present but not listed below.

*Juvenile Short Finned Eel*



***Table 4. Fauna of National and State Significance for H11 & H12 sub-catchment, source: Victorian Biodiversity Atlas, 2016***

| Fauna of National and State Significance (2005-2015) | |
|---|---|
| **Scientific Name** | **Common Name** |
| *Actitis hypoleucos* | Common Sandpiper |
| *Tringa nebularia* | Common Greenshank |
| *Gallinago hardwickii* | Latham's Snipe |
| *Plegadis falcinellus* | Glossy Ibis |
| *Ardea modesta* | Eastern Great Egret |
| *Biziura lobata* | Musk Duck |
| *Litoria raniformis* | Growling Grass Frog |
| *Miniopterus schreibersii bassanii* | Common Bent-wing Bat (southern ssp.) |
| *Delma impar* | Striped Legless Lizard |
| *Circus assimilis* | Spotted Harrier |
| *Falco subniger* | Black Falcon |
| *Sminthopsis crassicaudata* | Fat-tailed Dunnart |
| *Pseudemoia pagenstecheri* | Tussock Skink |
| *Galaxiella toourtkoourt* | Little Galaxias |
| *Chlidonias hybridus javanicus* | Whiskered Tern |
| *Nycticorax caledonicus hillii* | Nankeen Night Heron |
| *Pseudophryne bibronii* | Brown Toadlet |
| *Climacteris picumnus victoriae* | Brown Treecreeper (south-eastern ssp.) |
| *Grus rubicunda* | Brolga |
| *Anas rhynchotis* | Australasian Shoveler |
| *Aythya australis* | Hardhead |
| *Oxyura australis* | Blue-billed Duck |

Four unique threatened species found within the Victorian Volcanic Plans of H11 H12 sub-catchment include the Corangamite Water Skink, the Striped Legless Lizard, the Growling Grass Frog, which are protected nationally under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the Brolga, protected in the State of Victoria by the *Flora and Fauna Gurantee Act 1988*.

The Corangamite Water Skink (*Eulamprus tympanum marnieae*) is endemic to Victoria where it is restricted to the rocky verges of a few wetlands on the Victorian Volcanic Plain. The skink is a medium sized lizard and grows up too 25cm long and is a pale olive to dark yellowish-brown colour with irregular black markings. A heavy, irregular, somewhat broken black stripe extends from the snout along the sides to the hind limbs, while the limbs are overlain by heavy black stripes and blotches. The skink has undergone a decline, disappearing from at least two historical locations, and is known from only 30 sites representing 11 discrete existing populations (DSE, 2011). It has been known to exist at two sites around Lake Bolac and also at the Nerrin Nerrin wetlands.

*Striped Leggless lizard at Cross Roads, South West Victoria*

Threats such as rock removal, vegetation clearance, inappropriate grazing, wetland loss and inappropriate water management have contributed to its decline and threaten the remaining populations. The Corangamite Water Skink is listed as Endangered under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999, Threatened under the Victorian Flora and Fauna Guarantee Act 1988, and is considered Critically Endangered in Victoria (DSE, 2011).

The Striped Legless Lizard (*Delma impar*) is a grassland specialist, being found only in areas of native grassland and nearby grassy woodland and exotic pasture. Superficially, these animals resemble snakes, but can be readily distinguished from the latter by the presence of external ear openings, a fleshy undivided tongue and a tail which, when unbroken, is longer than the body. The striped legless lizard is patchily distributed in grasslands of south-eastern NSW, the ACT, north-eastern, central and south-western Victoria, and, possibly, south-eastern South Australia. It is believed to have declined throughout its distribution and is known to have disappeared from many sites. It is the loss and degradation of native grassland, through a variety of processes that is primarily responsible for the decline of D. impar (Smith & Robertson, 1999).

The Growling Grass Frog is one of the largest frog species in Australia and reaches up to 104mm in length. They vary in colour and pattern but in general are olive to bright emerald green with irregular gold, brown, black or bronze spotting with warty backs. This species is found mostly amongst emergent or fringing vegetation in or at the edges of still or slow-flowing water bodies such as lagoons, swamps, lakes, ponds and farm dams. It was previously widespread across Victoria, however has now disappeared from most of its former range. The species persists in isolated populations in the greater Melbourne area, in the south-west of Victoria and a few sites in central Victoria and Gippsland (Department of the Environment, 2016).

The Brolga is one of Australia's largest flying birds, measuring from anywhere between 1 to 1.3m in height, with a wing span ranging from 1.7 to 2.4m. The Brolga



*Brolgas at Tiverton Station, Western Victoria.*

is a pale grey colour with an obvious red to orange patch on their head with a black dewlap (piece of skin) hanging underneath their chin. The Brolga is found across north and north east Australia, north east Queensland and right through to Victoria and is listed as a threatened species under Victoria's Flora and Fauna Guarantee Act 1988.

The Brolgas survival depends on the presence of wetlands; during the breeding period, between July to December, there main habitat is freshwater meadows or shallow freshwater marshes, although they have been known to nest in the shallows of deep freshwater marshes and in association with vegetation on permanent open waters to provide protection from predators such as foxes. Brolga pairs bond for life and have been known to utilise the same nesting areas for up to 20 years. The birds also spend time on salt lakes throughout the region, probably feeding on brine shrimp and roosting. During the non-breeding period from late December to early May, habitat comprises deep freshwater marshes, vegetated areas in permanent open water and feeding areas in pasture, seed and stubble crops (Brolga Recovery Group, 2016).

*The Brolga is one of Australia's largest flying birds, measuring from anywhere between 1–1.3m in height, with a wing span ranging from 1.7 – 2.4m.*

The brolga feed on both plant and animal matter and will eat a variety of wetland plants, insects and amphibians, and have also known to eat mice. Brolgas are quite skilled at foraging for food, and can even do so with their head completely submerged in water. They will use their heavy bill as a type of crow bar to wedge the ground open and turn it over in search of food (DSE, 2010). An extensive drought, combined with draining and modification of wetlands and other pressures such as fox predation have driven brolga numbers in western Victoria to an historical low, at the April 2014 count, Brolga numbers in southwest Victoria were 464 (Brolga Recovery Group, 2016).

Drainage of shallow wetlands where Brolgas nest is the primary cause of the decline in Brolga numbers, compounded by predators such as foxes taking eggs and killing chicks. The cropping of swamps has been shown to result in a reduced diversity and density of plants compared with uncropped swamps, at a landscape level the widespread cropping of swamps could reduce the quantity and quality of Brolga habitat in the landscape (Brolga Recovery Group, 2016).

The Brolga Recovery Group was created in 2010 to implement the conservation objectives of the Department of Sustainability and Environment's Flora and Fauna Action Statement No. 119. This community-based group comprises of farmers, conservationists and interested people who organise workshops, field excursions and actively promotes the scientific collection of observations on brolgas. To address the lack of data on Brolga ecology, the Brolga Recovery Group has made available a free calendar for the community to use to record relevant observations of brolgas. This data is analysed and made available for researchers. (Birdlife Ballarat, 2016). For further information, visit www.brolgarecoverygroup.org.

## Pest Plants and Animals

There are a number of pest plant and animal species present within the H11 H12 sub-catchment and effective management of these species is key to improving the economic, social and environmental wellbeing of the sub-catchment. Weeds are among the most serious threats to south western Victoria's primary production and natural environment. They reduce farm and forest productivity, displace native species and contribute significantly to land degradation. Significant costs are borne by private and public land managers, industry, local government and utility companies. However, the full extent of weed damage is difficult to quantify due to the intangible costs of a reduction in biodiversity.

Weed species are classified into two main types, environmental weeds and agricultural weeds. Environmental weeds are those species that threatened the natural values of native areas such as bushlands, grasslands, waterways and wetlands. They can be introduced species or native species outside their normal rage and outcompete other indigenous species. Agricultural weeds threatened sustainable productivity, such as being toxic to stock, causing loss of condition and or death, or they out-compete desirable crop pasture species reducing production (Ararat Rural City Council, 2016).

Both environmental and agricultural weeds can be declared noxious, meaning they have been declared under the Catchment and Land Protection Act 1994 (CaLP Act) as a significant threat. Pest animals can also be declared under the CaLP Act if they pose a significant threat to the natural values of native areas. It's important to note that most environmental weeds will not be declared under the CaLP Act, however if the plant species is causing damage to a native environment, then it is defined as an environmental weed and should be managed to control its spread or eradicated if possible.

In Victoria, the CaLP Act is the main legislation covering weeds and pest animal management. One of the main objectives of the CaLP Act is to protect primary production, Crown land, the environment and community health from the effects of weeds and pest animals. The CaLP Act defines roles and responsibilities and regulates the management of declared weeds and pest animals (Department of Economic Development, Jobs, Transport and Resources, 2016). Under the CaLP Act all land owners have legal obligations regarding the management of declared noxious weeds and pest animals on their land. The level of threat posed by a weed species determines who is responsible for its control under the CaLP Act. Responsible agencies and/or individuals are required to control or eradicate these weeds according to the following categories:

- Regionally prohibited weeds are not widely distributed in a region but are capable of spreading further and it is reasonable to expect that they can be eradicated from a region. Land owners, including public authorities responsible for crown land management, must take all reasonable steps to eradicate regionally prohibited weeds on their land.
- Regionally controlled weeds are usually widespread in a region and to prevent their spread, ongoing control measures are required. Land owners have the responsibility to take all reasonable steps to prevent the growth and spread of regionally controlled weeds on their land.
- Restricted weeds pose an unacceptable risk of spreading in Victoria and are a serious threat to another State or Territory of Australia. Trade in these weeds and their propagules, either as plants, seeds or contaminants in other materials is prohibited (Department of Economic Development, Jobs, Transport and Resources, 2016).

The status of weeds in continually being reviewed and therefore the current category for certain weeds may change over time.



Below is a list of some of the weeds present within the H11 H12 catchment, this list is not definitive, and other weed species may be present within the catchment. If you know of a weed species which is not listed, or notice a different weed emerging on your land, please notify the Beyond Bolac CAG.

***Table 5. Declared weed species and their current classification found in H11 H12 sub-catchment 2016***

| Common Name | Species Name | CaLP Act 1994 Classification | Weeds of National Significance 1999 |
|---|---|---|---|
| Willow | *Salix Spp.* | Restricted | WoNS |
| Bridal Creeper | *Asparagus asparagoides* | Restricted | WoNS |
| Hawthorn | *Crataegus monogyna* | Restricted | |
| English Broom | *Cytisus scoparius* | Restricted | WoNS |
| Paterson's Curse | *Echium plantagineum* | Regionally Controlled | |
| Serrated Tussock | *Nessella trichotoma* | Regionally Controlled | WoNS |
| Spiny Rush | *Juncus acutus* | Regionally Controlled | |
| Bathurst burr | *Xanthium spinosum* | Regionally Controlled | |
| Gorse | *Ulex eutopaeus* | Regionally Controlled | WoNS |
| Blackberry | *Rubus fruticosus L. agg.* | Regionally Controlled | WoNS |
| Box Thorn | *Lycium ferocissimum Miers* | Regionally Controlled | WoNS |
| Boneseed/Bitou Bush | *Chrysanthemoides monilifera (L.) Norl.* | Regionally Controlled | WoNS |
| Cape Tulip | *Moraea Spp.* | Regionally Controlled | |
| Horehound | *Marrubium vulgare L.* | Regionally Controlled | |
| Sweet Briar | *Rosa rubiginosa L.* | Regionally Controlled | |
| St Johns Wart | *Hypericum perforatum L. Family Clusiaceae* | Regionally Controlled | |
| Amsinckia | *Amsinckia spp.* | Regionally Prohibited | |

Taskforce was created in 1999 by active Victorian community members who were concerned about the impacts of gorse.

The VGT is an advisory committee made up of passionate individuals and Natural Resource Management organisation representatives who uses investment attracted from government to develop community-led projects that aim to rid areas of Victoria from this pest and reduce its impact where that is not possible (VGT, 2016). Managing Gorse is a long term commitment and requires many techniques, the four parts of a successful gorse control program include prevention of spread, removal of above-ground mass of gorse, destruction of regrowth and follow-up seedlings for at least five years and up to 25 years (National Gorse Taskforce, 2006).

*Gorse on roadside beside Fiery Creek*

*Amsinckia*

There are two emerging weeds within the H11 H12 sub-catchment, Amsinckia and St Johns Wart, which should be monitored and managed appropriately. Amsinckia is also commonly known as yellow burr weed, buckthorn, tar weed or yellow gromwell. It is a small flowering plant which grows to a height of 30cm – 70cm and has branches covered with fine, stiff hairs or bristles. The flowers are self-pollinating and resemble a trumpet – shape. They are bright yellow to slightly orange in colour and are positioned on one side of the stem. The plant is found in degraded pastures, roadsides and in dry sandy areas and can rapidly spread by maintenance activities such as slashing and grading. This species is listed as regionally prohibited under the CaLP Act, and is not widely distributed but is capable of spreading further. It is likely that it could be eradicated from H11 H12 sub-catchment with a collaborative targeted approach by public authorities and land managers.

St Johns Wart is a flowering plant which grows to about 80cm. It produces woody flowering stems to 1.2 m in spring and are golden yellow with black dots on the margins. It invades grasslands, woodlands, open forest, pastures, forestry plantations, roadsides, railway lines and river banks. Seed can remain dormant in soil for at least 20 years. Well-established infestations can largely eliminate all other plants and restrict recruitment to the over storey. The plant is poisonous to livestock, when eaten, St John's wort causes inflammation of face, ears, lips; affects the nervous system (panting, salivation, respiratory distress) and alters heart, blood vessel and intestinal function. Affected animals can generally recover between 3 to 6 weeks once removed from access to the plant. Other weeds which have spread more widely across the catchment in recent years include Paterson's Curse and Serrated Tussock (Andrews D, 2016).

*St Johns Wart*

Pest animals also pose a serious threat to south western Victoria's primary production and natural environment. Rabbits wreak havoc across the sub-catchment and are declared as an established pest animal (wild or feral populations) under the CaLP Act. Rabbits are recognised as the most serious vertebrate pest in Victoria, responsible for major environmental and agricultural damage. Rabbits are a major factor in the loss and reduction of many native plant and animal species by causing detrimental habitat change, direct grazing competition and prevent natural regeneration of native species. Current techniques available for controlling rabbits can be categorised broadly as biological, chemical and mechanical.

Biological control for rabbits has been particularly effective and include the myxoma virus causing the disease myxomatosis, which only affects rabbits. The main chemical control used for rabbits is the poison; sodium flouroacetate (1080) which has an effective toxin providing a high mortality rate of up to 90 per cent. Destruction of warrens and above-ground harbours is the most widely used mechanical method for rabbit control. Warren ripping can be a cost-effective and efficient method for suppressing rabbit numbers and inhibiting reinvasion of the treated area, because it deprives rabbits of a safe place for breeding. Other methods used less widely are fencing, shooting, trapping and explosives to destroy warrens (DSEWPC, 2011).



Below is a list of some of the pest animals present within the H11 H12 catchment, this list is not definitive, and other pest animal species may be present within the catchment.

***Table 6. Some pest animal species found within H11 H12 sub-catchment.***

| Common Name | Speceis Name | CaLP Act 1994 | Fisheries Act 1995 | EPBC Act 1999 |
|---|---|---|---|---|
| Fox | *Vulpes vulpes* | Established Pest Animal | | Threatening Process |
| Rabbit | *Orycotolagus cuniculus* | Established Pest Animal (wild/feral populations) | | Threatening Process |
| Mosquito Fish | *Gambusia holbrooki* | | Noxious aquatic species | |
| Carp | *Cyprinus carpio* | | Noxious aquatic species | |


*Bill Sharp at the Southern Farming Systems field day*

## Land use

Agriculture is the most extensive land use in the H11 H12 sub catchment, in the past, the area was known for its high quality Merino wool however; recently there has been an increased emphasis on intensive agriculture, broad acre agriculture and horticulture, such as wine production. The Water and Land Use Change Study undertaken in 2004/2005 for Glenelg Hopkins CMA suggested that 31% of the catchment was used for cropping while 43.7% was used for broad acre grazing. The report predicted that broad acre grazing activities would decline with a large shift to crop based agriculture. By 2020, 25.7% of the catchment will be broad acre grazing and 42.3% will be crop based agriculture, by 2030; broad acre grazing will drop to only 15.3% with crop based agriculture increasing to 48.8% (Gervasi & P & P Design, 2006).

This change is due to a number of reasons, including drought, generational change and farm aggregation (Ararat Rural City Council & Planisphere, 2014). Other significant changes for the agricultural sector include an increase farm size together with decreased farmer numbers, increase use of contractors, an increasing use of technology and more corporate farms in the fertile cropping country in the south (Ararat Rural City Council, 2010).

Changes in farming methods have, over the years, led to improvements in water use efficiency, however, reduced run-off, salinity, acidification and erosion remain important issues for the catchment. Other emerging issues include cropping of wetland remnants, the removal of volcanic plains rocks (habitat) to increase viable cropping land and the potential for contamination by genetically modified crops. The agricultural sector is also facing prolonged drought and the projected variability of the climate. These shifts impact rural towns and communities with young people leaving farms and others moving away from farm work, this creates gaps in the social infrastructure of rural districts and small towns (Ararat Rural City Council & Planisphere, 2014).

Surface water and groundwater resources are heavily utilised for urban, industrial and agricultural uses. Population growth, intensification of agriculture and growth in dams associated with rural residential land use will place increasing demand on streams that are already highly 'stressed' (Clifton C, Daamen C & Horne A, 2005).

## Climate Variability

Climate projections for the Glenelg Hopkins Regions suggest that the weather will be hotter and drier in the coming years which will impact on land use, natural resources, the community and the biodiversity of the H11 H12 sub-catchment.

Temperature predictions suggests that there will be a greater number of hot days and few very cold days overall which is likely to have a significant impact on terrestrial habitats. The geographic range of both flora and fauna species will be altered, as will life cycle processes such as migration, flowering and breeding. The limited ability for fauna to move through the landscape will further impact upon species ability to adapt to the changes in climate. Ultimately the change in climate, will result in a decrease in the region's biodiversity and a change in the current location of species and ecological communities (GHCMA,2015).

Rainfall in the region is predicted to decrease with an increase in the intensity of extreme rainfall events leading to less moisture in the soil and more erosion events. Less rainfall and greater temperatures are likely to cause a reduction in pasture production and persistence which could lead to changes to feed management systems. With reduced rainfall land may become more suitable for cropping and this could increase pressures from production on remnant vegetation, wetlands and waterways (GHCMA, 2015). CMA Climate Change Strategy 9 9

Rivers, floodplains and wetlands would be greatly impacted by the reduction in rainfall and subsequent runoff and stream inflow. Rivers and wetlands that rely on direct precipitation will be most affected. The region's wetlands are likely to undergo a variety of changes such as reduction in size, conversion to dry land or a shift in wetland type. Despite wetlands being very vulnerable to climate change, they are by nature a resilient ecosystem (GHCMA, 2015).

The protection and enhancement of wetlands will become increasingly important due to their carbon sequestration potential and ability to act as 'stepping stones' for biodiversity through the catchment. Rivers are also critical for maintaining connectivity through the landscape. Riparian vegetation and refuge areas will become increasingly important with reduced stream inflow and more hot days. A reduction in water availability and possible increase in demand may intensify pressure on the region's water resources, including its rivers and groundwater (GHCMA, 2015).

*Wetland at Blythdale, Streatham*

## Why is a blueprint needed?

The Beyond Bolac CAG was formed from a dedicated group of locals who recognised that the drying of and future management of Lake Bolac was a catchment wide problem and would require the co-operation of many individual landholders, industry bodies and government agencies from across the catchment to make a difference.

This dedicated group have been working hard over the last 10 years and have successfully achieved many strategies from the H11 & H12 Catchment Health Report. The Beyond Bolac CAG is now looking to the future and planning for the next 10 years to maximise the outcomes it can achieve.

The Norman Wettenhall Foundation landscape restoration project has enabled the Beyond Bolac CAG to review its aim, create objectives, re-connect with its many stakeholders and develop a formal Blueprint to work towards to achieve large scale landscape restoration for the H11 and H12 sub-catchment area.

## What will the blueprint do?

Completing a Blueprint for the H11 and H12 sub-catchment will provide many benefits for Beyond Bolac CAG.

A Blueprint will

- Provide baseline information on the health of the catchment
- Enable the group to track change over time
- Provide an opportunity to
    - review the strategic plan for the group and key issues to focus on
    - re-connect with stakeholders and receive valuable feedback
    - make strategic decisions on where to invest funding and resources
    - view past projects and future projects visually using GIS mapping tools
- Assist the group to apply for future funding, and;
- Inspire community and stakeholders to take action on environmental and sustainability challenges facing the catchment

*First Committee receiving start up funding from Beth Mellick, Executive Director, The Norman Wettenhall Foundation*

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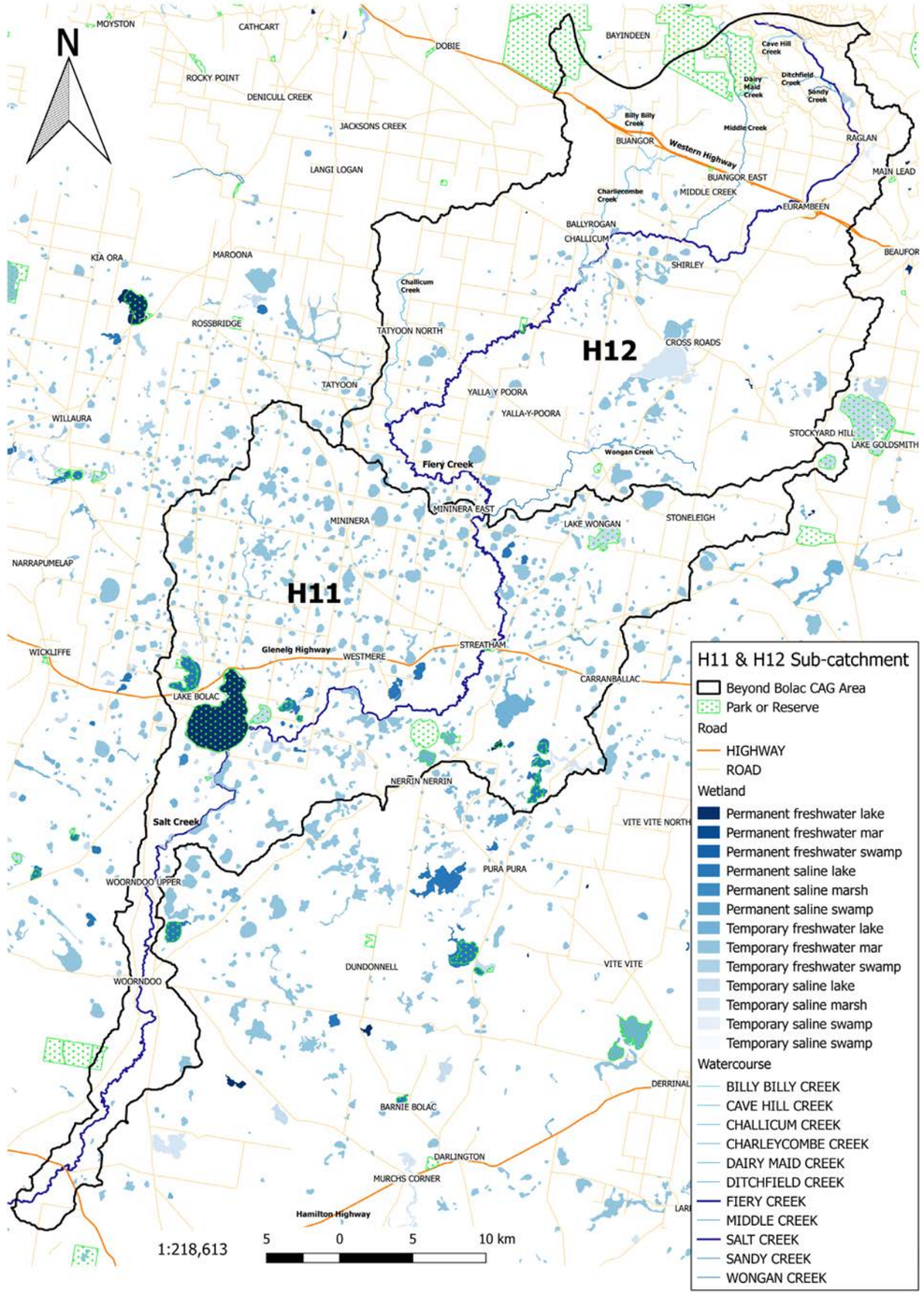
# BiodiversityMaps

The Biodiversity maps provided within the document will assist Beyond Bolac CAG make strategic decisions for the H11 H12 sub-catchment. They visually represent the biodiversity information for the sub-catchment and are a quick reference tool for the group to use when applying for funding, holding discussions with stakeholders or assisting land managers develop projects. The maps included are all available within a GIS program called Q-GIS, which will enable Beyond Bolac CAG to use the maps more effectively. Map users can zoom into specific areas and see much greater detail and data layers can be viewed altogether or singularly or a couple at the same time which can support greater analysis of the data. The data has been sourced from the State Government of Victoria and will need to be updated as new data layers are released



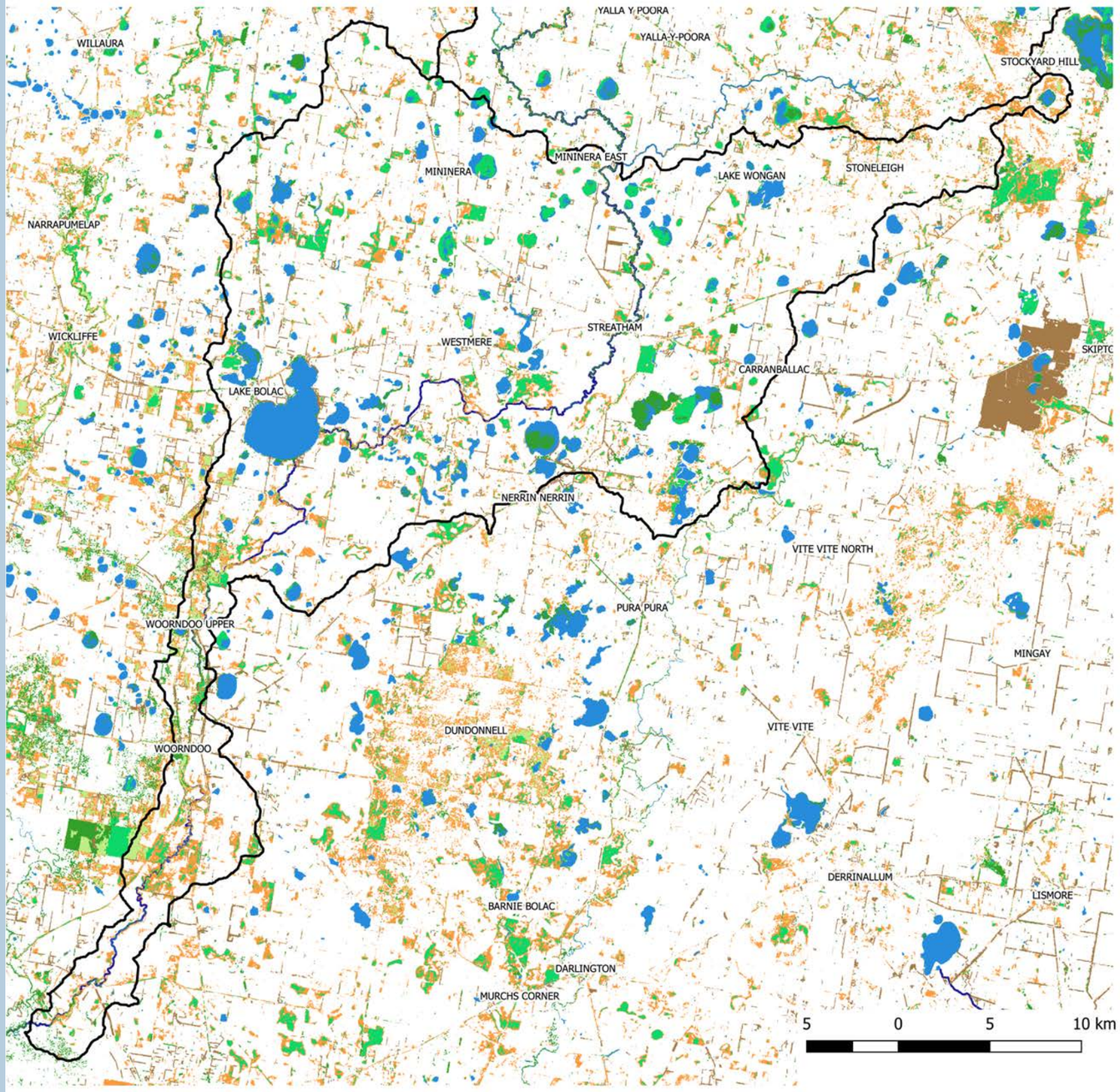
## Map 1 The Beyond Bolac Catchment Action Group Area

The Beyond Bolac CAG area covers approximately 168,000 ha and stretches from Hexham in the south to Raglan and Buangor in the north. The area corresponds to the sub-catchment of H11 & H12 of the Upper Hopkins River Basin. The Fiery and Salt Creeks are the major waterways of this sub-catchment, with Lake Bolac being a major lake. Fiery Creek flows into Lake Bolac from the north, and the overflow from Lake Bolac enters Salt Creek and flows south to the Hopkins River. There are numerous other permanent and temporary lakes and wetlands dotted across this landscape.



## Map 2 Modelled Native Vegetation 2005 Extent

This map shows the most current extent of native vegetation and major water-based habitat across the H11 H12 sub-catchment. The dataset categorises the landscape into native woody, native grassy and major native wetland cover together with probability ratings, ranging from "highly likely native vegetation cover" through to "unlikely to support native vegetation". It is a combination of a number of spatial datasets such as tree cover, rainfall and temperature together with time-series LANDSAT imagery and ground-truthed site data. For the H11 H12 sub-catchment, this maps shows that native vegetation is highly likely to be present mainly in public parks or reserves as well as along the Fiery Creek, particularly in the north and some parts of Salt Creek. It also shows that there are a number of patches across the catchment which could possibly be native vegetation.

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Modelled Native Vegetation Extent H11

- Beyond Bolac CAG Area

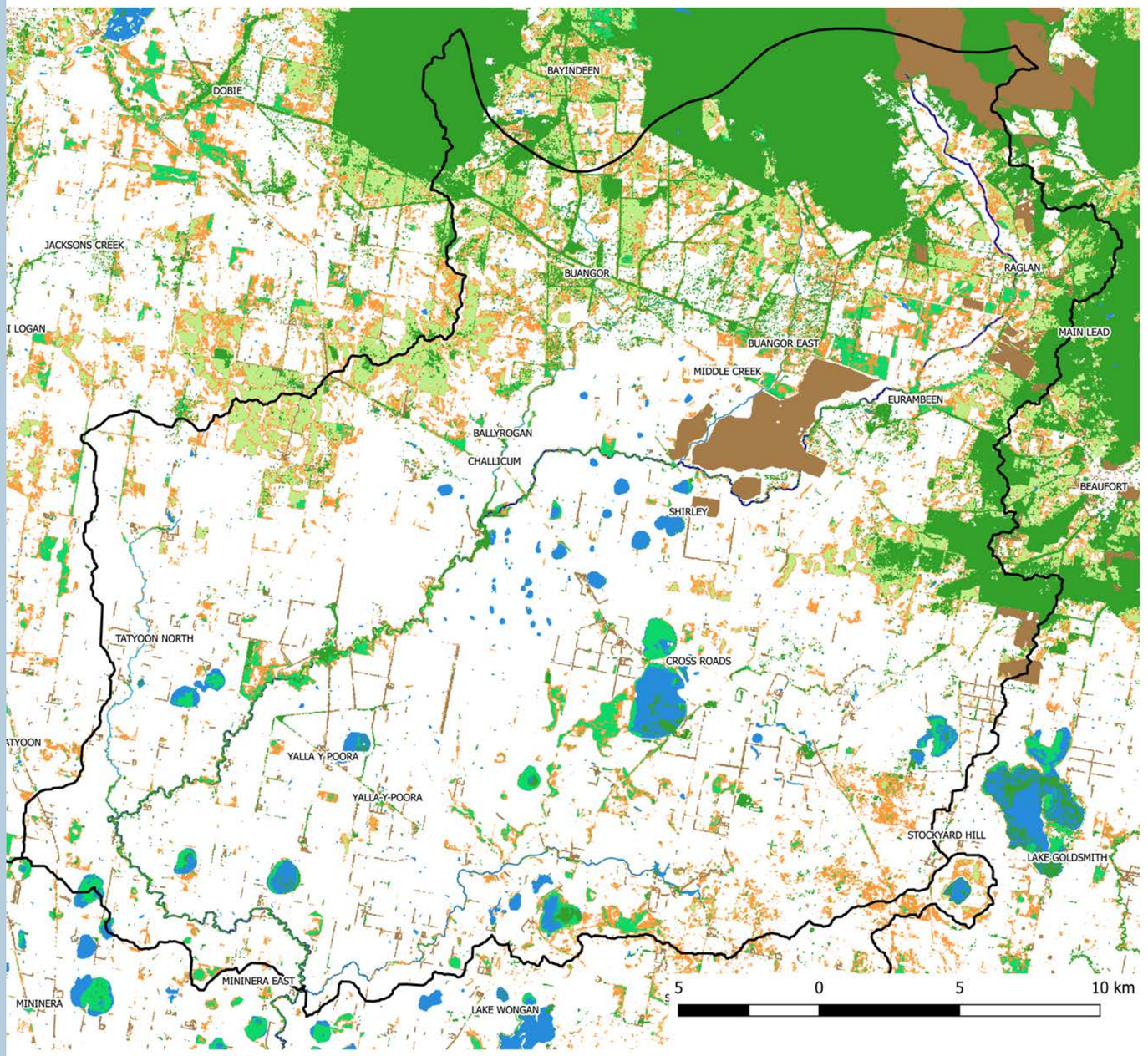
Native Vegetation

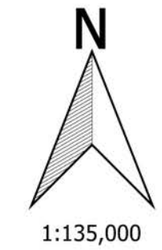
- Exotic woody vegetation
- Highly likely native vegetation - grassy
- Highly likely native vegetation - structurally modified
- Highly likely native vegetation - woody
- Possibly native vegetation
- Wetland habitat

Watercourse

- CHALLICUM CREEK
- FIERY CREEK
- SALT CREEK
- WONGAN CREEK

This map shows the most current extent of native vegetation and major water-based habitat across the H11 H12 sub-catchment. The dataset categorises the landscape into native woody, native grassy and major native wetland cover together with probability ratings, ranging from "highly likely native vegetation cover" through to "unlikely to support native vegetation". It is a combination of a number of spatial datasets such as tree cover, rainfall and temperature together with time-series LANDSAT imagery and ground-truthed site data. For the H11 H12 sub-catchment, this maps shows that native vegetation is highly likely to be present mainly in public parks or reserves as well as along the Fiery Creek, particularly in the north and some parts of Salt Creek. It also shows that there are a number of patches across the catchment which could possibly be native vegetation.




Modelled Native Vegetation Extent H12

- Beyond Bolac CAG Area

Native Vegetation

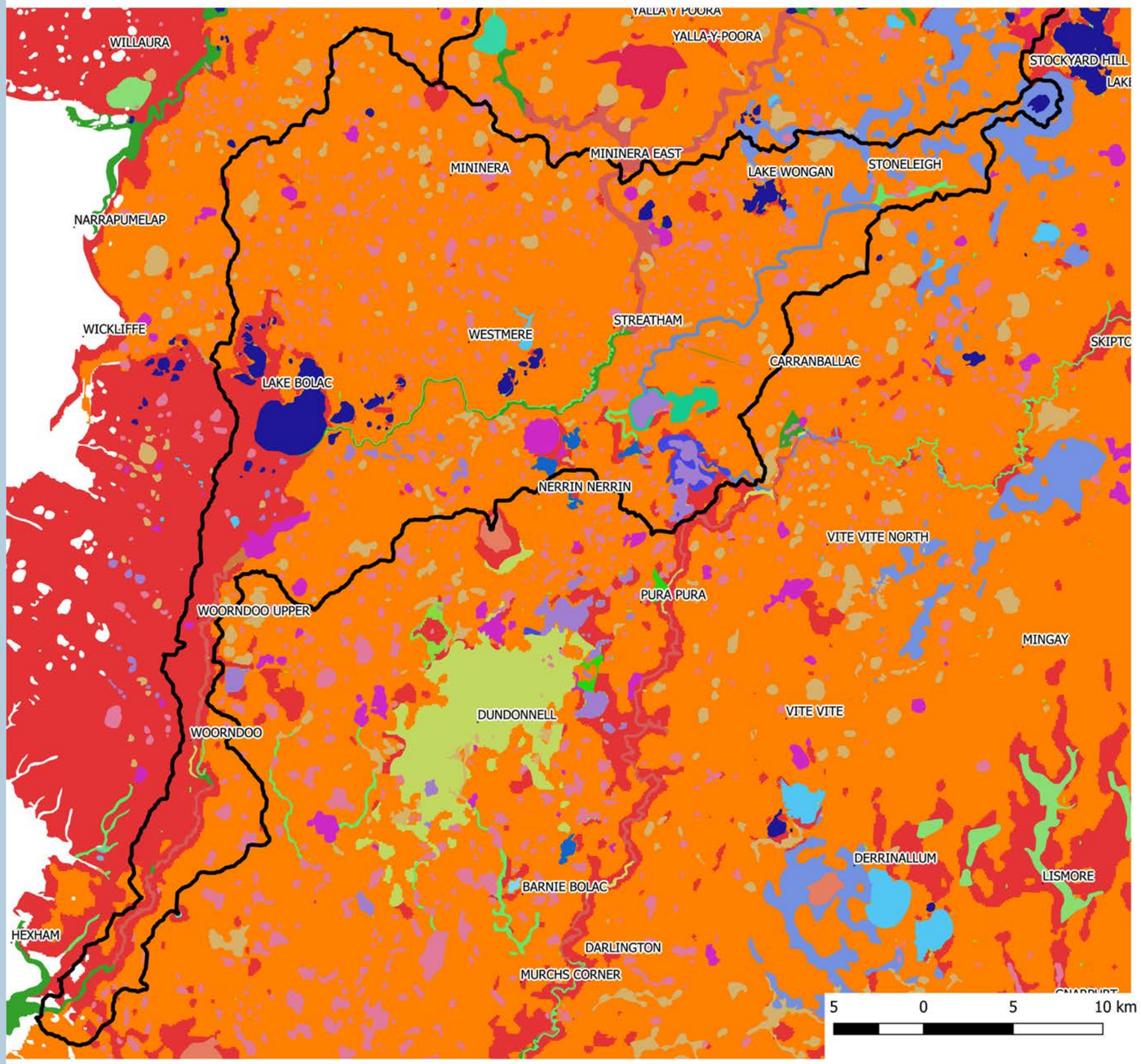
- Exotic woody vegetation
- Highly likely native vegetation - grassy
- Highly likely native vegetation - structurally mo
- Highly likely native vegetation - woody
- Possibly native vegetation
- Wetland habitat

Watercourse

- BILLY BILLY CREEK
- CAVE HILL CREEK
- CHALLICUM CREEK
- CHARLEYCOMBE CREEK
- DAIRY MAID CREEK
- FIERY CREEK
- MIDDLE CREEK
- SANDY CREEK
- WONGAN CREEK

## Map 3 Native Vegetation Pre 1750 Ecological Vegetation Classes

This map shows the estimated modelled extent of vegetation at EVC level prior to European settlement. It is based on field data, environmental spatial data (soils, rainfall, topography etc.) and historical records such as Parish plans. For the H11 H12 sub-catchment, prior to European Settlement, it is believed that there were a total of 56 different EVC's which existed and supported a large variety of plants and animals.

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Pre 1750 Native Vegetation EVC H11

Beyond Bolac Catchment Action Area

Pre 1750 Native Vegetation EVC

- Aquatic Herbland/Plains Sedgy Wetland Mosaic
- Brackish Drainage-line Aggregate
- Brackish Lake Aggregate
- Brackish Wetland
- Creekline Grassy Woodland
- Creekline Tussock Grassland
- Floodplain Riparian Woodland
- Floodplain Riparian Woodland/Plains Grassy Woodland Mosaic
- Freshwater Lake Aggregate
- Freshwater Lignum Shrubland
- Grassy Woodland
- Grey Clay Drainage-line Aggregate
- Heathy Dry Forest
- Lignum-Cane Grass Swamp
- Plains Grassland
- Plains Grassland/Plains Grassy Woodland Mosaic
- Plains Grassland/Stony Knoll Shrubland Mosaic
- Plains Grassy Wetland
- Plains Grassy Woodland
- Plains Grassy Woodland/Stony Knoll Shrubland Mosaic
- Plains Sedgy Wetland
- Plains Sedgy Woodland
- Plains Swampy Woodland
- Riparian Woodland
- Riparian Woodland/Escarpment Shrubland Mosaic
- Saline Lake Aggregate
- Scoria Cone Woodland
- Stony Knoll Shrubland
- Stony Knoll Shrubland/Plains Grassy Woodland/Plains Grassy Wetland Mosaic
- Stony Rises Woodland
- Water Body - Fresh
- Water body - salt
- Wetland Formation

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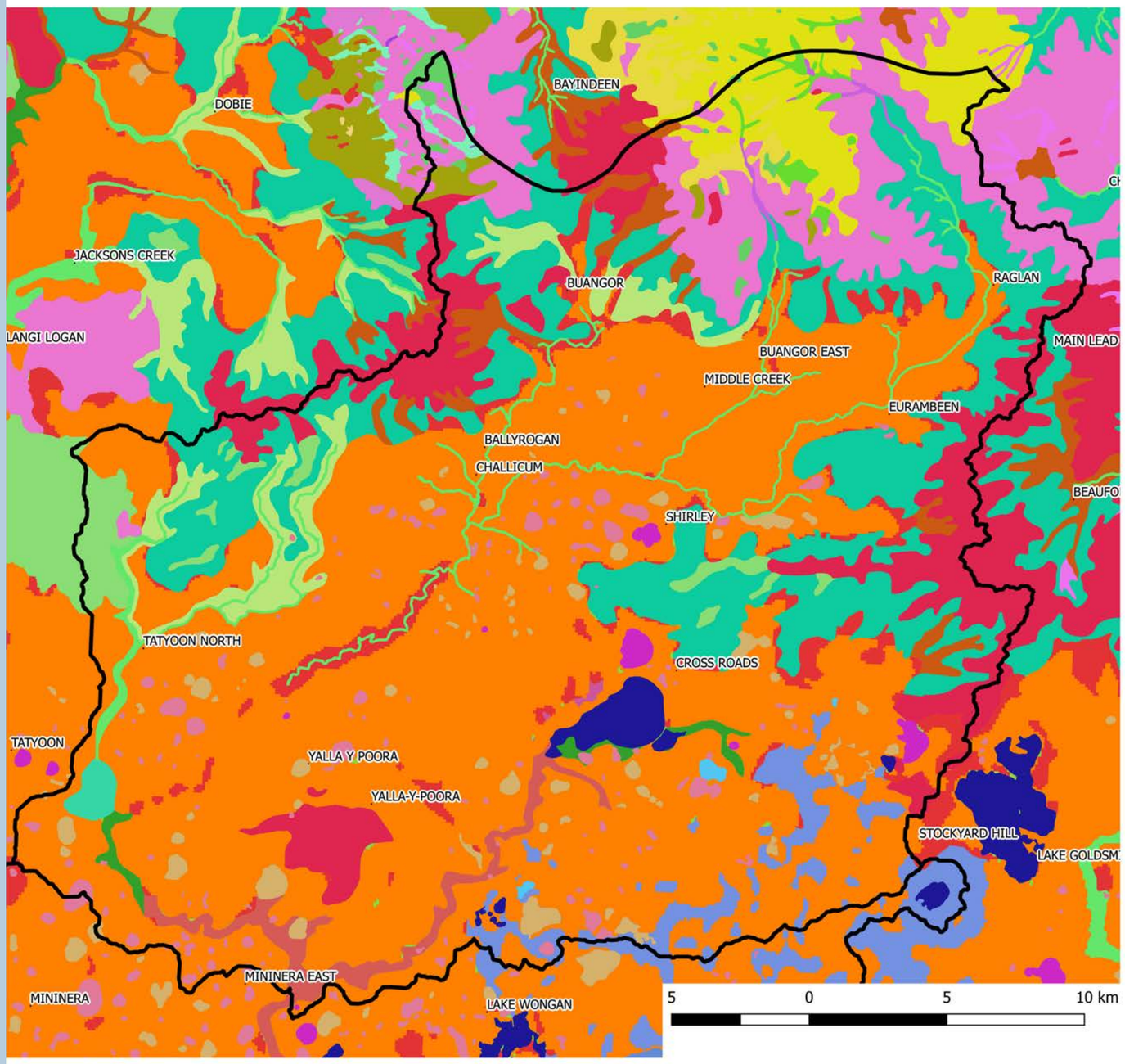


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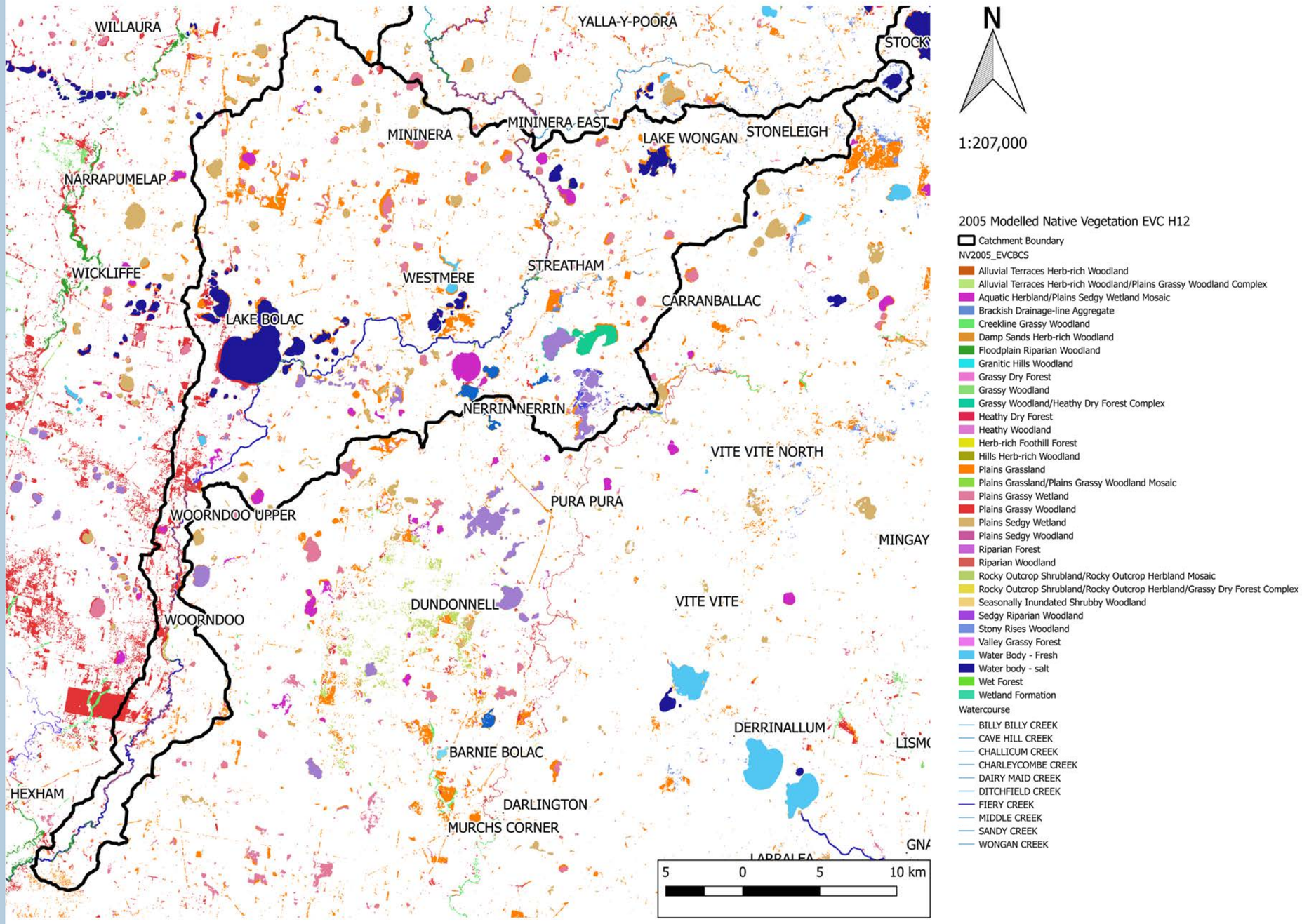
Pre 1750 Native Vegetation EVC H12

- Beyond Bolac Catchment Action Area

Pre 1750 Native Vegetation EVC

- Alluvial Terraces Herb-rich Woodland
- Alluvial Terraces Herb-rich Woodland/Plains Grassy Woodland Complex
- Aquatic Herbland/Plains Sedgy Wetland Mosaic
- Brackish Drainage-line Aggregate
- Creekline Grassy Woodland
- Damp Sands Herb-rich Woodland
- Floodplain Riparian Woodland
- Granitic Hills Woodland
- Grassy Dry Forest
- Grassy Woodland
- Grassy Woodland/Heathy Dry Forest Complex
- Heathy Dry Forest
- Heathy Woodland
- Herb-rich Foothill Forest
- Hills Herb-rich Woodland
- Plains Grassland
- Plains Grassland/Plains Grassy Woodland Mosaic
- Plains Grassy Wetland
- Plains Grassy Woodland
- Plains Sedgy Wetland
- Plains Sedgy Woodland
- Riparian Forest
- Riparian Woodland
- Rocky Outcrop Shrubland/Rocky Outcrop Herbland Mosaic
- Rocky Outcrop Shrubland/Rocky Outcrop Herbland/Grassy Dry Forest Complex
- Seasonally Inundated Shrubby Woodland
- Sedgy Riparian Woodland
- Stony Rises Woodland
- Valley Grassy Forest
- Water Body - Fresh
- Water body - salt
- Wet Forest
- Wetland Formation

This map shows the most current estimated extent of vegetation at EVC level from expert analysis and interpretation of statistical and spatial information undertaken in 2005. This map shows a total of 67 different EVC's existing in 2005.



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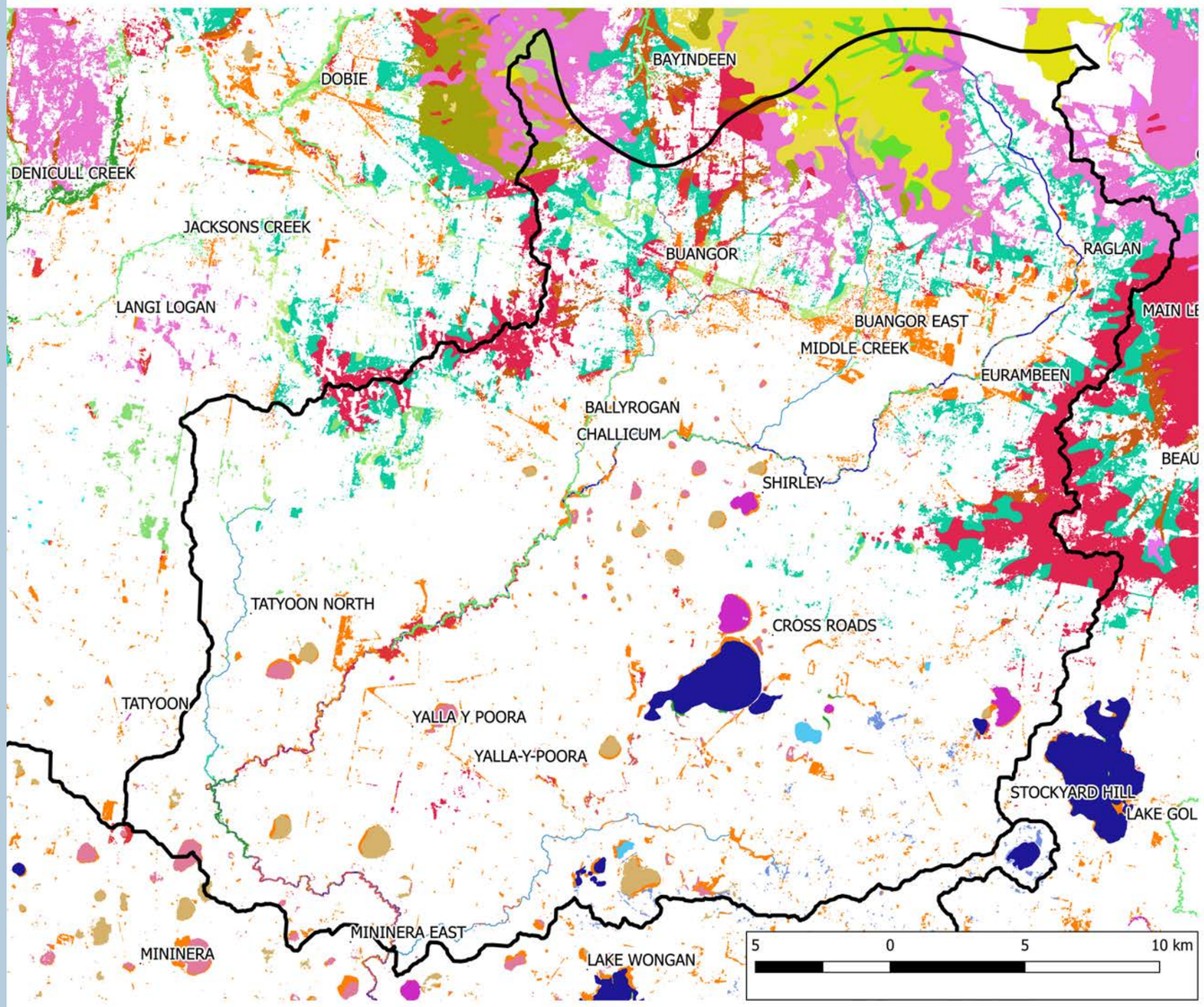


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2005 Modelled Native Vegetation EVC H12

Catchment Boundary

NV2005_EVCBCS

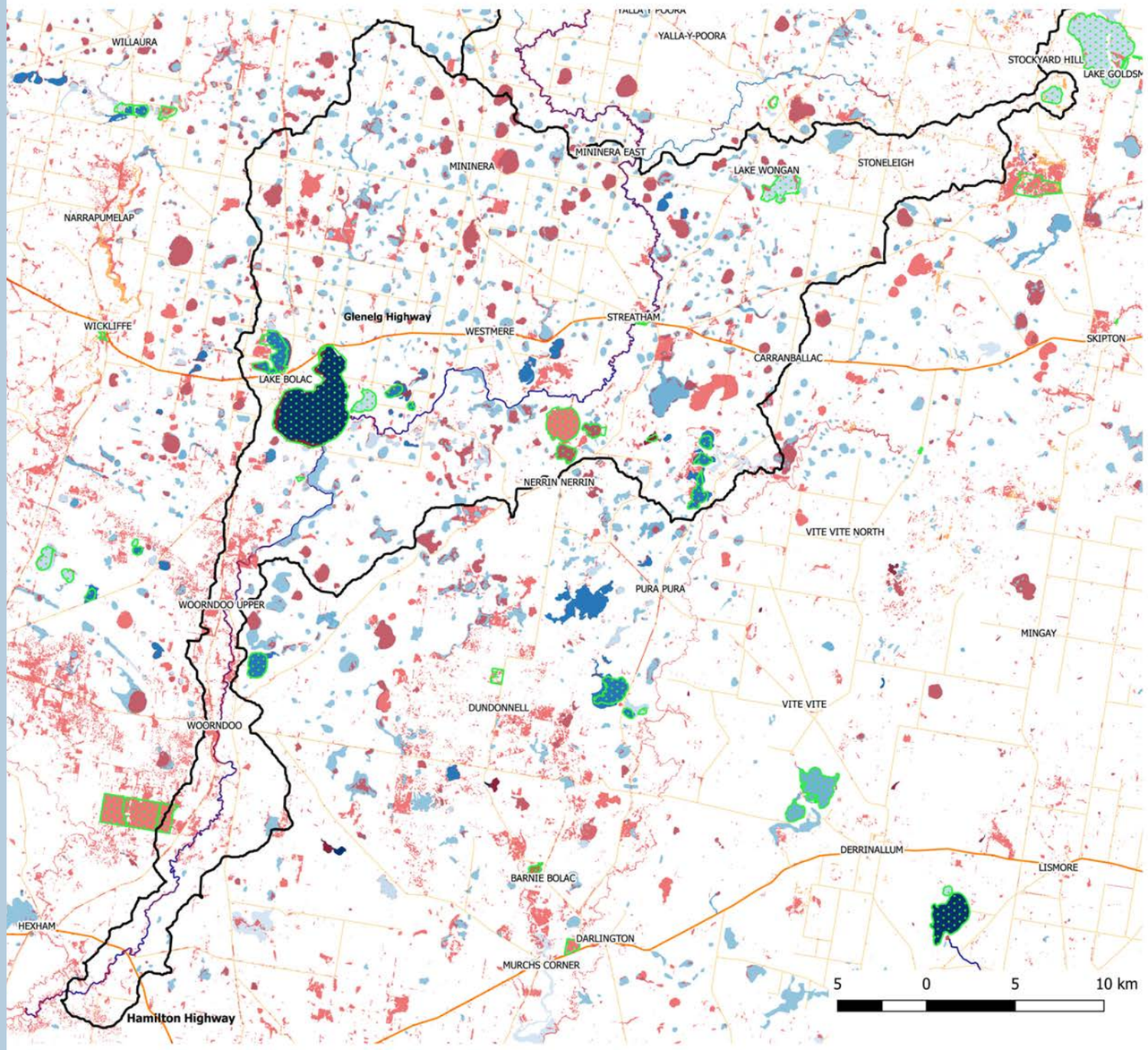
- Alluvial Terraces Herb-rich Woodland
- Alluvial Terraces Herb-rich Woodland/Plains Grassy Woodland Complex
- Aquatic Herbland/Plains Sedgy Wetland Mosaic
- Brackish Drainage-line Aggregate
- Creekline Grassy Woodland
- Damp Sands Herb-rich Woodland
- Floodplain Riparian Woodland
- Granitic Hills Woodland
- Grassy Dry Forest
- Grassy Woodland
- Grassy Woodland/Heathy Dry Forest Complex
- Heathy Dry Forest
- Heathy Woodland
- Herb-rich Foothill Forest
- Hills Herb-rich Woodland
- Plains Grassland
- Plains Grassland/Plains Grassy Woodland Mosaic
- Plains Grassy Wetland
- Plains Grassy Woodland
- Plains Sedgy Wetland
- Plains Sedgy Woodland
- Riparian Forest
- Riparian Woodland
- Rocky Outcrop Shrubland/Rocky Outcrop Herbland Mosaic
- Rocky Outcrop Shrubland/Rocky Outcrop Herbland/Grassy Dry Forest Complex
- Seasonally Inundated Shrubby Woodland
- Sedgy Riparian Woodland
- Stony Rises Woodland
- Valley Grassy Forest
- Water Body - Fresh
- Water body - salt
- Wet Forest
- Wetland Formation

Watercourse

- BILLY BILLY CREEK
- CAVE HILL CREEK
- CHALLICUM CREEK
- CHARLEYCOMBE CREEK
- DAIRY MAID CREEK
- DITCHFIELD CREEK
- FIERY CREEK
- MIDDLE CREEK
- SANDY CREEK
- WONGAN CREEK

This map shows the Bioregional Conservation status of the EVC's which currently exist across the catchment. The combination of EVC and bioregion is used to determine the bioregional conservation status (BCS) of an EVC. This is a measure of the current extent and quality for each EVC, when compared to it's original (pre-1750) extent and condition. Each EVC is categorised as either being endangered, vulnerable or depleted.

This map is derived from a combination of the Victorian bioregions, pre-1750 EVCs, native vegetation extent and the vegetation quality datasets from the Victorian Government. Throughout the H11 sub-catchment, all the EVC's present have been classed as endangered or vulnerable, in the far north of H12 sub catchment there are some large areas of depleted EVC's.

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2005 EVC Bioregional Conservation Significance H11

- Beyond Bolac Catchment Action Group Area
- Parks or Reserves

NV2005_EVCBCS

- Endangered
- Vulnerable

Wetland

- Permanent freshwater lake
- Permanent freshwater mar
- Permanent freshwater swamp
- Permanent saline lake
- Permanent saline marsh
- Permanent saline swamp
- Temporary freshwater lake
- Temporary freshwater mar
- Temporary freshwater swamp
- Temporary saline lake
- Temporary saline marsh
- Temporary saline swamp

Watercourse

- CHALLICUM CREEK
- FIERY CREEK
- SALT CREEK
- WONGAN CREEK

Road

- HIGHWAY
- ROAD

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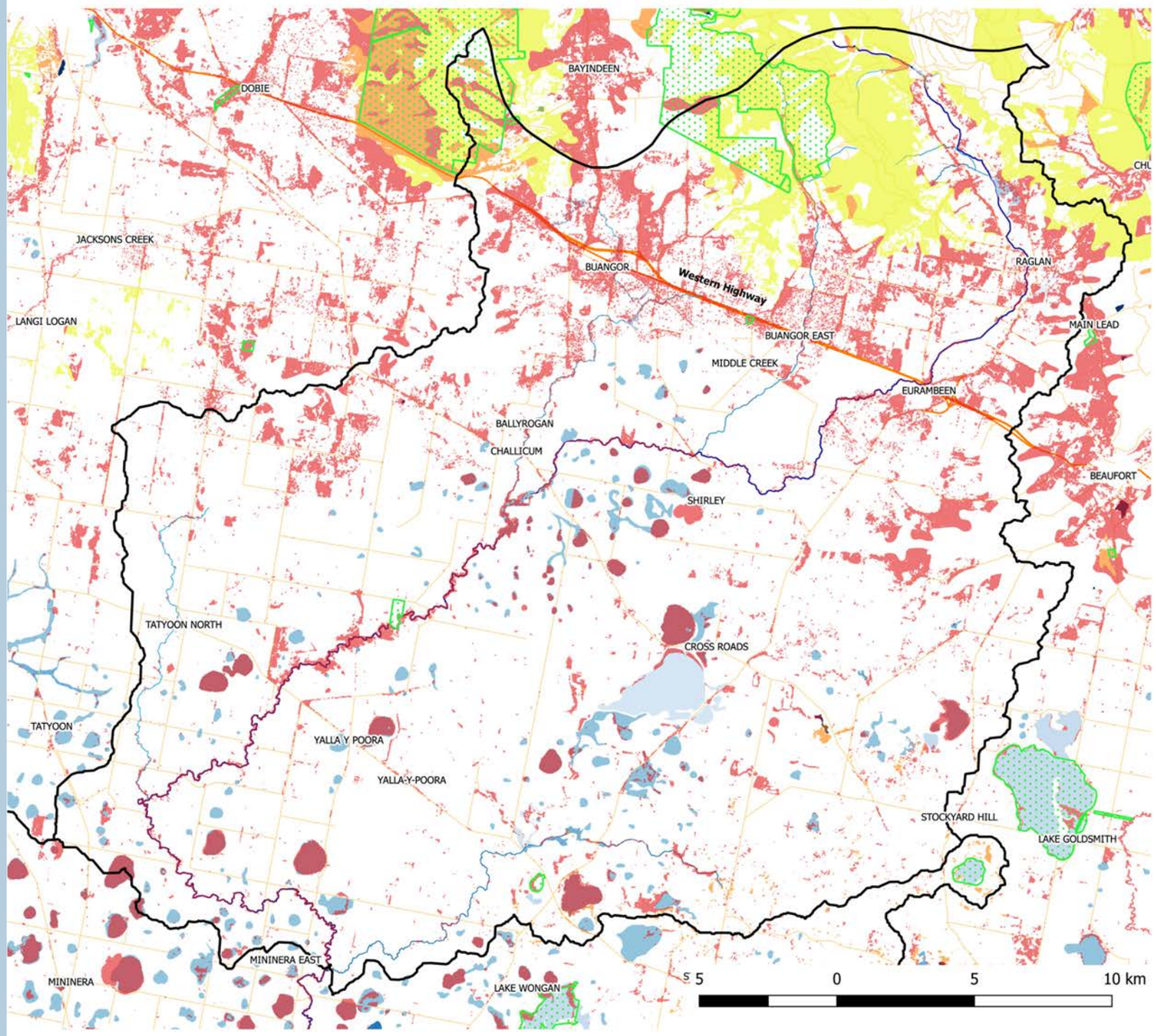




2005 EVC Bioregional Conservation Sigficance H12

- Beyond Bolac Catchment Action Group Area
- Parks or Reserves

NV2005_EVCBCS

- Endangered
- Vulnerable
- Depleted

Wetland

- Permanent freshwater lake
- Permanent freshwater swamp
- Permanent saline lake
- Temporary freshwater lake
- Temporary freshwater mar
- Temporary freshwater swamp
- Temporary saline lake
- Temporary saline marsh
- Temporary saline swamp

Watercourse

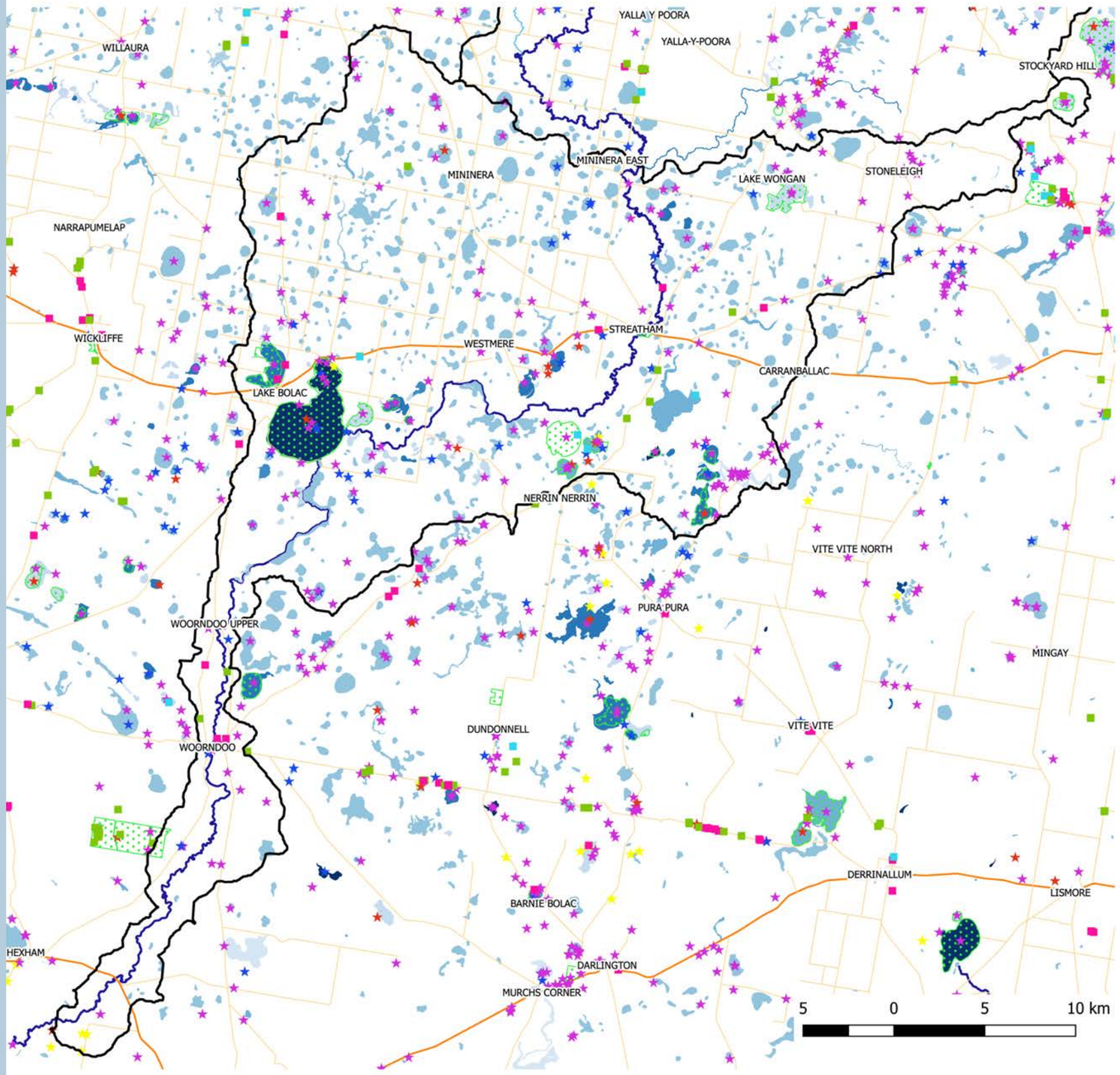
- BILLY BILLY CREEK
- CAVE HILL CREEK
- CHALLICUM CREEK
- CHARLEYCOMBE CREEK
- DAIRY MAID CREEK
- DITCHFIELD CREEK
- FIERY CREEK
- MIDDLE CREEK
- SANDY CREEK
- WONGAN CREEK

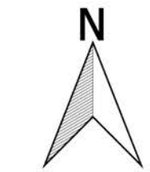
Road

- HIGHWAY
- ROAD

This map contains a snapshot in time of flora and fauna taxa records from the Victorian Biodiversity Atlas (VBA). The VBA for flora incorporates data from the Flora Information System and Victorian Rare or Threatened Population database. These include records from Victorian Government Departmental surveys, botanists, herbarium, field naturalists, consultants, universities, and the general public. The VBA for fauna incorporates the Atlas of Victorian Wildlife, Aquatic Fauna Database, Subtidal Reef Monitoring Program and Intertidal Reef Monitoring Program data and include records from Victorian Government Departmental surveys, Museum of Victoria specimens, Birds Australia atlas, environmental consultants and field naturalists groups.

This map shows the number of threatened flora and fauna records across the catchment, and also what their status is. There are only a few fauna species present with H11 that are listed as critically endangered, the majority of fauna species within the sub-catchment have been listed as vulnerable. While the flora records show many species are listed as endangered or vulnerable, with a few rare species being present throughout.

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Threatened Flora & Fauna H11

- Beyond Bolac CAG Area

Threatened Flora
- Endangered
- Rare
- Vulnerable

Threatened Fauna
- Critically endangered
- Endangered
- Extinct in the Wild
- Vulnerable
- Near threatened
- Park or Reserve

Road
- HIGHWAY
- ROAD

Wetland
- Permanent freshwater lake
- Permanent freshwater mar
- Permanent freshwater swamp
- Permanent saline lake
- Permanent saline marsh
- Permanent saline swamp
- Temporary freshwater lake
- Temporary freshwater mar
- Temporary freshwater swamp
- Temporary saline lake
- Temporary saline marsh
- Temporary saline swamp

Watercourse
- CHALLICUM CREEK
- FIERY CREEK
- SALT CREEK
- WONGAN CREEK

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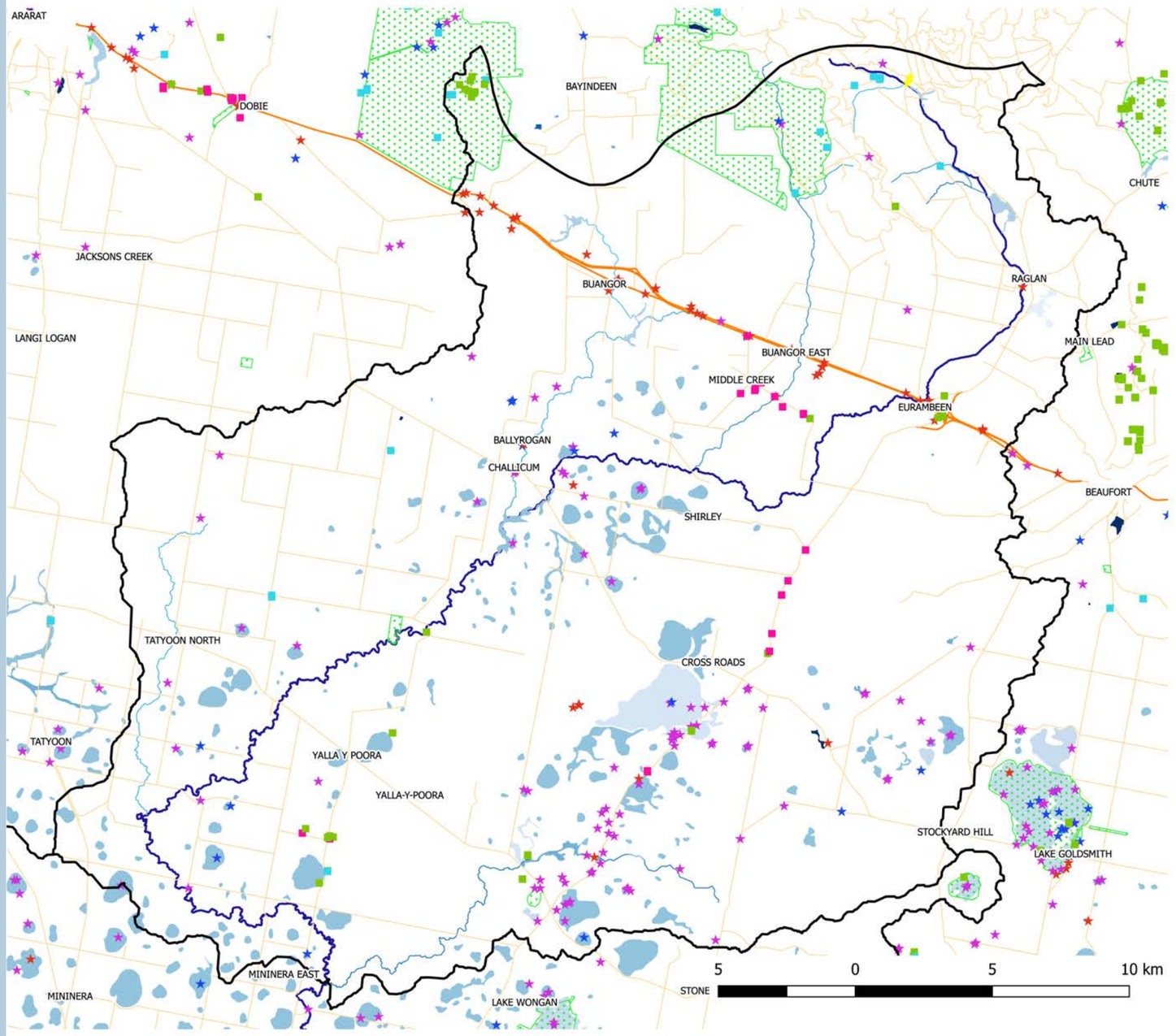


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Threatened Flora & Fauna H12

- Beyond Bolac CAG Area

Threatened Flora
- Endangered
- Rare
- Vulnerable

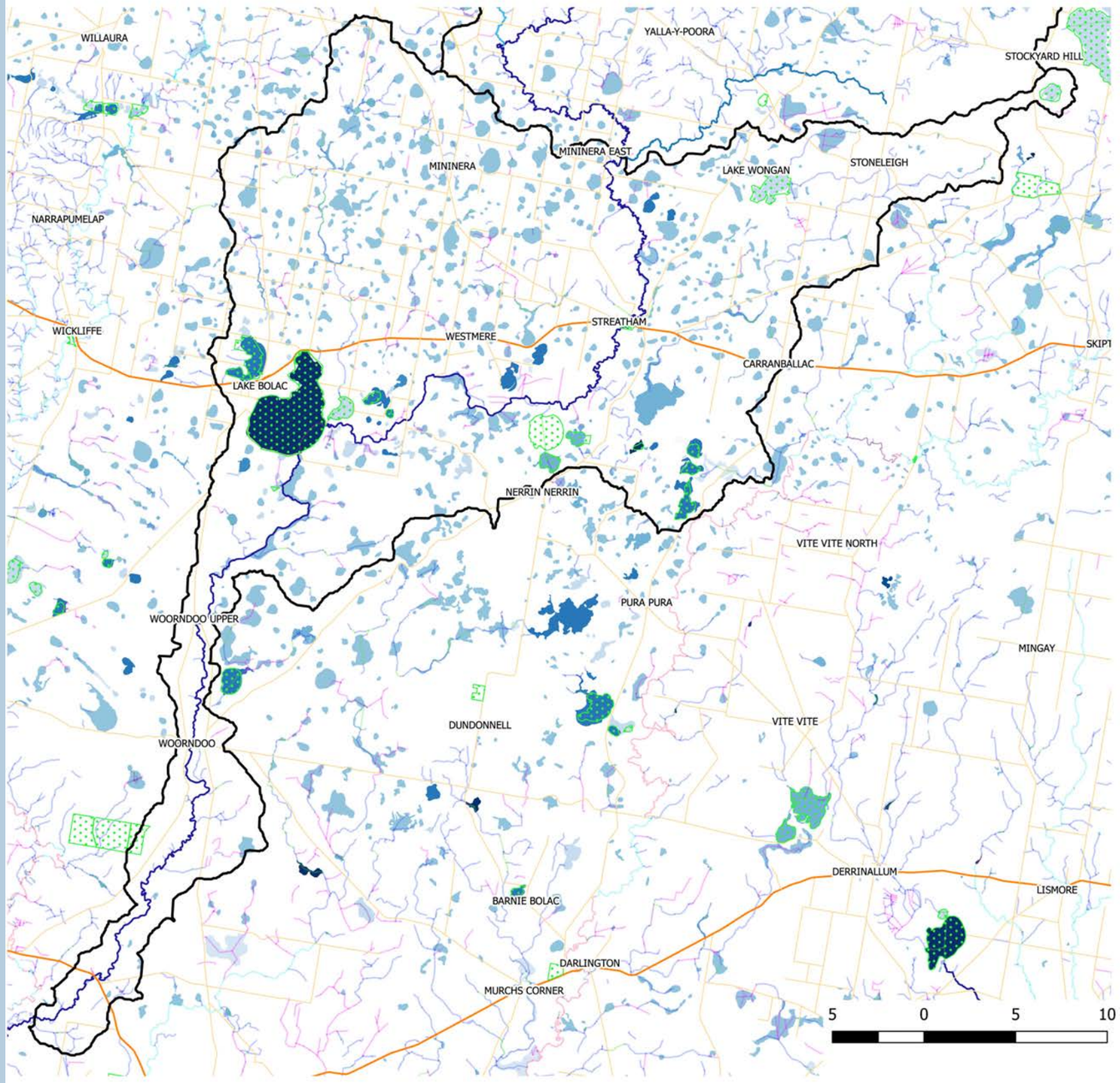
Threatened Fauna
- Critically endangered
- Endangered
- Vulnerable
- Near threatened
- Park or Reserve

Road
- HIGHWAY
- ROAD

Wetland
- Permanent freshwater lake
- Permanent freshwater swamp
- Permanent saline lake
- Temporary freshwater lake
- Temporary freshwater mar
- Temporary freshwater swamp
- Temporary saline lake
- Temporary saline marsh
- Temporary saline swamp

Watercourse
- BILLY BILLY CREEK
- CAVE HILL CREEK
- CHALLICUM CREEK
- CHARLEYCOMBE CREEK
- DAIRY MAID CREEK
- DITCHFIELD CREEK
- FIERY CREEK
- MIDDLE CREEK
- SANDY CREEK
- WONGAN CREEK

This map shows the natural and man-made hydrographic features across catchment, as well as the wetland types. The hydrological features have been categorised into Watercourses, such as channels, rivers and streams and connectors, such as drains. The wetlands layer shows the extent and type pf wetlands present. The wetlands are classified into primary categories based on wetland system type, salinity regime, water regime, water source, dominant vegetation and wetland origin. The H11 sub-catchment has a large number of wetlands present, many of which are ephemeral.

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Hydrology H11

- Beyond Bolac CAG Area
- Park or Reserve

Road
- HIGHWAY
- ROAD

Watercourse Name
- CHALLICUM CREEK
- FIERY CREEK
- SALT CREEK
- WONGAN CREEK

Watercourse Type
- watercourse_river
- watercourse_stream
- connector_river
- connector_stream
- connector_channel_drain
- watercourse_channel_drain

Wetland
- Permanent freshwater lake
- Permanent freshwater mar
- Permanent freshwater swamp
- Permanent saline lake
- Permanent saline marsh
- Permanent saline swamp
- Temporary freshwater lake
- Temporary freshwater mar
- Temporary freshwater swamp
- Temporary saline lake
- Temporary saline marsh
- Temporary saline swamp

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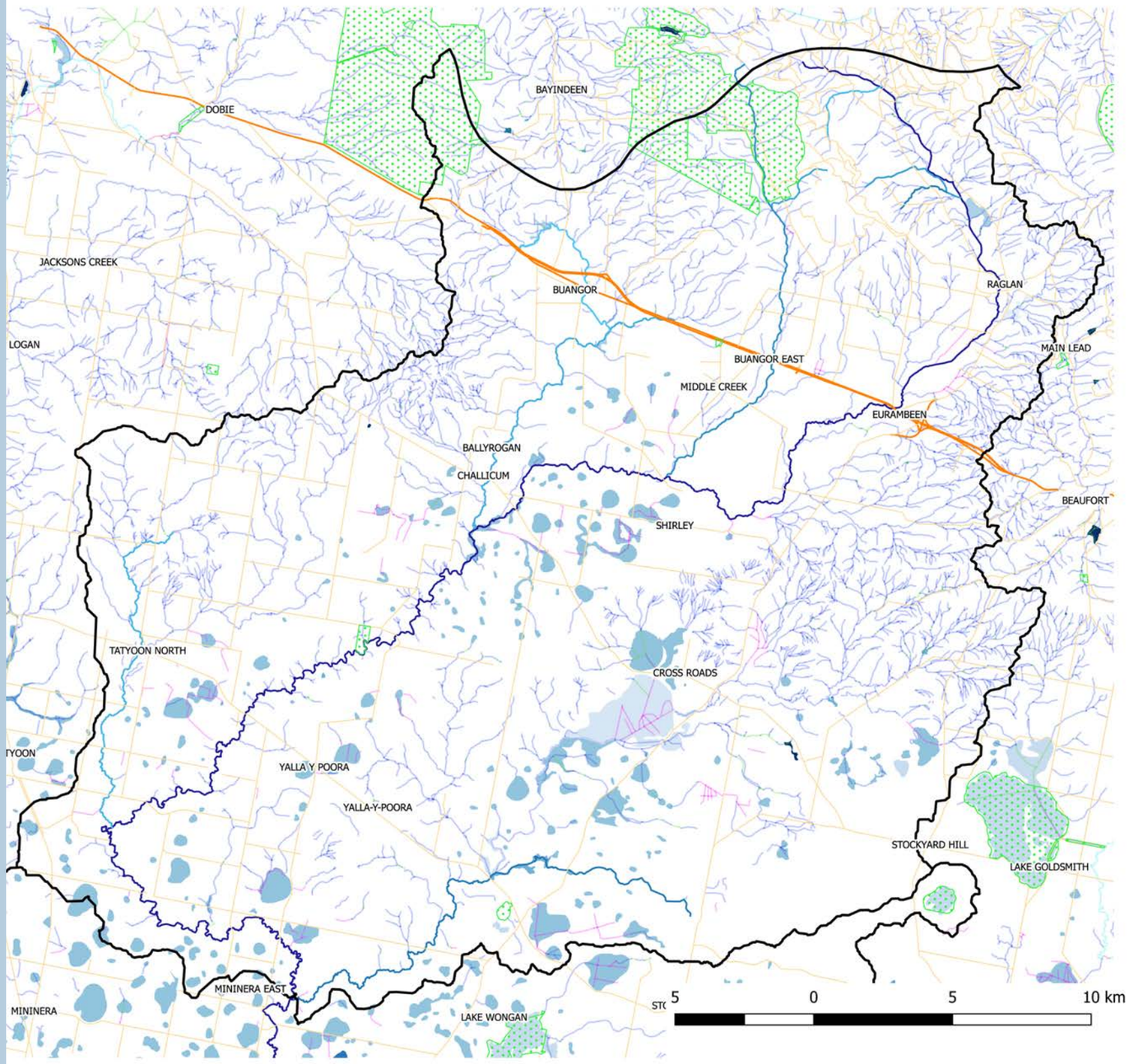
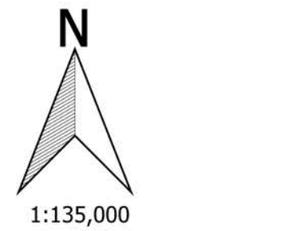



Hydrology H12

- Beyond Bolac CAG Area
- Park or Reserve

Road

- HIGHWAY
- ROAD

Watercourse Name

- BILLY BILLY CREEK
- CAVE HILL CREEK
- CHALLICUM CREEK
- CHARLEYCOMBE CREEK
- DAIRY MAID CREEK
- DITCHFIELD CREEK
- FIERY CREEK
- MIDDLE CREEK
- SANDY CREEK
- WONGAN CREEK

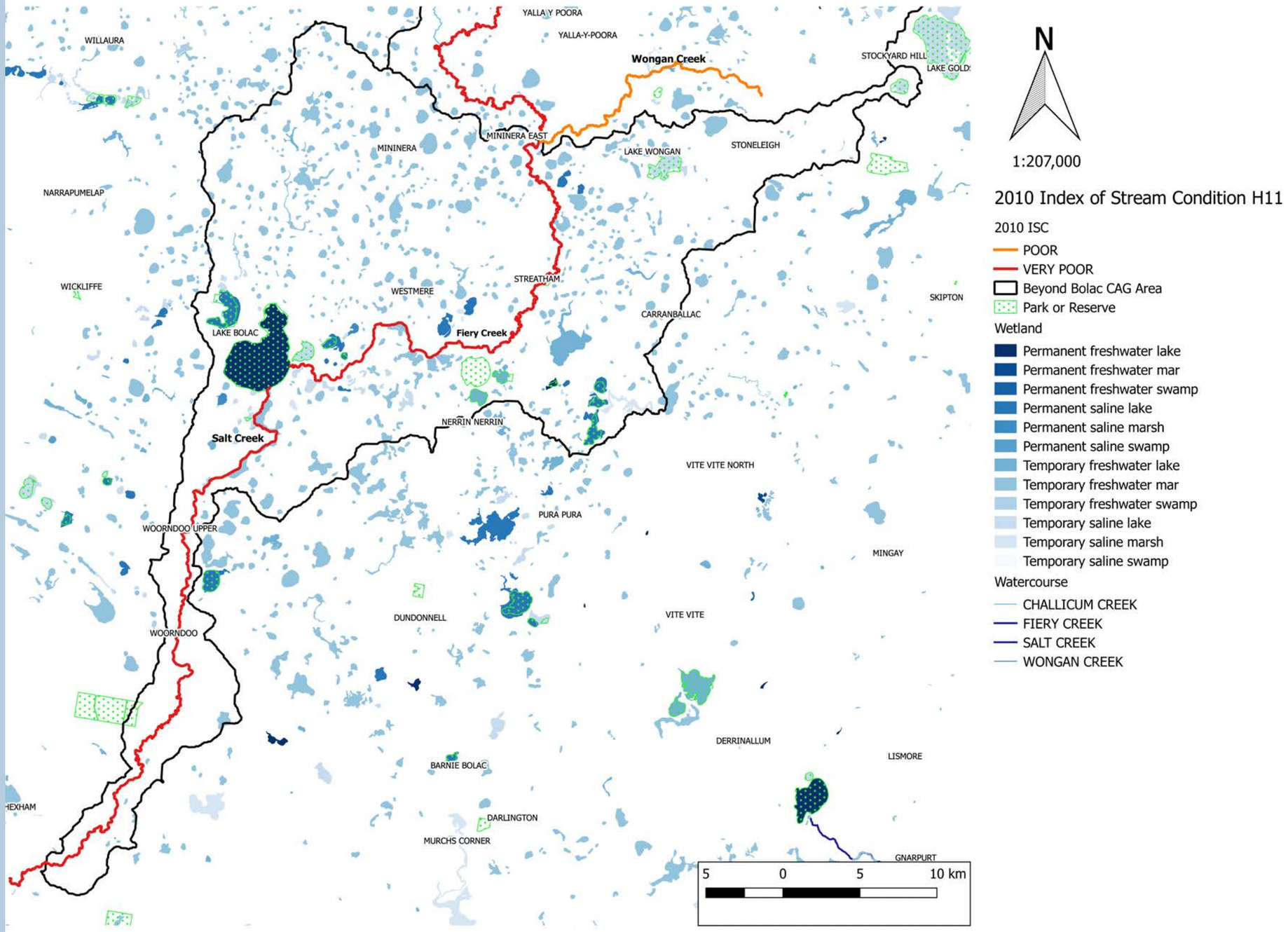
Watercourse Type

- watercourse_river
- watercourse_stream
- connector_river
- connector_stream
- watercourse_drain
- connector_channel_drain
- watercourse_channel_drain

Wetland

- Permanent freshwater lake
- Permanent freshwater swamp
- Permanent saline lake
- Temporary freshwater lake
- Temporary freshwater mar
- Temporary freshwater swamp
- Temporary saline lake
- Temporary saline marsh
- Temporary saline swamp

This map is a depiction of the 2010 Index of Stream Condition assessment which was undertaken across Victoria by the Department of Environment and Primary Industries. The map shows which rivers within the sub-catchment were included in the assessment, and what environmental condition they were assessed to be in. Based on this assessment, the Salt Creek and Fiery Creek have been assessed as Very Poor within the H11 sub-catchment, while in the H12 sub-catchment, Wongan Creek and the upper reaches of the Fiery Creek fared better being assessed as Poor.



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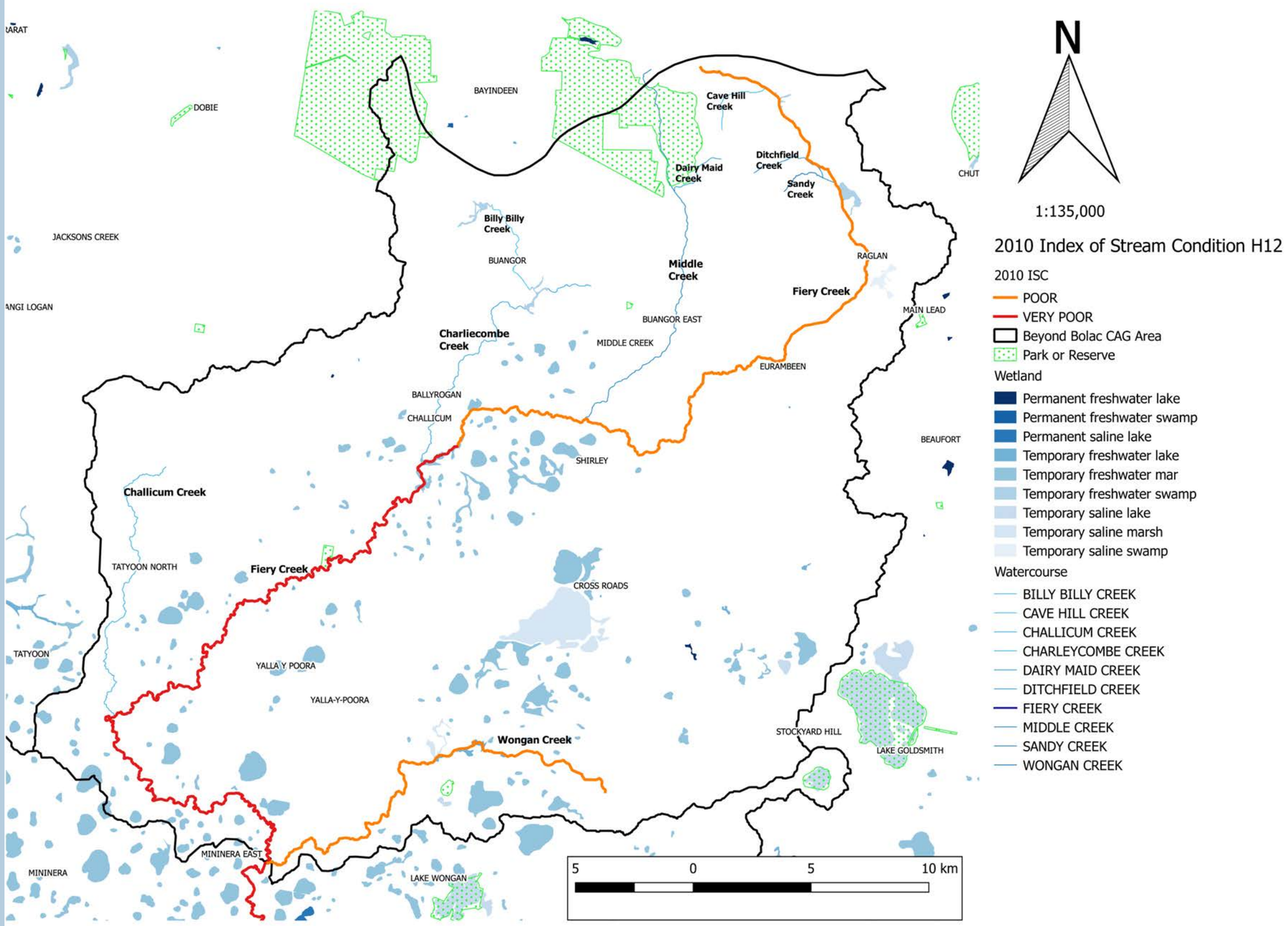
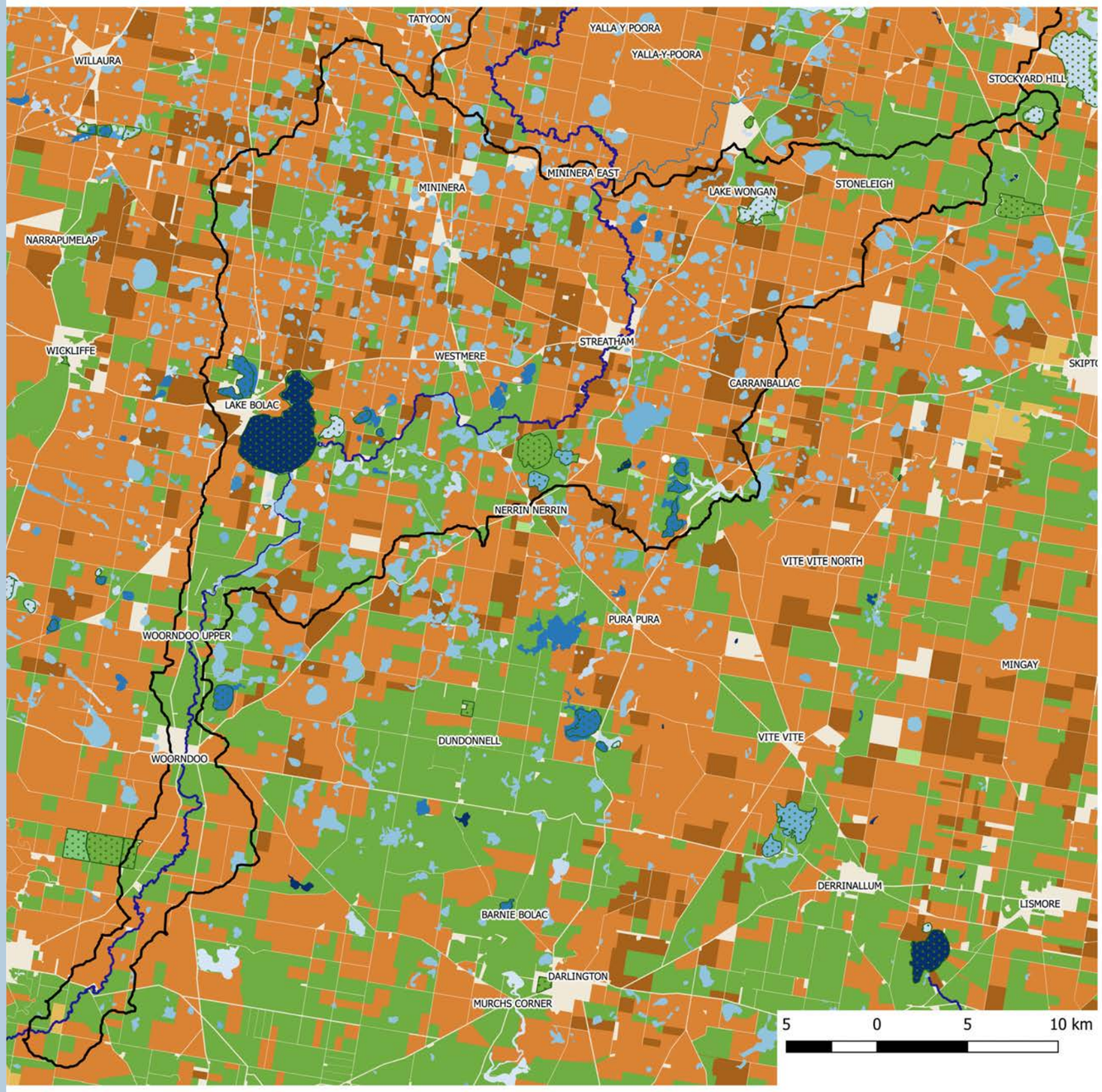


This map shows the various land cover classifications in 2014 derived from time series analysis of satellite imagery from NASA. Ground data is also collected annually across Victoria using a random sampling approach for validation of the classifications. This maps shows that brassicas, cereals and pasture and grassland are the dominate land cover classifications across the H11 sub-catchment, with cereals being more dominate in the H12 sub-catchment.



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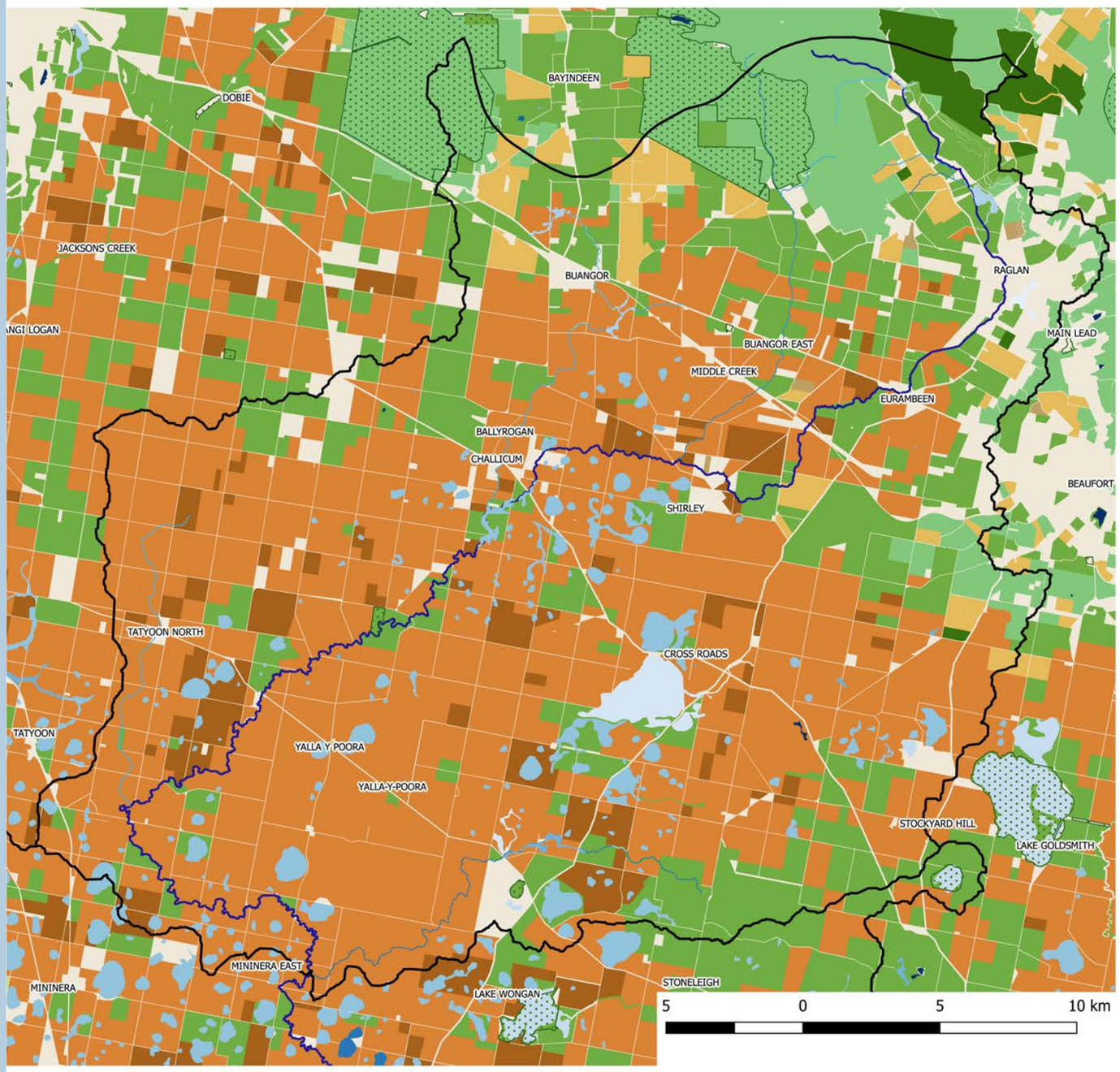
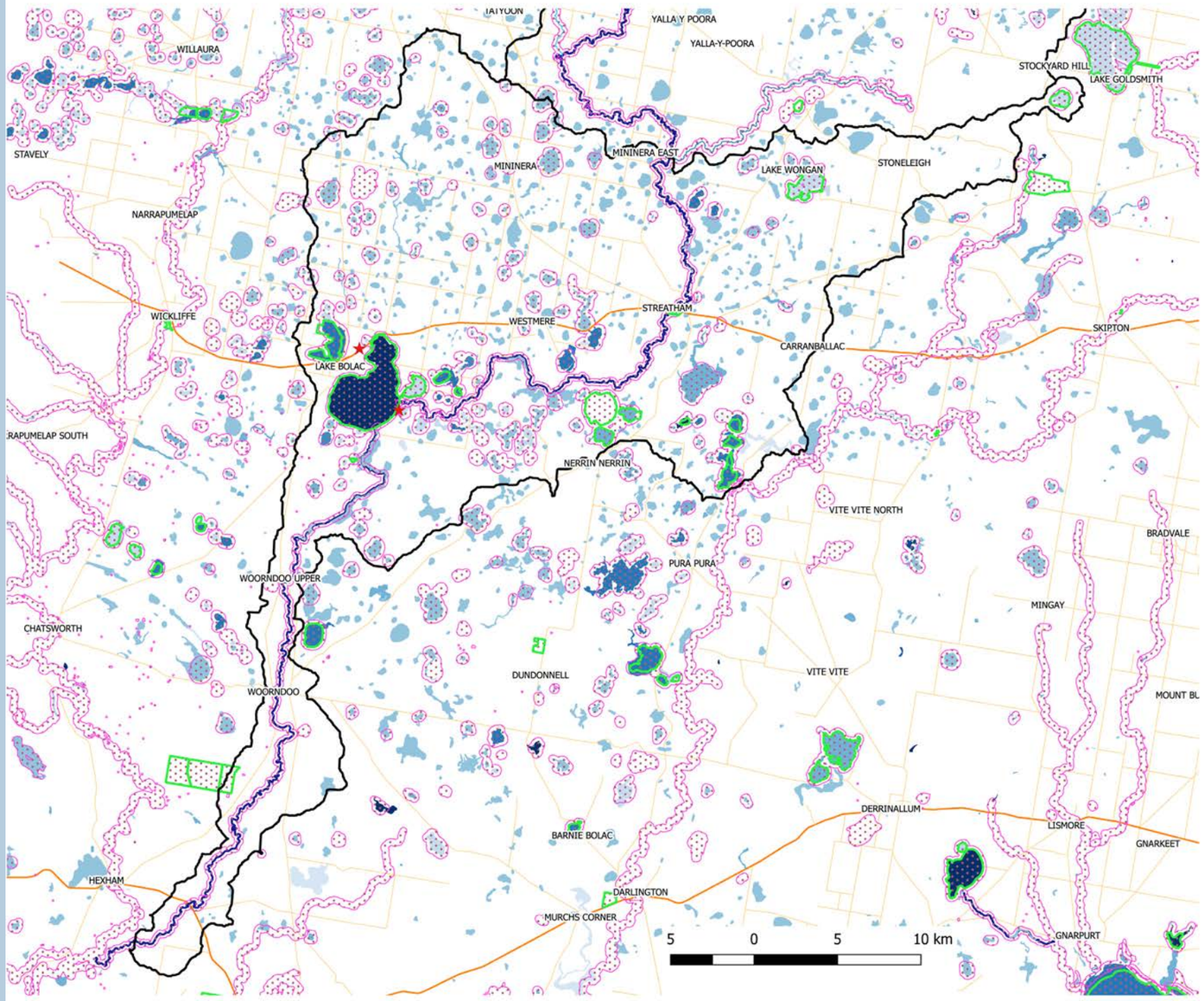


This map shows areas of cultural heritage sensitivity. These areas are either known to contain, or are likely to contain Aboriginal cultural heritage places and objects and are defined in the Aboriginal Heritage Regulations 2007. Cultural Heritage Sensitivity mainly occurs along waterways and around wetlands, as these areas are where it is most likely to find evidence of aboriginal existence. This map also shows two known aboriginal archaeological sites near Lake Bolac where stone arrangements, animal bones, stone tools and charcoal have been found. The cultural heritage sensitivity maps for Victoria are also publically available online.

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Cultural Heritage H11

- Beyond Bolac Catchment Action Group Area
- Approximate location Cultural Archaeological Site
- Park or Reserve
- Cultural Heritage Sensitivity

Wetland

- Permanent freshwater lake
- Permanent freshwater mar
- Permanent freshwater swamp
- Permanent saline lake
- Permanent saline marsh
- Permanent saline swamp
- Temporary freshwater lake
- Temporary freshwater mar
- Temporary freshwater swamp
- Temporary saline lake
- Temporary saline marsh
- Temporary saline swamp

Watercourse

- CHALLICUM CREEK
- FIERY CREEK
- SALT CREEK
- WONGAN CREEK

Road

- HIGHWAY
- ROAD

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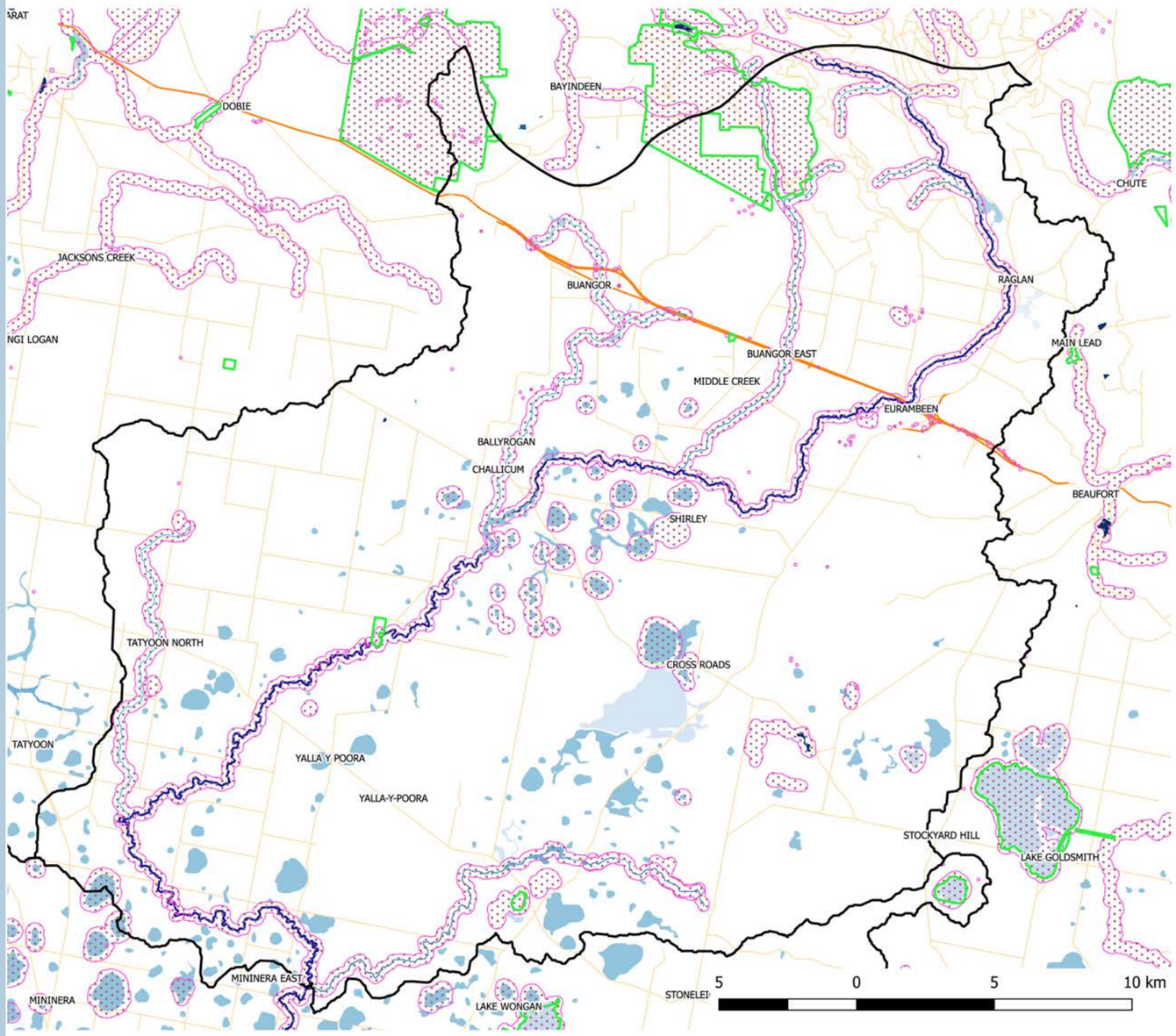


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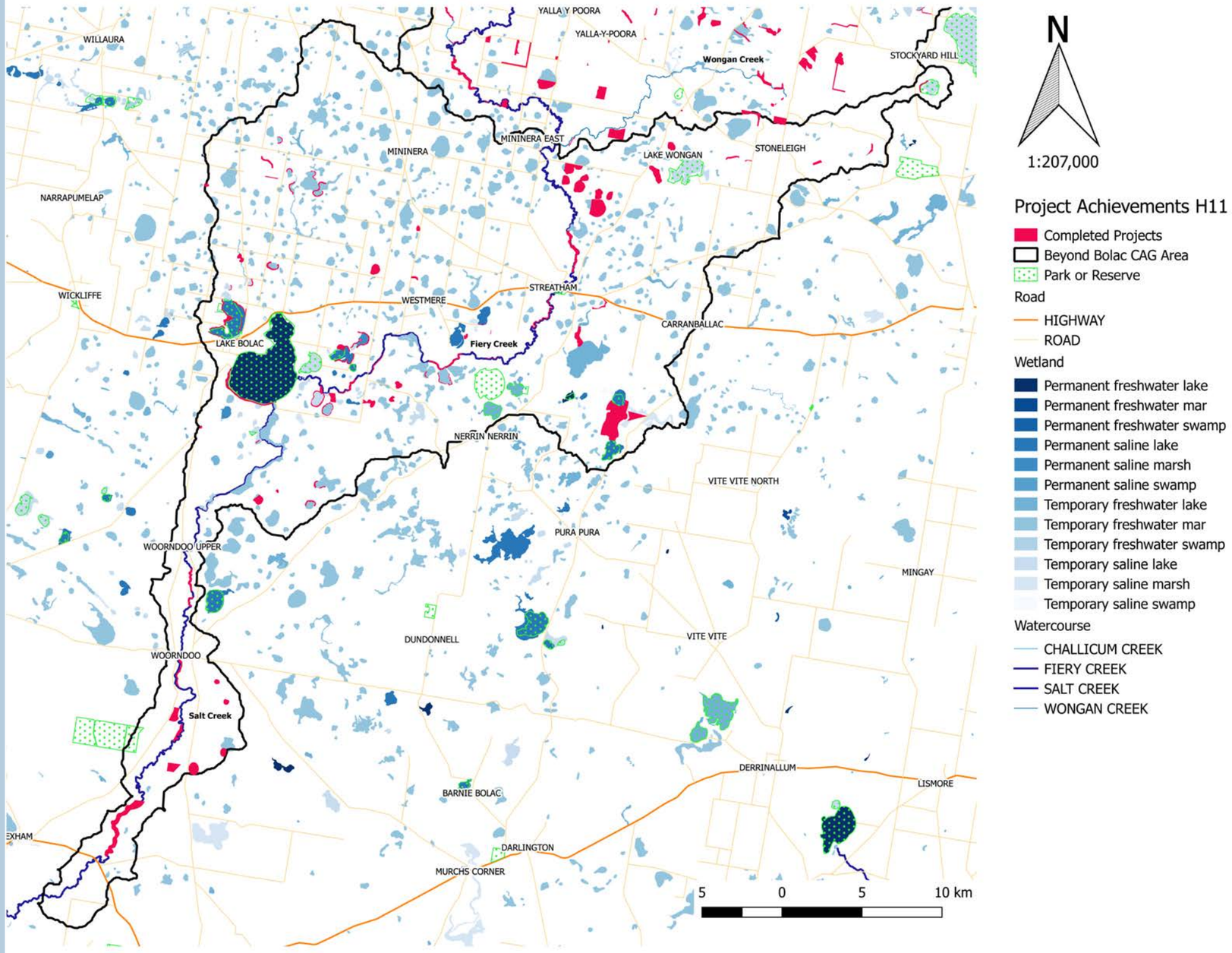
Cultural Heritage
- Beyond Bolac Catchment Action Group Area
- Park or Reserve
- Cultural Heritage Sensitivity

Wetland
- Permanent freshwater lake
- Permanent freshwater swamp
- Permanent saline lake
- Temporary freshwater lake
- Temporary freshwater mar
- Temporary freshwater swamp
- Temporary saline lake
- Temporary saline marsh
- Temporary saline swamp

Watercourse
- BILLY BILLY CREEK
- CAVE HILL CREEK
- CHALLICUM CREEK
- CHARLEYCOMBE CREEK
- DAIRY MAID CREEK
- DITCHFIELD CREEK
- FIERY CREEK
- MIDDLE CREEK
- SANDY CREEK
- WONGAN CREEK

Road
- HIGHWAY
- ROAD

This map shows all funded projects which have been completed within the catchment. The majority of these projects have been implemented by Beyond Bolac CAG; however, some have been implemented by Glenelg Hopkins CMA. Knowing where projects have been undertaken will assist Beyond Bolac CAG plan future projects across the catchment.

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Project Achievements H11

- Completed Projects
- Beyond Bolac CAG Area
- Park or Reserve

Road

- HIGHWAY
- ROAD

Wetland

- Permanent freshwater lake
- Permanent freshwater mar
- Permanent freshwater swamp
- Permanent saline lake
- Permanent saline marsh
- Permanent saline swamp
- Temporary freshwater lake
- Temporary freshwater mar
- Temporary freshwater swamp
- Temporary saline lake
- Temporary saline marsh
- Temporary saline swamp

Watercourse

- CHALLICUM CREEK
- FIERY CREEK
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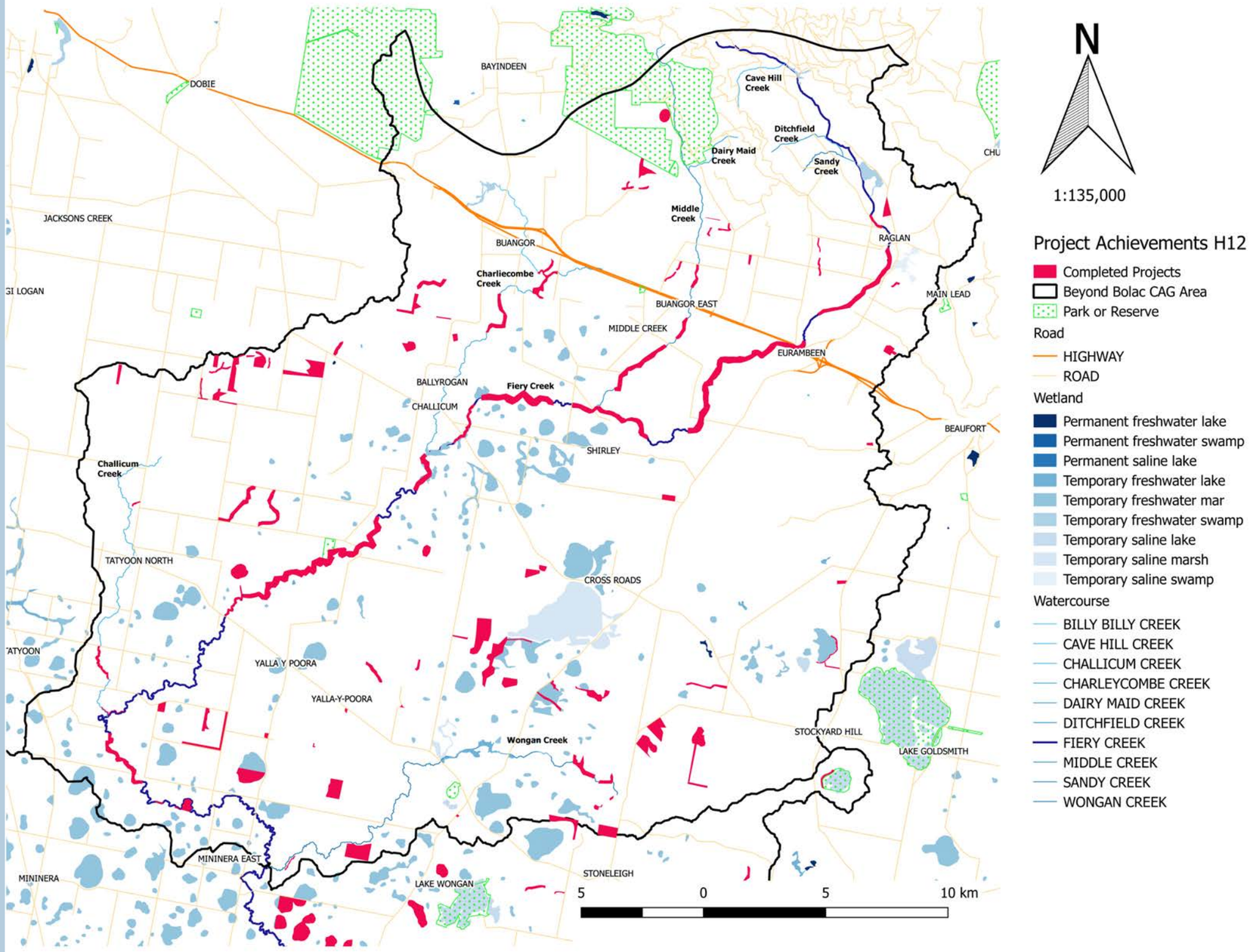


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Project Achievements H12

- Completed Projects
- Beyond Bolac CAG Area
- Park or Reserve

Road

- HIGHWAY
- ROAD

Wetland

- Permanent freshwater lake
- Permanent freshwater swamp
- Permanent saline lake
- Temporary freshwater lake
- Temporary freshwater mar
- Temporary freshwater swamp
- Temporary saline lake
- Temporary saline marsh
- Temporary saline swamp

Watercourse

- BILLY BILLY CREEK
- CAVE HILL CREEK
- CHALLICUM CREEK
- CHARLEYCOMBE CREEK
- DAIRY MAID CREEK
- DITCHFIELD CREEK
- FIERY CREEK
- MIDDLE CREEK
- SANDY CREEK
- WONGAN CREEK

# FutureChallenges

*Healthy native grasslands in western Victoria*

Beyond Bolac CAG recognises that there are a number of factors that will influence the natural environment in the H11 H12 sub-catchment. Changes in land use, weather patterns, and an increased demand for natural resources will help shape the local environment, community and economy, presenting challenges and opportunities for the sub-catchment's future management.

Within the catchment, there has been a shift away from grazing sheep and cattle to more intensive agriculture, broad acre cropping and horticulture. This shift, in land use, will impact on the natural assets within the catchment, such as waterways and wetlands, however, it will also provide greater diversity in agricultural business which could provide a boost to the local economy and provide opportunities for Beyond Bolac CAG to form partnerships and seek support for unique projects. Beyond Bolac CAG will need to stay abreast of the various land uses within the catchment and continue to support and work with all stakeholders to ensure the health of the catchment isn't compromised.

Climate variability, across the catchment, will also pose challenges to land managers; climate projections for the Glenelg Hopkins Regions suggest that the weather will be hotter and drier in the coming years which will impact on land use, natural resources, the community and the biodiversity of the H11 H12 sub catchment. Despite the overall trend of a hotter and drier climate being clear there are uncertainties in climate change projections and their application at a regional level. These uncertainties are compounded when identifying impacts at local scales because of complexities in ecological interactions and interdependencies (GHCMA, 2015). Beyond Bolac CAG will need to understand how the variability in the climate will impact on terrestrial and aquatic habitats across the catchment and seek to undertake projects to assist the catchment and land managers adapt to the changing climate.

Community involvement will remain an ongoing challenge for the Beyond Bolac CAG. To ensure the ongoing success of the group, the committee will need to look at ways of attracting new members to the committee, as well as maintaining the interest of existing Landcare members and enticing other farmers to become Landcare members to participate in future programs and projects. A survey, undertaken by the ABS, called the General Social Survey suggest that there has been a decline in Australians volunteering. In 2014, people were less likely to be involved with an environment group than they were in 2010 (14% compared to 19%). While some forms of social participation measured in the GSS show a general decline, traditional forms of social and civic participation continue to play an important role in Australian society.

It is important to recognise societal shifts in the ways in which people meet and interact. Digital forms of communication and social networking have provided new opportunities for some people to connect with others, including those who are less mobile or geographically isolated. Some have suggested that younger people, in particular, prefer using social media to collect and disseminate information. This preference for online networking could be linked to Australian's in particular feeling time poor and being able to connect with others online during a time that suits the individual best is highly desirable (ABS, 2015).

*Australian farmers are intimately connected to the land and depend on healthy ecosystems to provide soil health, nutrient and waste recycling, pollination from insects, sediment control and clean water.*

Australian farmers are intimately connected to the land and depend on healthy ecosystems to provide soil health, nutrient and waste recycling, pollination from insects, sediment control and clean water.

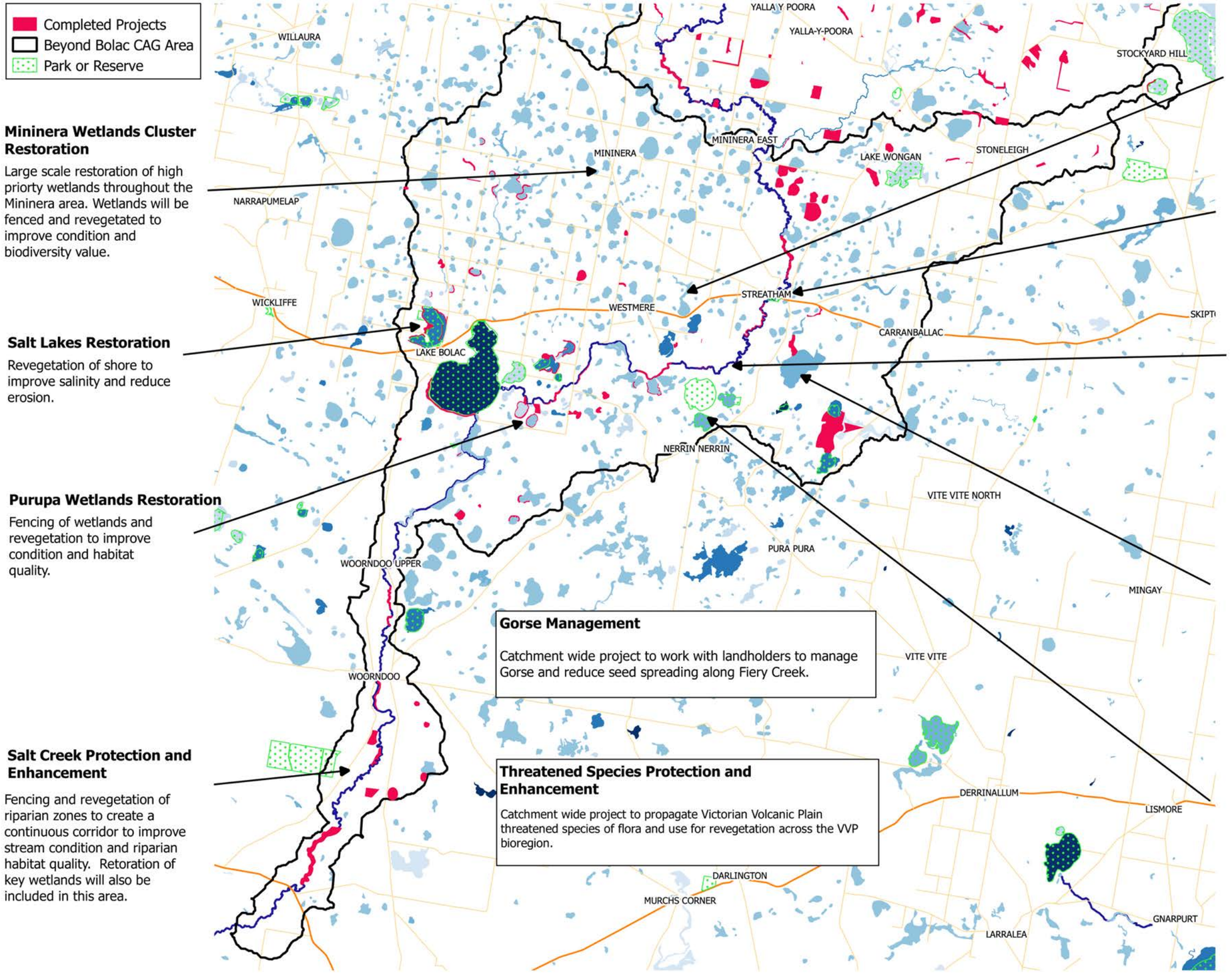
To secure an environmentally sustainable and profitable future, farmers need to continue to employ a range of strategies (ABS, 2015). A national Landcare survey undertaken in 2013 identified that 73% of farmers were part of an agricultural related group, and of these the largest grouping was the local Landcare and Farming Systems groups at 32% with CMA/NRM groups being one of the smallest at 8%.

Nearly one third of farmers who were part of local Landcare and Farming Systems groups, cited information that is tailored to local conditions and issues (29%); hands on field days that are locally relevant (22%); Social networking (12%) and opportunity to see what other farmers are doing (11%) as their main reasons for being part of these groups (Hayr, 2013). Australian farmers feel that Landcare is still relevant to the future, but also feel that Landcare needs to continue to innovate and evolve (Hayr, 2012). How Beyond Bolac CAG is structured and managed into the future will be essential to gaining continued support and involvement from the community.

# Future Project Ideas



A list of potential projects has been developed by Beyond Bolac CAG to assist the group meet its vision over the next 10 years. The below maps indicate visually where these projects will take place within the catchment, and provides a brief summary of what the project aims to achieve. It's important to note that these projects are provided for discussion purposes only and detailed local planning and on-ground works for such projects will require consultation with all relevant land managers and stakeholders. These project ideas are not set in stone and will most likely change as the projects evolve over the coming years.




**Mininera Wetlands Cluster Restoration**

Large scale restoration of high priorty wetlands throughout the Mininera area. Wetlands will be fenced and revegetated to improve condition and biodiversity value.

**Salt Lakes Restoration**

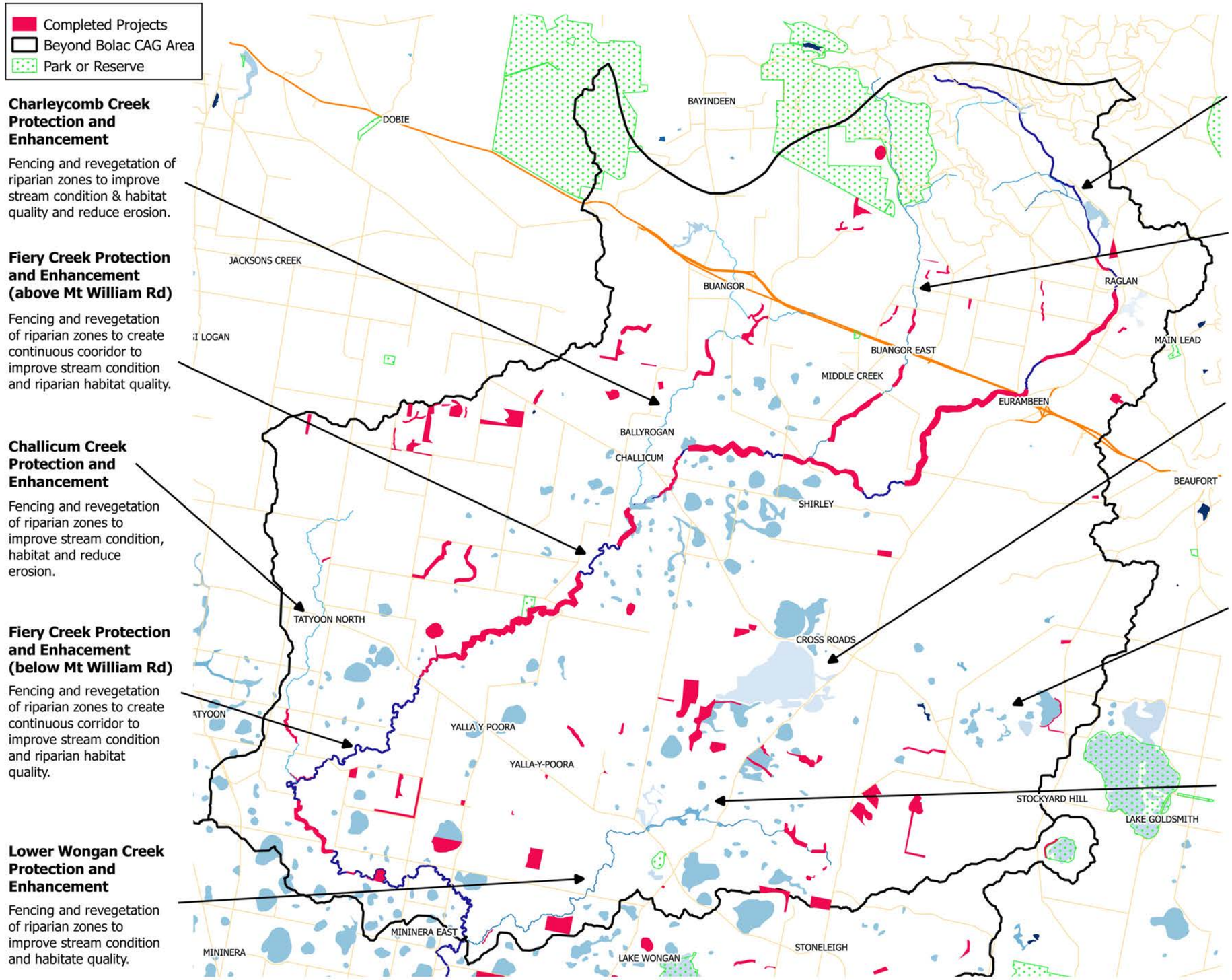
Revegetation of shore to improve salinity and reduce erosion.

**Purupa Wetlands Restoration**

Fencing of wetlands and revegetation to improve condition and habitat quality.

**Salt Creek Protection and Enhancement**

Fencing and revegetation of riparian zones to create a continuous corridor to improve stream condition and riparian habitat quality. Retoration of key wetlands will also be included in this area.




**Charleycomb Creek Protection and Enhancement**

Fencing and revegetation of riparian zones to improve stream condition & habitat quality and reduce erosion.

**Fiery Creek Protection and Enhancement (above Mt William Rd)**

Fencing and revegetation of riparian zones to create continuous cooridor to improve stream condition and riparian habitat quality.

**Challicum Creek Protection and Enhancement**

Fencing and revegetation of riparian zones to improve stream condition, habitat and reduce erosion.

**Fiery Creek Protection and Enhacement (below Mt William Rd)**

Fencing and revegetation of riparian zones to create continuous corridor to improve stream condition and riparian habitat quality.

**Lower Wongan Creek Protection and Enhancement**

Fencing and revegetation of riparian zones to improve stream condition and habitate quality.

**Upper Fiery Creek Protection and Enhancement**

Fencing and revegetation of riparian zones to create continuous corridor to improve stream condition and biodiversity value

**Middle Creek Protection and Enhancement**

Fencing and revegetation of riparian zones to improve stream condition, habitat quality and reduce erosion.

**Northen Crossroads (St Marnocks) Wetlands Cluster Restoration**

Fencing and revegation of wetlands to improve condition and habitat quality for the protection of threatened and endangered species.

**Mawallock Wetland Restoration and wildlife corridor**

Fencing and revegetation of wetlands to improve condition & habitat quality & linking remnant patches to improve habitat connectivity through landscape

**Wongan Creek (west sub-catchment) Protection and Enhancement**

Fencing and revegetation of riparian zones to improve stream condition, salinity & habitat quality and protect threatened species.

# MonitoringandEvaluation

Monitoring and evaluating the success of projects helps to improve current and future outputs, outcomes and impacts. Beyond Bolac CAG will evaluate projects undertaken to identify weaknesses and apply successful strengths to future projects. The group will also undertake a continuous assessment to monitor the implementation of projects to provide all stakeholders with early detailed information, such as whether the outputs are being met or that the schedules planned are being reached. This will enable the group to take action to correct the weaknesses as quickly as possible.

This Biodiversity Blueprint provides the baseline data for Beyond Bolac CAG to use to evaluate its performance over time. The Beyond Bolac Catchment Action Group Strategic Plan 2016–2021 provides targets for each strategy as well as a timeframe to achieve the target. The group will review the strategic plan annually, to see if its meeting the targets set, make any changes required to improve its project implementation and set its program for the following year.



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# Appendix1.

***Map Data Resources***

| Map # | Resource Name & Title | Data Custodian | Attribution | Abstract | Currency Date | Web URL |
|---|---|---|---|---|---|---|
| 2 | NV2005_EXTENT<br><br>Native Vegetation - Modelled Extent 2005 | Department of Environment, Land, Water & Planning- Biodiversity and Ecosystem Services (DEPI) | Copyright © The State of Victoria, Department of Environment, Land, Water & Planning 2016 | Modelled dataset of Native Vegetation and major water-based habitats, created by the Arthur Rylah Institute, and completed July 15th, 2007 | 24 August 2009 | https://www.data.vic.gov.au/data/dataset/native-vegetation-modelled-extent-2005 |
| 3 | NV1750_EVCBCS/EVC1750<br><br>Native Vegetation - Modelled 1750 Ecological Vegetation Classes (with Bioregional Conservation Status) | Department of Environment, Land, Water & Planning- Biodiversity and Ecosystem Services (DEPI) | Copyright © The State of Victoria, Department of Environment, Land, Water & Planning 2016 | This is a derived dataset that delineates the current Bioregional Conservation Status of EVCs within the modelled 1750 EVC dataset. | 20 March 2008 | https://www.data.vic.gov.au/data/dataset/native-vegetation-modelled-1750-ecological-vegetation-classes-with-bioregional-conservation-status |
| 4 & 5 | NV2005_EVCBCS<br><br>Native Vegetation - Modelled 2005 Ecological Vegetation Classes (with Bioregional Conservation Status) | Department of Environment, Land, Water & Planning- Biodiversity and Ecosystem Services (DEPI) | Copyright © The State of Victoria, Department of Environment, Land, Water & Planning 2016 | This is a derived dataset that delineates the Bioregional Conservation Status of EVCs. The dataset is derived from a combination of Victorian bioregions (VBIOREG100), Pre 1750 EVCs (NV1750_EVC) and the current version of Native Vegetation Extent (NV2005_EXTENT). Bioregional conservation status and geographic occurrence are applied to unique Bioregion-EVC units. | 20 March 2008 | https://www.data.vic.gov.au/data/dataset/native-vegetation-modelled-2005-ecological-vegetation-classes-with-bioregional-conservation-status |
| 6 | VBA_FAUNA25<br><br>Victorian Biodiversity Atlas fauna records (unrestricted) for sites with high spatial accuracy | Department of Environment, Land, Water & Planning- Biodiversity and Ecosystem Services (DEPI) | Copyright © The State of Victoria, Department of Environment, Land, Water & Planning 2016 | This layer contains a snapshot of fauna taxa records from the Victorian Biodiversity Atlas (VBA) (including most threatened taxa and marine protists). The main attributes in this layer are survey id, survey location, date, time, locational accuracy, taxa recorded, counts, observation type, survey type, collector, and reliability of the record. The VERS_DATE column identifies the currency of the data. This layer excludes restricted taxa records. These records are contained in the related (but restricted) dataset VBA_FAUNA_RESTRICTED. | 28 July 2015 | https://www.data.vic.gov.au/data/dataset/victorian-biodiversity-atlas-fauna-records-unrestricted-for-sites-with-high-spatial-accuracy |
| 6 | VBA_FLORA25<br><br>Victorian Biodiversity Atlas flora records (unrestricted) for sites with high spatial accuracy | Department of Environment, Land, Water & Planning- Biodiversity and Ecosystem Services (DEPI) | Copyright © The State of Victoria, Department of Environment, Land, Water & Planning 2016 | This layer contains a snapshot of flora taxa records from the Victorian Biodiversity Atlas (VBA) (including most threatened taxa). The main attributes in this layer are survey id, survey location, date, time, locational accuracy, taxa recorded, counts, observation type, survey type, collector, and reliability of the record. The VERS_DATE column identifies the currency of the data. This layer excludes restricted taxa records. These records are contained in the related (but restricted) dataset VBA_FLORA_RESTRICTED. | 29 July 2015 | https://www.data.vic.gov.au/data/dataset/victorian-biodiversity-atlas-flora-records-unrestricted-for-sites-with-high-spatial-accuracy |

| Map # | Resource Name & Title | Data Custodian | Attribution | Abstract | Currency Date | Web URL |
|---|---|---|---|---|---|---|
| 7 | HY_WATERCOURSE<br><br>Watercourse Network 1:25,000 - Vicmap Hydro | Department of Environment, Land, Water & Planning -Information Services Division | Copyright © The State of Victoria, Department of Environment, Land, Water & Planning 2016 | This layer is part of Vicmap Hydro and contains line features delineating hydrological features.<br><br>Includes; Watercourses (ie channels, rivers & streams) & Connectors. | 22 April 2016 | https://www.data.vic.gov.au/data/dataset/watercourse-network-1-25-000-vicmap-hydro |
| 7 | WETLAND_CURRENT<br><br>Victorian Wetland Environments and Extent - up to 2013 | Department of Environment, Land, Water & Planning- Water Division | Copyright © The State of Victoria, Department of Environment, Land, Water & Planning 2016 | Polygons showing the extent and types of wetlands in Victoria. This layer is an update of the Wetland 1994 layer, it incorporates new regional mapping, some supplementary mapping and repositioning of planimetrically inaccurate wetlands. Supplementary mapping involved identifying and delineating wetlands which had not previously been mapped, but did not modify the extent of existing wetlands. It was undertaken primarily using aerial photograph interpretation (photos from 2007 to 2011) supplemented with existing geospatial datasets that provided context and informed the identification of wetland boundaries (e.g. vegetation mapping, topography). Wetlands were classified (according to the new classification framework) into primary categories based on wetland system type, salinity regime, water regime, water source, dominant vegetation and wetland origin. | 15 June 2015 | https://www.data.vic.gov.au/data/dataset/victorian-wetland-environments-and-extent-up-to-2013 |
| 9 | LANDUSE_2014<br><br>Victorian Land Use Information System 2014/2015 | Department of Economic Development, Jobs, Transport and Resources - Agriculture Research and Development | Copyright © The State of Victoria, Department of Economic Development, Jobs, Transport and Resources 2016 | The Victorian Land Use Information System (VLUIS) dataset has been created by the Spatial Information Sciences Group of the Agriculture Research Division in the Department of Economic Development, Jobs, Transport, and Resources. The method used to create VLUIS is significantly different to traditional methods used to create land use information and has been designed to create regular and consistent data over time. It covers the entire landmass of Victoria and separately describes the land tenure, land use and land cover for each cadastral parcel across the state, biennially for land tenure and use and annually for land cover; for each year from 2006 to 2015. | 28 May 2015 | https://www.data.vic.gov.au/data/dataset/victorian-land-use-information-system-2014-2015 |
| 10 | SENSITIVITY<br><br>Areas of Cultural Heritage Sensitivity | Department of Premier and Cabinet- Office of Aboriginal Affairs Victoria (DPC) | Copyright © The State of Victoria, Department of Premier and Cabinet 2016 | This dataset contains a spatial representation of “Areas of Cultural Heritage Sensitivity” as specified in Division 3, Part 2 of the Aboriginal Heritage Regulations 2007 (the Regs). Areas of cultural heritage sensitivity are areas that are either known to contain, or are likely to contain Aboriginal cultural heritage places and objects. These areas, which include various landforms within Victoria, are defined in the Aboriginal Heritage Regulations 2007. This polygon dataset is a representation of those areas as defined in the Regs | 05 April 2016 | https://www.data.vic.gov.au/data/dataset/areas-of-cultural-heritage-sensitivity |

***Map 8 Index of stream Condition***

The Index of Stream condition map was produced by creating a GIS data layer using information provided in the Department of Environment & Primary Industries, 2010 Index of Stream Condition- The Third Benchmark of Victorian River Condition ISC3. The lines have been drawn into the map and do not have any GPS co-ordinates attached to them.

***Map 10 Cultural heritage sites***

The cultural heritage sites layer was produced by creating a GIS data layer using the map of the approximate location of the two sites as shown in Glenelg Hopkins CMA's H11 & H12 Catchment Health Report- Lake Bolac, Fiery & Salt Creeks, pg 12. These site have been drawn into the map and do not have accurate GIS coordinates attached to them.

*BBCAG members at catchment field trip August 2016*

This document and associated GIS mapping was composed by Jileena Cole under the guidance of the Beyond Bolac Catchment Action Group. Funded by The Norman Wettenhall Foundation under their Landscape Restoration Program.