WEST GIPPSLAND CATCHMENT MANAGEMENT AUTHORITY

West Gippsland Regional NRM
Climate Change Strategy

West Gippsland
Catchment Management Authority

Australian Government

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Cover: Lower Franklin River, above: Tarra Bulga by Jonathon Stevenson

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Executive summary

The West Gippsland region has been exposed to major climate related events, including wildfire, flood and drought in recent times. These events have had a significant impact on the natural environment, including native habitat and biodiversity, waterways, coastal ecosystems and soils; all of which already face pressures from existing threatening processes.

The CSIRO and the Bureau of Meteorology have released climate change projections that provide updated information on how the climate may change to the end of the 21st century. The latest projections indicate that these major climate related events are not isolated. In the future the region will be subject to a warmer, drier and more variable climate. The frequency and magnitude of flood, fire and drought is projected to increase and there will be additional impacts from rising sea levels and increased storm surge.

While future climate projections suggest modest climate effects in the short-term, the longer term outlook is of greater concern with significant temperature increases and an overall reduction in average rainfall and seasonality for the West Gippsland region. For this reason a 2070 time frame has been used to inform the adaptation and mitigation options within this Strategy.

An effective regional climate change response requires both adaptation and mitigation actions across public and private land. This Strategy identifies a suite of feasible and robust adaptation options that encompass incentives, capacity building, planning and research initiatives to improve the adaptive capacity of highly valued natural assets across five climate change planning areas. These areas were identified as sharing similar landscape and socio-demographic features, as well as clusters of high value natural assets that are vulnerable to climate change.

The region is well placed to support mitigation activities, including the establishment of large scale biodiversity plantings that will improve landscape connectivity and sequester carbon, as well as exploring emerging opportunities to store blue carbon through the protection and restoration of coastal ecosystems such as saltmarsh, mangrove and seagrass communities. In many cases these mitigation actions will complement appropriate adaptation responses for land, water and biodiversity.

As a sub-strategy of the West Gippsland Regional Catchment Strategy (RCS), this Strategy seeks to acknowledge and build on the actions already being undertaken by natural resource managers, and identifies how actions in the RCS can be augmented and refined to ensure that natural resource management programs in the region are climate ready.

1. Purpose and context

1.1 Introduction

Climate change is a significant issue for the future of regional communities and the landscapes in which they exist. In West Gippsland, natural resource managers have been at the forefront of adapting to a variable and changing climate, responding with agility to major climate related events, including wildfire, flood and drought in recent times.

Future projected changes in climate are predicted to have substantial effects on natural assets and the broader landscape. These changes are likely to amplify the current challenges, making it imperative to better understand future risks from climate change and to develop flexible, robust options that can be incorporated into natural resource management (NRM) programs.

The West Gippsland Catchment Management Authority (WGCMA) has developed this West Gippsland Regional NRM Climate Change Strategy (the Strategy) to help natural resource managers and land and water managers make informed decisions that consider uncertainty, risk and feasibility of options for climate change adaptation and mitigation.

The Strategy was developed through a process that aimed to answer the following questions:

- What will the likely climatic conditions be for the WGCMA region between now and 2070?
- How might these climatic conditions impact the region's natural environment?
- What parts of the region are more vulnerable to climate change?
- How can NRM planners, land and water managers best prepare to mitigate or adapt to the potential impacts?
- Where should adaptation take place within the region and what types of adaptation action are the most appropriate and feasible?
- Where are the most appropriate locations for biodiverse carbon sequestration plantings, which can both offset greenhouse gas emissions and build landscape resilience?

The Strategy draws on recent climate change projections from the CSIRO and Bureau of Meteorology (BoM), a detailed climate change impact and vulnerability assessment, as well as published literature, research from the Southern Slopes Climate Change Adaptation Research Partnership (SCARP), and input from regional stakeholders.

The Strategy recognises that climate change impacts are not viewed in isolation from existing threatening processes (such as weed invasion, habitat fragmentation, erosion and sedimentation) and that they may be intensified or in some cases ameliorated by climate change.

It is a strategic document that considers the likely impacts on natural assets from climate change at the regional scale.

1.2 Purpose and scope

The purpose of the Strategy is to help NRM planners and land and water managers to understand and consider the potential impacts of climate change on natural assets within the WGCMA region, and to inform the development and implementation of other regional scale strategies and plans. It therefore does not intend to provide details for on-ground action at a site specific or local scale.

The Strategy does:

- identify landscapes within the region that are the most vulnerable to potential climate change impacts and strategies to build landscape integrity,
- guide adaptation and mitigation options to address climate change impacts on natural ecosystems,
- help guide the selection of locations at a landscape scale within the region that are suitable for future biodiverse carbon plantings and related sequestration options (e.g. aquatic bio sequestration or 'blue carbon'),
- use the best available research, information and specialist opinion, and was developed in collaboration with regional stakeholders.

The Strategy does not:

- examine climate change impacts on the built environment or infrastructure,
- examine issues at a property or farm scale,
- examine fauna species in detail – the focus is rather on the provision of habitat that supports fauna,
- examine flora species – the focus is at the regional scale and therefore at the scale of ecological communities,
- provide direction to industry on proposed future land use change, or
- provide direction on consumptive water supply and demand management, as this is the responsibility of the Department of Environment, Land, Water and Planning (DELWP) and the relevant Water Authorities.

Whilst the focus of the Strategy is on the natural environment, consideration has be given to how agencies responsible for coastal and built environments, agricultural land managers and forestry are planning to adapt in the face of climate change, and examined the interaction between future land management approaches and any potential impacts on the natural environment.

This Strategy is amongst a suite of initiatives examining the implications of climate change in the region and therefore is not intended to be the definitive answer to the issue of climate change.

New information on climate change will continue to become available in coming years, and new tools and frameworks for vulnerability assessment are likely to emerge.

Considering how climate may change, assessing subsequent vulnerabilities, and determining what to do next, will be ongoing needs and are likely to become further embedded into NRM planning and program design in the future.

This Strategy aims to assist in establishing an ongoing dialogue between NRM planners and land and water managers on how together; we can continue to adapt and respond to the impacts of climate change, using a growing array of practical options.

2 Legislation, policy and strategic context

2.1 Federal policy context

In November 2014, an amended Carbon Farming Initiative Amendment Bill 2014 was passed by Parliament, which established the Emissions Reduction Fund (ERF).

The ERF is the centrepiece of the Australian Government's policy suite to reduce Australia's greenhouse gas emissions.[1] Businesses and communities are being contracted through a competitive process to implement projects that will lead to a reduction in emissions. Project activities must be in accordance with approved emissions reduction methods under the ERF. Natural resource management activities including reforestation, revegetation and agricultural soil improvement are eligible where appropriate methodologies have been developed and approved.[2]

The ERF operates alongside existing programs designed to reduce emissions and builds on the previously established Carbon Farming Initiative (CFI). The CFI is a legislated, Australian voluntary carbon offsets scheme administered by the Clean Energy Regulator.[3] The CFI allows land managers to earn Australian carbon credit units (ACCUs) by reducing greenhouse gas emissions and increasing carbon sequestration in vegetation and soils through changes to agricultural and land management practices. ACCUs can be sold either to the Government through a carbon abatement contract, or on the secondary market to people and businesses wishing to offset their emissions.[4]

2.2 State policy context

The *Climate Change Act 2010* (the Act) provides guidance on the Victorian Government's roles and responsibilities in responding strategically to climate change in the context of national climate change policy settings. The Act requires decision makers to take climate change into account when making decisions under key pieces of legislation including the *Catchment and Land Protection Act 1994*, *Coastal Management Act 1995*, *Environment Protection Act 1970*, *Flora and Fauna Guarantee Act 1988*, and *Water Act 1989*. The Climate Change Act requires the Victorian Government to develop a Climate Change Adaptation Plan every four years and to outline the potential impacts and risks associated with a changing climate. The first Victorian Climate Change Adaptation Plan released in 2013 provides the framework for managing climate risks to critical Victorian Government assets and services. It aims to help position the Victorian Government to prepare for future climate challenges and to adapt to change.[5]

2.3 Regional strategic context

The West Gippsland Regional Catchment Strategy (RCS) is the overarching strategic planning document that identifies priorities for natural resource management in the region for the period 2013-2019. The RCS sets the direction for how the region's land, water and biodiversity resources should be managed in order to maintain or improve the condition of priority natural assets over time. The aim of the RCS is to provide a framework for the integrated management of catchments, which will maintain long term sustainable land productivity, while also conserving the environment.

Climate variability has been acknowledged as a potential threat to the condition of significant, highly valued natural assets within the RCS, however analysis of the impacts of climate change and identification of potential adaptation and mitigation responses were not in scope when developing the RCS.

As a sub-strategy to the RCS, the West Gippsland Regional NRM Climate Change Strategy aims to support the integration of climate change knowledge into the current RCS and to further inform the implementation program, future strategies, sub-strategies and planning tools. Figure 1 below describes the relationships between this strategy, the West Gippsland RCS and the broader state and federal policy context.

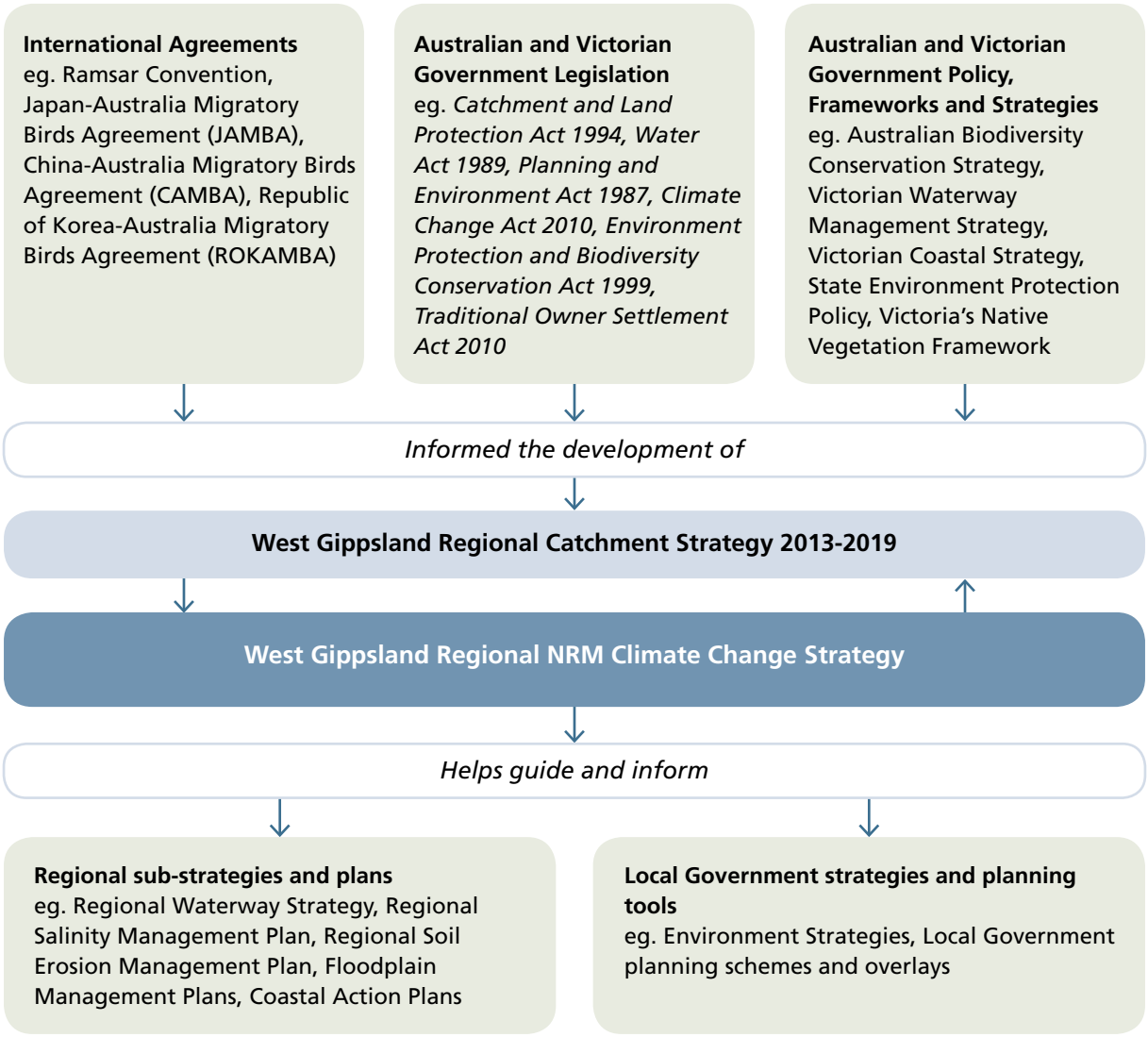

Figure 1: Strategic Framework

3. Strategy development

In 2012, the Australian Government launched the Regional Natural Resource Management Planning for Climate Change Fund (NRM Fund). The aim of the NRM Fund is to improve regional NRM planning through the use of the latest climate change science, information and scenarios to help plan for the potential impacts of climate change. The NRM Fund is comprised of two streams depicted in Figure 2 below:

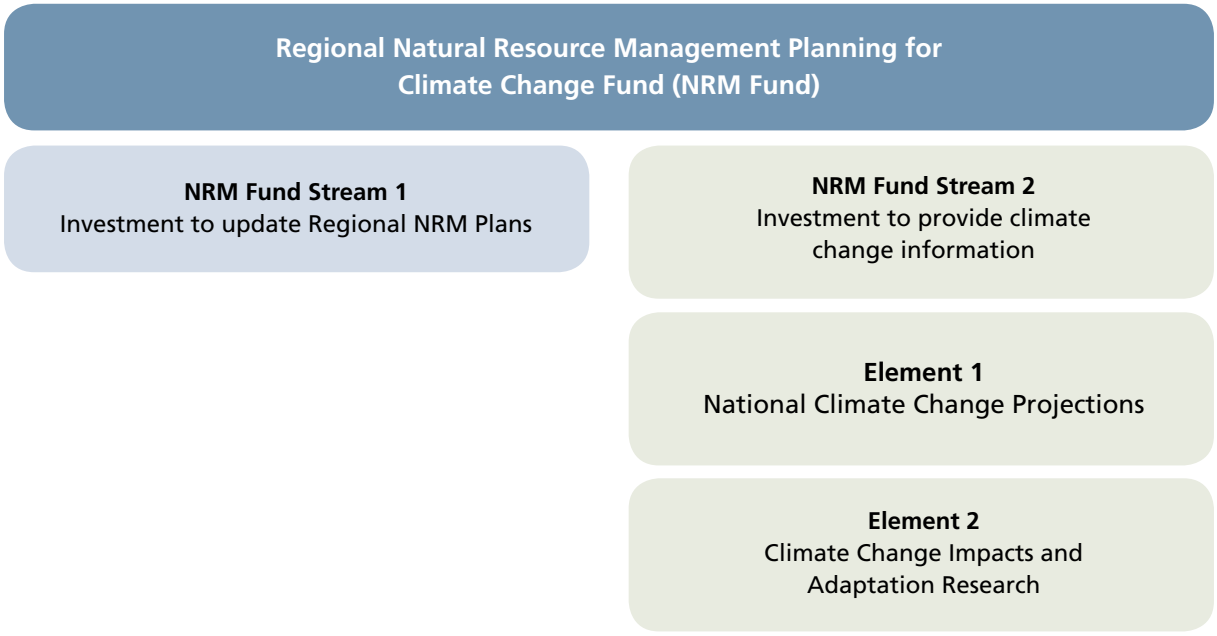

Figure 2: Regional NRM Planning for Climate Change Funding Streams

Stream 1 provided investment to develop the Strategy in accordance with the following guiding principles as specified by the Australian Government:

- Plans identify priority landscapes for carbon plantings and strategies to build landscape integrity and guide adaptation and mitigation actions to address climate change impacts on natural ecosystems
- Planning process is logical, comprehensive, and transparent
- Plans use best available information and are based on collaboration

Stream 2 provided investment to research bodies to produce information, products and tools to help inform the development of this Strategy through two separate elements.

- **Element 1:** National downscaled climate projections were produced by CSIRO and the Bureau of Meteorology. Projections were based on sophisticated global climate modelling data, which underpins the 2013 Fifth International Panel on Climate Change (IPCC) Assessment Report.
- **Element 2:** Researchers from universities and State agencies involved in the Southern Slopes Climate Change Adaptation Research Partnership (SCARP) synthesised research and relevant information to produce fit-for-purpose approaches in conjunction with CMAs for use in developing their climate change strategies.

3.1 Development framework

Figure 3 below demonstrates the framework that was applied to develop the Strategy. It shows the three main phases and summarises the key activities involved in assessing the regional vulnerability of natural assets to climate change, and in developing possible options for adaptation and mitigation. The process is described in more detail in the following sections.

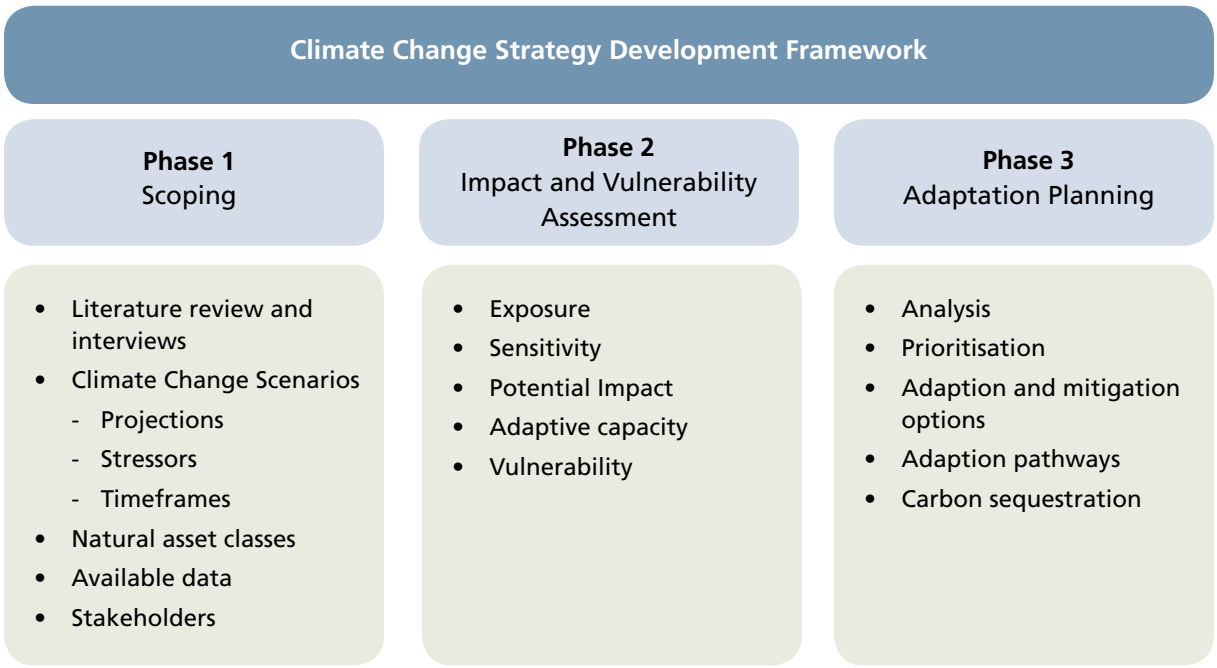

Figure 3: Framework for Strategy Development

3.1.1 Scoping

The scoping phase lays the foundations for subsequent analysis and planning and involved the following activities:

- **Literature review and interviews.** A review of Australian and international literature on climate change impacts and adaptation options, in conjunction with targeted interviews with regional stakeholders, was undertaken to understand potential implications for the region's natural assets as the result of climate change.
- **Climate variables and projections.** Determining which climate models, emission scenarios, climate stressors and timeframes to use to represent possible climate futures.
- **Natural asset classes.** Natural assets were grouped into broad asset classes to support the vulnerability assessment process. These were consistent with those used in the RCS development process and included: native vegetation, rivers and streams, wetlands, estuaries and soil.
- **Available data.** The most applicable statewide spatial datasets were identified and sourced to use in the vulnerability assessment process.
- **Stakeholders.** Key people and organisations were identified to involve in interviews and workshops, to bring necessary information and knowledge to the table, and optimise the range of decision makers and planners able to share the experience and develop shared understandings of regional climate vulnerability, mitigation and adaptation options.

3.1.2 Impact and Vulnerability Assessment

The first step in the process involved identifying the natural assets that are most vulnerable to climate change. A spatial impact and vulnerability assessment was completed to inform NRM planning for climate change at the regional scale.[6] The assessment was completed for multiple natural asset classes and included the use of available data on the characteristics, values and condition of the assets. The assets considered in the assessment were consistent with those used in the RCS process. The assessment incorporated multiple projections of future climate over different timeframes and considered the potential climate change impact and vulnerability using the assessment framework presented in Figure 4 below. The assessment covered the whole of the state of Victoria.

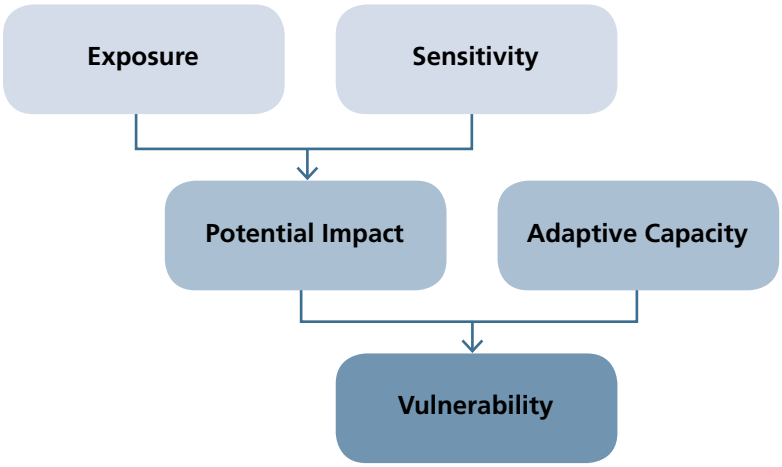

Figure 4: Climate change impact and vulnerability assessment framework

The latest climate change projections for Australia released by the CSIRO and the Bureau of Meteorology, which provide updated national and regional information on how the climate may change to the end of the 21st century, were used in the impact and vulnerability assessment. The projections are relative to the IPCC reference period 1986-2005 and are based on the outputs of sophisticated global climate models (GCMs) used in the Coupled Model Inter-comparison Project phase 5 (CMIP5) judged to perform well over Australia. Climate scenarios considered in the assessment in terms of carbon emission projections based on the CMIP5 model results provided by CSIRO were:

- Representative Concentration Pathways 4.5 – Moderate future carbon emissions scenario.
- Representative Concentration Pathways 8.5 – High future carbon emissions scenario.

Representative Concentration Pathways (RCPs) are four greenhouse gas (GHG) concentration trajectories adopted by the IPCC for its fifth assessment report. RCPs describe four possible climate futures, all of which are considered plausible, depending upon the level of GHG emissions in years to come. RCP 4.5 represents a pathway where emissions peak around 2040, then decline. RCP 8.5 represents a pathway where emissions continue to rise throughout the 21st century.

The elements of the assessment framework are further explained below.

Exposure. Relates to the climate stressors that affect natural assets. Exposure is a measure of the predicted changes in the climate for the future scenario assessed. It included an examination of two direct stressors (change in temperature and rainfall), and two indirect stressors (sea level rise and storm surge).

Sensitivity. Reflects the inherent responsiveness of assets to climatic stressors or influences, and the degree to which changes in climate might affect the assets in their current form. Sensitive assets are highly responsive to climate and can be significantly affected by small climate changes (e.g. changes in temperature and rainfall).

Potential impact. The combination of exposure and sensitivity to climate change reflects its potential impact.

Adaptive capacity. The ability of natural assets, in their current state, to adjust to climate change, to take advantage of opportunities, or to cope with the consequences. The adaptive capacity of a system describes its ability to modify its characteristics or behaviour so as to cope better with changes in external conditions.

Vulnerability. The degree to which an asset is susceptible to or unable to cope with adverse effects of climate change. Vulnerability is a function of the character, magnitude and rate of climate change to which an asset is exposed, its sensitivity and its adaptive capacity.[6]

3.1.3 Adaptation and Mitigation Planning

The final phase of the Strategy drew upon the results of the scoping and assessment phases to help formulate possible mitigation and adaptation options and explore pathways for adaptation under changing climatic and socio-economic conditions over time. This phase involved a series of workshops and consultation that involved:

- **Analysis.** Analysing the results of the impact and vulnerability assessment and literature review to assist in identifying the most vulnerable natural assets within the region (including RCS priorities and non-priorities) and then gaining a conceptual understanding of the interaction between climate change and existing threats to natural asset condition. The results from the vulnerability assessment using the RCP 4.5 scenario indicated that there may only be moderate levels of impact on natural assets in the West Gippsland region until the 2090 time period. Whereas the RCP 8.5 emission scenario (where emissions continue to rise throughout the 21st century) indicated moderate to high levels of impact on natural assets from 2070 onward. Taking into account the results of the impact and vulnerability assessment, it was decided that the RCP 8.5 emission scenario for the 2070 time period would be used to inform this Strategy. This scenario has been chosen because it provides a longer planning horizon than the Regional Catchment Strategy (55 years compared with 20 years), and has been judged to provide a plausible picture of possible moderate to high level impacts, under specific changes in climate factors, particularly changes in temperature and rainfall.
- **Prioritisation.** Filtering and prioritising the most vulnerable natural assets and proposing areas of focus for adaptation planning within the region, with the assistance of regional stakeholders.
- **Adaptation and mitigation options.** Formulating preferred options to mitigate and adapt to climate change, with the assistance of regional stakeholders.
- **Adaptation pathways.** Considering the range of possible adaptation options and how robust and flexible these may be across a range of potential futures, with the assistance of regional stakeholders.

- **Carbon sequestration.** Understanding the possibilities for increased plantings to sequester carbon, which will help to mitigate rising concentrations of atmospheric carbon dioxide (CO^2) and contribute to habitat linkages across the region. Evaluating the feasibility, risk and cost implications to help identify preferred locations for carbon sequestration and habitat linkage plantings, with the assistance of regional stakeholders.

Section 5 introduces a set of planning areas that were used for the identification of strategies for adaptation and mitigation drawing on the results of the vulnerability assessment. These areas share similar patterns of biophysical and socio-economic characteristics and are coherent with the priority areas identified in the West Gippsland RCS.

Section 6 describes the adaptation and mitigation strategies for the respective planning areas and outlines the range of options that have been identified to increase the adaptive capacity of vulnerable assets. A range of important contextual factors such as landscape characteristics, land use and socio-demographic differences have been considered in the development of these options. Each of the strategies and options were assessed for their adaptation or mitigation benefit; social, technical and economic feasibility; potential for maladaptation and relevance over time (i.e. 2030, 2050, 2070 and 2090). It should be noted that in many cases mitigation actions, such as biodiverse planting or 'blue carbon' sequestration performs both an adaptation and mitigation response.

4. Climate change

4.1 What is climate change?

It is important to understand the difference between weather, climate, climate variability and climate change. The following definitions have been sourced from the CSIRO.[7]

Weather is the day-by-day variation in temperature, wind and rainfall. Weather usually changes from hour to hour and from town to town.

Climate is more stable and refers to the average weather conditions over at least a 30 year period (i.e. long term average).

Climate variability and climate change are different aspects of climate.

Climate variability refers to the year-to-year variations around the average weather conditions. For example not all consecutive summers will be identical - some summers will be cooler and some will be hotter than the long term average. Seasonal climate variability is a key feature in the West Gippsland region.

Climate change refers to any long-term trends or change in average weather conditions over many decades.

Consideration of both the shorter term variability and longer term change in climate is important. When climate change is superimposed on natural climate variability, it leads to a change in the frequency, intensity and duration of extreme weather events, such as droughts, heavy rainfall, fire weather, heat waves, hail storms and flooding.[7]

4.1.1 What is causing the climate to change?

The scientific basis for climate change is that changes in the earth's atmosphere, due to the increased emission of carbon dioxide and other greenhouse gases (including methane and nitrous oxide), are trapping heat and increasing temperatures. This is altering global weather patterns and climate. Climate change can occur due to a combination of natural and human induced causes.

With greenhouse gas emissions continuing to increase, the Bureau of Meteorology expects the warming trend of the past century to accelerate throughout this century. It also expects changes to rainfall patterns and to the frequency of extreme weather events like cyclones and droughts.

The future climate will depend on whether the world manages to slow or even reduce greenhouse gas emissions. Since greenhouse gases have a long lifetime in the atmosphere, any change in emissions will have a delayed effect on atmospheric concentrations, so these concentrations are expected to increase, leading to further warming and climate change for many decades.

4.2 What is climate change adaptation?

Given the uncertainty around the climate and other socio-economic variables in the future, keeping as many management options open as possible is vital.[8] Climate change adaptation focuses on improving the ability of a system or people to adjust to climate change (including climate variability and extremes), to reduce potential damage, to take advantage of opportunities, or to cope with the consequences.

In this way adaptation may accommodate the medium and long term impacts of climate change, such as sea level rise, increases in temperature and changing rainfall patterns. Examples of options for adaptation in natural resource management include:

Supporting the protection of core habitat areas of native habitat in good condition

- Enhance the condition of remnant vegetation, to conserve biodiversity and maintain ecological integrity.
- Identify and protect refugia.
- Develop buffers around rainforest remnants.
- Enhance riparian vegetation and support stream-bank protection.
- Preserve genetic diversity by conserving habitat over a gradient of climatic zones.

Building resilient landscapes and seascapes

- Build connectivity, especially between representative habitats, providing avenues for species migration.
- Promote a multi-purpose, landscape mosaic to improve the functionality of natural and production focused ecosystems.
- Limit impediments to make space for the migration of coasts, rivers and coastal wetlands; and consider land swaps or offsets.
- Introduce genetics from drier, hotter areas.

Removing or minimising existing stressors

- Manage invasive plants and animals, and diseases; including surveillance and prompt responses to incursions.
- Monitor the impacts of existing water allocations and factor climate change into water resource and salinity planning.
- Develop alternative water sources to reduce the pressure on stressed water assets.

Promoting best management practices on farms and in forests

- Manage soils to reduce erosion and nutrient loss risks on farms and in forests (e.g. revegetate gully heads, maintain optimal soil cover, and manage run-off).
- Manage grazing to protect vulnerable areas (e.g. remnant vegetation and riparian areas).
- Promote water use efficiency.

Adopting engineering solutions to protect key natural assets

- Manipulate hydrology of wetlands to maintain ecological processes.
- Manage the delivery of environmental flow allocations in response to changing conditions and understandings.
- Consider levees to protect key natural assets, if long-term protection is possible and has net benefits.

Adaptive management and effective monitoring

- Monitor the implications of new policies and emerging land and other resource uses, including changes in agriculture.
- Practice active adaptive management in the implementation and evaluation of NRM actions.
- Understand how, and why, landscapes are changing.

Promoting integrated catchment management and inter-agency collaboration

- Integrate adaptation to climate change into natural resource management planning across all sectors of government.
- Prepare for more frequent bushfires and explore strategies that minimise risks to vulnerable assets.
- Conduct targeted education and awareness programs that promote understanding of climate change impacts, options and trends.

4.3 What is climate change mitigation?

Climate change mitigation involves direct actions to reduce the rate of release to the atmosphere of greenhouse gases (e.g. emission reductions) and/or increasing the sequestration of carbon through activities such as revegetation and soil storage.

Capture of greenhouse gases, such as carbon dioxide, can occur at the point of emission (e.g. from power plants) or through natural processes (such as photosynthesis), which remove carbon dioxide from the earth's atmosphere and which can be enhanced by appropriate management practices. Native vegetation, aquatic ecosystems and agricultural land are important to climate change mitigation. Firstly because of the significance of their carbon stock, and secondly because their exchange of greenhouse gases between the atmosphere and soils and vegetation can go both ways. Many human activities such as logging, fuel reduction burning, grazing of livestock or cultivation, influence the exchange of greenhouse gases with the atmosphere and ultimately the overall regional carbon footprint.

In West Gippsland there are a range of activities, such as investment in renewable energy sources or transition away from high emission farming systems, which will decrease regional carbon emissions. The main focus of the Strategy however will be on sequestration activities that have the ability to increase carbon storage in plants and soils, whilst protecting the values of priority regional assets including waterways, wetlands, terrestrial habitat, coastal ecosystems and agricultural land.

Carbon sequestration is the general term used for the capture and long-term storage of carbon dioxide in the various carbon pools in vegetation, soils and living organisms. These options are outlined in Table 1.

Table 1: Carbon sequestration options for natural assets

Asset type	Carbon sequestration options
Native vegetation (terrestrial)	Biodiverse plantings Natural regeneration Farm forestry, including woodlots and plantations
Waterways	Riparian plantings Natural regeneration
Wetlands	Grazing control promoting reestablishment of natural wetland vegetation Buffer plantings Natural regeneration
Coastal ecosystems	Blue carbon through protection and enhancement of saltmarsh, mangrove and seagrass habitats
Soils	Changed land use (e.g. cropping to grazing) 'Improved' cropping systems (e.g. no-till) Changed management of grazing land

These options are further discussed below:

Biodiverse plantings

Biodiverse plantings typically involve establishment of indigenous vegetation through tube stock or direct seeding methods on a range of sites from 'greenfield' to areas with scattered remnants. In recent years there has been a focus on re-establishing the vegetation that occurred prior to clearing, in the form of ecological vegetation classes (EVCs), for which detailed prescriptions exist. These types of plantings have been generally proven to be most beneficial for fauna and maintenance of local ecological processes, however, the degree of site modification plays a key role in what will succeed best in certain locations.

Natural regeneration

Natural regeneration means allowing or assisting the bush to grow back by itself. Generally it is the most effective and most economical way to expand patches of native vegetation and improve their condition. Where existing native seed sources exist, grazing by introduced species, especially sheep, cattle, rabbits and native species, especially kangaroos and wallabies is the key inhibitor of natural regeneration. Existing weed loads, also play a role in reducing the potential of areas to naturally regenerate.

Farm forestry

Farm forestry involves incorporation of commercial tree growing into farming systems. It can take many forms, including timber belts, alleys and widespread tree plantings. Farm forestry can provide farmers with an alternative source of income, through the sale of wood products such as sawlogs, firewood and bioenergy. It can improve agricultural production by providing shelter for stock and crops and can provide substantial environmental benefits such as salinity control.

Riparian plantings

Riparian plantings are essentially a subset of biodiverse plantings associated with waterway restoration. Located in the most fertile parts of the landscape with high moisture availability, riparian areas usually offer excellent conditions for tree growth and carbon sequestration. Extensive river restoration works have been undertaken along the region's waterways as the result of work by the WGCMA, Landcare and the previous River Improvement Trusts.

Blue carbon

Vegetated coastal habitats (saltmarsh, mangroves, and seagrass meadows), collectively known as 'blue carbon' habitats, together sequester nearly equivalent quantities of organic carbon (Corg) as their terrestrial counterparts, in spite of their comparatively limited biomass (0.05% of terrestrial plant biomass).

West Gippsland contains significant areas of habitat suitable for the conservation and sequestration of 'blue carbon'. In many cases these habitat areas are in good condition and therefore the protection of these ecosystems, and their carbon stores, should be a high priority. Research undertaken by Deakin University in 2014 reported that these features make vegetated coastal habitats ideal candidates for carbon offset programs and nature-based climate mitigation initiatives.[9] Wetlands (which include alpine peatland, freshwater wetland and coastal wetlands) are also thought to be significant carbon sinks.[10] However further work is required to better understand the effects of wetting and drying cycles on the capture and retention of carbon in these ecosystems.

A preliminary assessment of the potential of 'Blue Carbon' for the West Gippsland region was completed in 2014 with the following recommendations to maximize carbon stocks within vegetated coastal habitats.[9]

- Prioritise "Blue Carbon" hotspots for conservation.
- Produce updated seagrass distribution maps.
- Focus revegetation projects on saltmarsh ecosystems and/or estuarine environments closer to fluvial inputs.
- Restore natural hydrology to enhance carbon sequestration in vegetated coastal habitats.
- Investigate the drivers of sea urchin barrens within Nooramunga Marine and Coastal Park and their potential impacts on blue carbon stocks in the absence of management intervention.
- Research into the distribution and carbon storage potential of wetland ecosystems in West Gippsland.

It is not clear how 'blue carbon' would be assessed under the current ERF approved methods, although work is underway to develop and approve an appropriate method.

Grazing management

Grazing of agricultural land by sheep and cattle is a prominent land use in the West Gippsland region. The timing and intensity of grazing, together with factors such as fertiliser application and management of soil nutrients can influence pasture groundcover and soil carbon levels. Changes in grazing management in areas associated with remnant vegetation, riparian areas and wetlands can be an important mechanism in allowing natural regeneration in areas with important biodiversity values, in addition to increasing carbon sequestration.

Mitigation options are also considered within the context set by the Australian Government in outlining the Principles that should underpin regional planning for climate change, including:

- identifying priority landscapes for carbon plantings,
- identifying strategies to build landscape integrity,
- guiding adaptation and mitigation actions to address climate change impacts on natural ecosystems,
- avoiding adverse impacts associated with carbon in the landscape.

Section 6 highlights how these principles have been considered in the identification of complementary adaptation and mitigation responses across the relevant planning areas.

4.4 Regional climate vulnerability and future projections

4.4.1 Regional overview

The West Gippsland catchment region is determined by the WGCMA boundary. It extends from Warragul and San Remo in the west, to the Gippsland Lakes in the east, and from the Great Dividing Range in the north to Wilsons Promontory in the south (Figure 5).

The West Gippsland region is characterised by a variety of soil types. Soils are moderately well structured across the region and support a range of agricultural enterprises and natural ecosystems.

The eastern highlands, Strzelecki Ranges and the western half of the region receive high rainfall, have deep soils and support extensive areas of native forest. The plains in the east of the region are in the rain shadow of the highlands, where the remaining native vegetation is mainly woodland, grassy woodland, heathland and riparian complexes in low-lying areas.

The region is home to a wide range of terrestrial, marine and aquatic flora and fauna species, many of which are threatened. For example, 69 fauna and flora species listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and 141 of Victoria's 601 threatened species formally listed under the *Flora and Fauna Guarantee Act 1988* (FFG Act) are located within the region. There is a high representation of endangered, rare and vulnerable ecological vegetation classes across the region. Historic wide-scale clearing that opened up the region for settlement, agriculture and industry has resulted in a considerable loss of native vegetation throughout the landscape.

There is a diversity of marine environments in the region ranging from open coasts, sandy beaches, bays, inlets and estuaries.[11]

Figure 5: West Gippsland Catchment Management Authority region

4.4.2 Current climate conditions and climate variability

The West Gippsland region currently has maximum temperatures and minimum rainfall in summer. The region has mild to warm summers with average maximum temperatures around 21 to 23˚C near the coast and elevated areas, and 23 to 25˚C further inland. In winter, average maximum temperatures are mostly around 12 to 14˚C, but drop to less than 10˚C in the mountains. Frosts are rare near the coast, but do occur further inland.[12]

West Gippsland is Victoria's wettest region, with an annual rainfall average of 926 millimetres. However, there is substantial variation across the region (Figure 6). The southern flanks of the Great Dividing Range, the Strzelecki Ranges and the south western part of the region receive high rainfalls of 1000 to over 1600 millimetres a year, falling as snow on the higher peaks of the Great Dividing Range in winter. Annual average rainfall decreases to less than 600 millimetres in the east as a result of a rain shadow effect from Wilson's Promontory and the Strzelecki Ranges.[12]

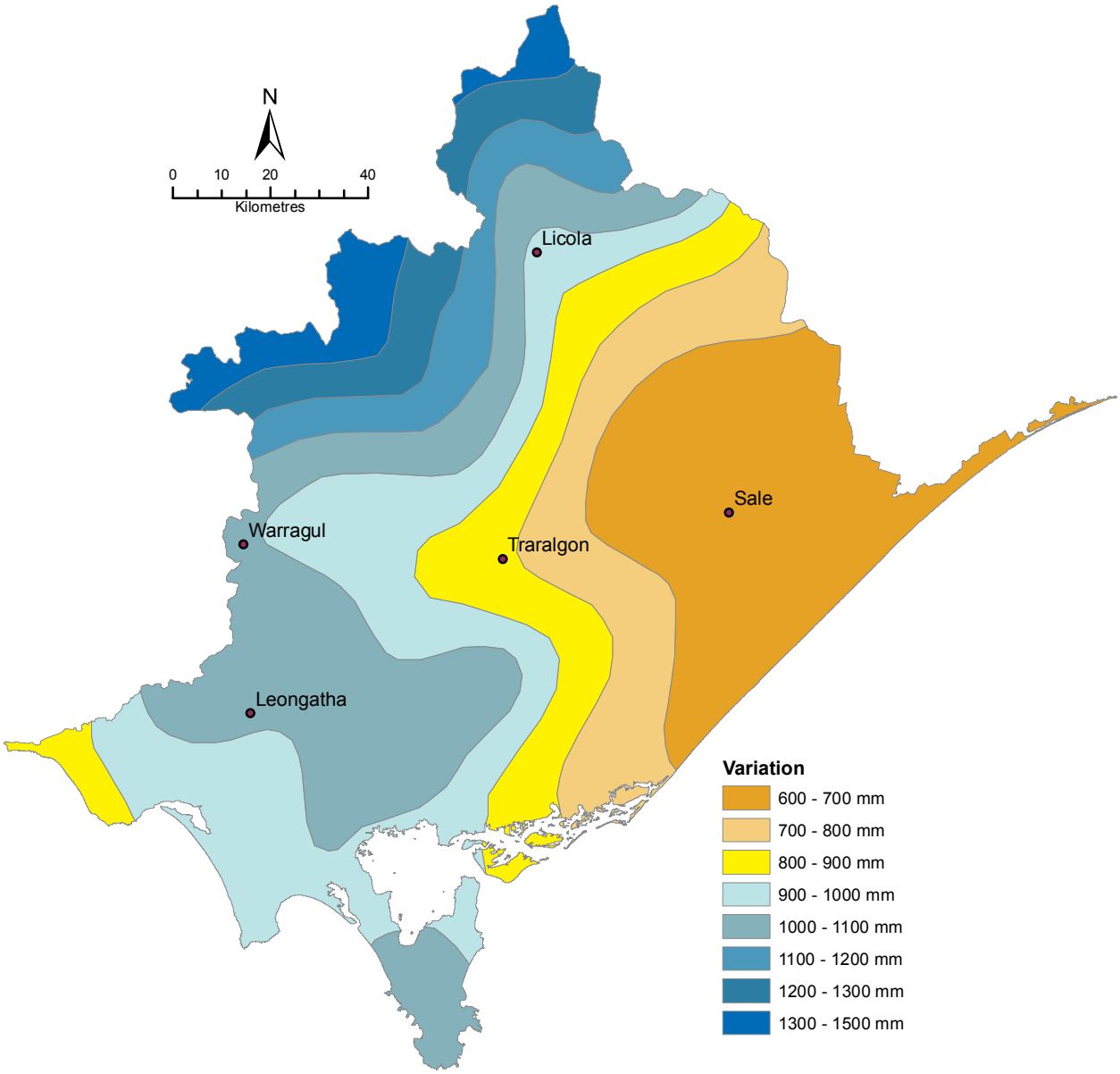

Figure 6: How average annual rainfall varies across the region (based on 1961-1990 average)[12]

Low pressure systems off the east coast can be responsible for extremely heavy rainfall events in the east of the region.[13] Although they can occur at any time of the year, east coast lows are more common during autumn and winter with a maximum frequency in June.

Rainfall variability gives rise to dry and wet periods and influence the frequency of flood and fire that have an effect on land management and the health of natural assets in the region.

Sea level rise is variable due to factors including prevailing winds, the changing strength of ocean currents, and gravitational pull of the polar ice-sheets. Rising sea levels in the region are observed through storm surges and coastal flooding; coastal erosion and shoreline retreat; increasing salinity of coastal waterways and inundation of low-lying coastal areas.

Understanding the current and past climate patterns within the region helps us to start thinking about potential future changes to climate and climate variability.

4.4.3 Future climate projections

Future climate projections provided by the CSIRO and Bureau of Meteorology are based on the outputs of global climate models, which are supplemented by additional regional modelling and/or statistical downscaling to represent finer, regional scale patterns. The projections are based on four Representative Concentration Pathways (RCPs), three emissions scenarios (low, intermediate and high), and 20-year time increments correlating to the years 2030, 2050, 2070 and 2090. The projections indicate that the future climate in the West Gippsland region is likely to have the following characteristics.[14]

Temperature

- Average daily minimum and maximum temperatures are predicted to increase, with an increase in the temperature reached on the hottest days, an increase in the frequency of very hot days and duration of warm spells.

Rainfall

- Decline in average annual rainfall and winter-spring rainfall, with potentially an increase in summer rainfall.
- Tendency for heavier rainfall interspersed by longer dry periods, with some extremely dry and wet years, with natural variability continuing to be a major driver of rainfall.[8]

Intensity of rainfall and more time in drought

- Intensity of heavy rainfall events is predicted to increase, with timing and magnitude driven by natural variability.
- A decline in the number, but an increase in the intensity of east coast lows, impacting on average rainfall and heavy rain events.
- Time spent in drought is predicted to increase over the course of this century in line with changes to average rainfall, and the frequency and duration of extreme droughts will increase.

Snow

- Snowfall and maximum snow depth have declined significantly since 1960 and are projected to continue to decline.

Wind

- Little change in annual average wind speed.
- Higher wind speeds during the cooler months (July to October) and lower wind speeds during the warmer months (November to May).

Relative Humidity and Evaporation

- Decrease in relative humidity across all seasons, projections to this effect will intensify over the course of the century.
- A tendency for decreases in humidity to coincide with areas of rainfall decline, leading to reduced effective water availability and decreased streamflow through lower moisture inputs and higher rates of evapotranspiration.

Fire

- More frequent and intense fires are projected as a result of increased temperature and reduced relative humidity and increased time in drought.

Marine and Ocean conditions

- Continued gradual increase in sea levels and more frequent sea level extremes, including storm surge, is projected.
- Warming and acidification of coastal waters is projected to increase with effects becoming apparent late in the century.

5 Regional risks and opportunities associated with climate change and variability

Natural resource managers and landholders across the region are already living with and responding to climate variability, but future climate trends may present new challenges. The projected changes in climate have the potential to impact on natural assets and land management practices in unexpected ways. It is important to understand how agricultural and public land managers within the region are planning to adapt in the face of climate change, the interaction between future land management practices and any potential impacts on the natural environment.

The implications of future changes in climate are likely to have a number of direct and indirect effects. Climate variables other than temperature and rainfall, which also influence processes in the landscape like plant growth and the hydrological cycle, are also important to consider.

By the end of the century the overall amount of rainfall may change significantly, a decline in winter-spring rainfall with potentially increased summer rainfall will result in more rainfall being lost to evaporation and evapotranspiration. This has implications for both natural assets and the implementation of NRM activities (such as the timing and methods for establishment of native vegetation). The availability of water will have implications for agricultural production, particularly for those industries reliant on irrigation and winter-filling of dams.

Projected decreases in average rainfall and higher rates of evaporation will result in reduced run-off and reduced inflows to rivers, estuaries and wetlands. Conversely an increased frequency and intensity of intense rainfall events may result in increased flooding.

The combination of decreased average rainfall, increased temperature and more variability (including more time in drought and increased intense rainfall events) is likely to lead to a shift in the flow regimes of rivers in West Gippsland.

Demand for water may also increase as a result of warmer temperatures and as the population grows, in line with projected demographic trends for the region. Therefore, the need to use water more efficiently will be even greater.

Climate change impacts on natural assets will likely be exacerbated by acting synergistically with other threats such as fire, flood, habitat loss and change in land-use and management practices, invasive animals and pests and diseases, and altered water availability and flow regimes.[15]

5.1 Region-wide issues

A key issue of concern for the region arises from issues that operate at a broad landscape scale with impacts across public and private land, and where urban areas and rural land meet. Landscape scale threats, such as invasive plants and animals and fire, may be elevated due to changing climate conditions, and have the potential to further impact on environmental values. Managing these issues across land tenure and landscape type is complex and requires collaboration between public and private land managers, combined with an improved understanding of the potential risks associated with these issues.

5.1.1 Invasive plants

Invasive plants (weeds) are one of the major threats to both natural assets and productivity of freehold land. Climate change will impact on weeds in two main ways, firstly the range of weed species present in the region will change, and secondly the invasiveness of weed species will change favouring some species over others. The main drivers for climate change on invasive plants include increased temperatures, changed rainfall, increased CO^2 levels, more extreme weather, more frequent frosts, changed phenology and changed land use. The rate of response of invasive plants is expected to be faster than for other plants, including native species and crops. Consideration should also be given to species not currently found in West Gippsland but with potential to establish under a changing climate.

5.1.2 Fire

The fires of 2006-07, 2009, 2013 and 2014 demonstrated the extent to which different types of fire (i.e. bushfire, grassfires and mine fire) impact on different landscapes in the West Gippsland region, and the scale of its impact.

Under a changing climate there is potential for an increase in both the frequency and intensity of bushfire, which would broadly:

- alter the distribution and composition of ecosystems,
- lower the yield and quality of water from fire-affected catchments,
- threaten the security of plantation forests,
- increase emissions of greenhouse gases to the atmosphere,
- increase damage to property, livestock and crops.[16]

Greater bushfire activity could temporarily contaminate water catchments with sediments and ash, along with posing more chronic issues for natural ecosystems with low bushfire tolerance.

Increased fire is also likely to magnify the impact of other threats, including invasive plants and animals, soil erosion and declining water quality, so consideration needs to be given as to how best to manage these risks in tandem.

5.1.3 Intense rainfall, flooding and erosion

Intense rainfall events increase the risk of severe flooding. This can cause direct impacts on infrastructure, such as damage to roads and bridges, as well as waterways and floodplains, with downstream impacts from erosion and sediment deposition. Flooding also impacts private assets such as farm infrastructure and soil, crops and livestock. Stormwater flooding caused by runoff from severe storms in areas with high degrees of imperviousness (due to roads, roofs, etc.) is also likely to increase and there may be more flash flooding in summer periods because of the increased frequency of intense rainfall events.

In the future, intense rainfall events will be increasingly likely to follow longer periods without rain (combined with higher temperatures and evaporation) that may correspond with lower ground cover. This has the potential to cause higher rates of soil erosion on land systems that are already susceptible due to factors such as slope and soil type. This has significant implications for lower landscape ecosystems, including the iconic Gippsland Lakes and Corner Inlet.

5.2 Implications for the natural environment

5.2.1 Rivers and inland wetlands

Most of the direct impacts of climate change on freshwater systems in southern Victoria are predicted to come from a decline in rainfall leading to a decrease in runoff, with impacts to flow regimes across the year.[8] Impacts will also arise for aquatic biota from increases in temperature and weather related events, such as fire and drought.

Increased frequency of higher intensity rainfall events has the potential to increase flooding, exacerbate bed and bank erosion in river channels resulting in increased turbidity and sediment loads, potentially with the introduction of pollutants and nutrients from adjacent catchments.

In contrast lower base flows in rivers and higher temperatures, as is currently typical in summer and autumn, combined with elevated nutrient levels will create a more favourable environment for algal blooms.[17] In West Gippsland, this may mean an increase in the occurrence of algal blooms in rivers and creeks.

A reduction in the frequency and duration of high flows and inundation of waterways may result in significant changes in plant and animal communities, particularly for rivers and wetlands that change state from permanently inundated to an alternating wetting and drying regime, whilst seasonal waterways will shift to a longer duration dry phase. These waterways are likely to lose species that require a frequent (or permanent) inundation for survival or critical life history requirements.[8]

These same waterways will also be less frequently connected to their primary water source and each other; reducing opportunities for movement and dispersal of plants and aquatic fauna and reducing genetic mixing.[18]

The rivers and streams that were assessed as having the highest potential vulnerability to climate change impacts under a high emissions scenario, by the year 2070 are presented in Appendix 3, together with an indication of whether the waterway assets are a priority within the West Gippsland RCS and which RCS Landscape Priority Area/s the asset relates to.

Analysis undertaken for wetlands across Victoria[18] concluded that the most vulnerable wetlands to climate change will be:

- rainfall-fed wetlands located in regions where reductions in rainfall are highest,
- river fed wetlands located on floodplains of rivers that will experience a large decrease in the frequency of high flow events,
- groundwater fed wetlands associated with local groundwater flow systems, and
- alpine wetlands.

For all inland wetlands, the primary impact of climate change, regardless of source water, will be a reduction in the frequency and duration of inundation events and an increase in the duration of dry periods. This is likely to manifest in a decrease in the number and area of permanent and seasonal wetlands and increase in the number of and area of intermittent wetlands.

The inland wetland assets (complexes) within the West Gippsland region that were assessed as having the highest potential vulnerability to climate change impacts under a high emissions scenario, by the year 2070 are presented in Appendix 3. These vulnerable wetland complexes include shallow freshwater marshes, freshwater meadows, deep freshwater marshes and alpine wetlands. An indication of whether the vulnerable inland wetland assets are a priority asset within the West Gippsland RCS and which RCS Landscape Priority Area the asset relates to is also provided.

5.2.2 Coasts, estuaries and coastal wetlands

Coastal areas are subject to a range of hazards including inundation, erosion and flooding, and there is potential for these to increase in frequency and extent under future climate scenarios. The drivers of these include changes in sea level rise, storm surge, tides and rainfall.[19] [20] [8]

In the shorter term storm surge is likely to cause damage through erosion and loss of vegetation, and in the longer term sea level rise has potential to impact on coastal habitats, agricultural and peri urban areas through inundation and salinisation. Increased flooding and inundation of coastal settlements is also likely to damage housing and infrastructure. Loss of habitat is possible where coastal habitats including beaches, intertidal flats, rocky shorelines, saltmarsh and mangroves get trapped between landward boundaries and rising sea level.[19]

Where newly inundated areas are available for colonisation, seagrass should be able to move into these new areas provided that the rate of change in sea level is not greater than the ability of an individual species to colonise new habitat, and provided that the newly inundated areas have suitable substrate for colonisation. *Zostera muelleri*, commonly found in intertidal zones in Victoria, is considered stable and persistent and can act as a pioneer species.[21]

The Gippsland coast is highly erodible and is at risk of subsidence, as well as sea level rise. Consequently impacts on non-vegetated soft sediment habitats are likely to be magnified. Where sea walls and levees exist, landwards migration of intertidal habitat in this area will constrain migration, as will sand dunes if they are not breached by storm surge events.[21]

Estuaries and coastal wetlands are complex, dynamic and variable environments, changing with both catchment inflows and marine currents and sand-sediment dynamics.[22] Due to their position in the landscape they are highly vulnerable to direct impacts from climate change.[23] Estuaries and coastal wetlands are likely to be highly vulnerable to climate change, including from changes to inflows, storm surge and sea level rise, with associated impacts resulting from erosion and changes to salinity and water quality.

Changes associated with climate change to dissolved carbon dioxide levels, temperature, rainfall and sea level are likely to interact to affect the circulation of water, levels of salinity, suspended sediments, dissolved oxygen and biogeochemistry of estuaries.[24] However, predicting impacts is difficult because changes are also likely to occur in freshwater and marine systems that subsequently influence estuaries.[24] For example, increasing temperatures and more frequent intense rainfall events are likely to continue to provide the conditions suitable for algal blooms in the Gippsland Lakes. However; reduced streamflows (resulting from reduced rainfall and runoff) and increasing salinity may result in conditions that are less suitable for algal blooms.

Like many natural assets the combined effects of threats from pollution, changes in land use and altered natural river flow patterns are expected to be exacerbated by the effects of climate change.[23]

Smaller riverine estuaries, typical of many of those along the Victorian coast, have been identified as being highly vulnerable to environmental change. This is because they are highly dependent on river flow and groundwater supply for good water quality and suitable habitat for animals and plants.[23]

There are opportunities for coastal wetlands to adapt and migrate inland as sea level rises. However, for bay or inlet estuary types they may become much more constrained as sea level rise pushes them back into the river channels. For many of these ecosystems, the biggest obstacle to migrate naturally inland is the presence of roads, houses and other infrastructure, such as seawalls and levees.

The coastal wetland assets (complexes) and estuaries that were assessed as having the highest potential vulnerability to climate change impacts under a high emissions scenario, by the year 2070 is shown in Appendix 3. An indication of whether the vulnerable coastal wetland and estuary assets are at risk of storm surge and sea level rise impacts is also provided. Appendix 3 details which vulnerable coastal wetland and estuary assets are priorities within the West Gippsland RCS and the RCS Landscape Priority Area the assets relate to.

5.2.3 Native vegetation

Climate change impacts are likely to affect native vegetation through reduced rainfall and increased temperatures.[24] Increased evapotranspiration will in turn impact on the availability of soil moisture and water availability for surface and groundwater systems. It is likely that this will result in a gradual change in the composition of vegetation communities, as some species are replaced by those suited to warmer, drier environments. Some changes may occur earlier, in response to the increased occurrence of extreme events such as droughts or because they are already close to a tipping point.[8] These impacts are likely to be greatest on seasonally dry ecosystems including wetlands and those dependent on shallow water tables (i.e. alpine peatlands and Banksia woodlands), and may be exacerbated by increased groundwater abstraction.[24]

Grasslands may be affected by elevated carbon dioxide and changes to soil moisture, with an increase likely to favour some types of grasses.[8] An increase in the density of tree and shrub species in favour of grassland species is already occurring and is likely to be a major issue across Australia.[19]

The combined effect of changes in climate variables and invasive plants on vulnerable communities poses a significant threat. The response is likely to be variable, however with tropical invasive species more likely to expand their ranges and cool-climate invasive species more likely to retract. Similarly, there could be additional interactions that result from other factors such as soils and land use change.[24] Increased threats from invasive species benefiting from climate change may exceed the direct threats of climate change to many vegetation communities.[24]

Other potential impacts for vegetation communities include:[19]

- Primary production could increase where rain is not limiting, due to increased carbon dioxide,
- Earlier flowering of a range of flora,
- Loss of carbon stocks through changed fire regimes, including more intense and frequent fires and drying of terrestrial vegetation,
- Increased mortality during drought of heat-sensitive species,
- Breeding failures due to loss or mismatch of pollinators,
- Seeding and germination failure due to too high temperatures or lack of soil moisture,
- Potential negative impacts of wildfires on long-lived species and irreversible changes to vegetation communities.

The broad native vegetation groups that were assessed as having the highest potential vulnerability to climate change impacts under a high emissions scenario, by the year 2070 is shown in Appendix 3. An indication of whether the vulnerable assets are a priority asset within the West Gippsland RCS and which RCS Landscape Priority Area the asset relates to is also provided.

5.2.4 Native Fauna

The key threats to fauna are generally associated with their habitat. Key concerns include habitat fragmentation and loss of habitat quality, poor water quality, altered hydrological regimes, barriers to fish passage, competition from invasive plants and animals, and altered fire regimes. Climate change is likely to amplify these existing threatening processes, making their impacts considerably worse. Future declines or losses of local populations of species, and species extinctions are possible as a result.

While the fauna of West Gippsland has adapted to a variable and episodic climate, the impact of future climate change is difficult to predict with any certainty. The effects of climate change on flora and fauna will occur at different levels, from individual to ecosystems. Species may alter distribution, abundance, behaviour and the timing of events such as migration or breeding. The most susceptible species will be those with restricted or specialised habitat requirements, poor dispersal abilities or small populations.[12]

Natural environments are already responding to climate change. Species are moving to higher elevations in alpine regions, some species' ranges are expanding southward to cooler climates, migratory birds are arriving earlier and departing later, and breeding seasons are occurring earlier.

Although many Victorian species appear able to withstand short-term climatic variability, longer-term shifts in climate and the increased frequency or intensity of extreme events will provide a significant challenge to the survival of many species because of their limited capacity to adapt to changing environments. If the adaptive capacity of species is exceeded, migration to more suitable conditions will be a necessity. A compounding factor in Victoria is that the high level of habitat fragmentation will limit the migration opportunities of the less-mobile species. Species inhabiting high-altitude or southerly habitats will have limited scope to migrate.[25]

There is a growing body of research associated with potential fauna impacts from climate change in alpine ecosystems. Australia's alpine fauna are thought to be highly vulnerable to the effects of climate change.[26] Shorter drier winters and reductions in snow cover are projected as the result of climate change, which will have implications for Victoria's unique alpine region and the flora and fauna species that live there, many of which are already endangered. Species endemic to the alpine regions will have nowhere to retreat to as the climate warms.[12]

Coastal wetlands and embayments provide critical habitat for a diversity of migratory waders and aquatic bird species, making this one of the most significant areas for these species in Australia. Future climate impacts associated with sea level rise and storm surge are likely to drive shifts in the extent and distribution of key habitats such as seagrass and mudflats, with potentially major impacts on species that depend on these ecosystems, including numerous significant bird and fish species.

5.2.5 Soils and land

The vulnerability of soils to climate change is dependent on the inherent properties of the soil as described by the soil type and the level of ground cover.

The consequences of a warmer and drier climate on soils include a reduction in soil carbon levels, increased risk of soil erosion and loss of nutrients, changes in land suitability for certain types of agriculture, increases in the occurrence of 'transient' salinity, and water quality impacts, particularly following bushfires.[27]

An increase in fire frequency and intensity, particularly in areas of permanent vegetation, will reduce the amount of ground cover and soil stability and consequently increase the risk of water erosion.[27] Soil erosion during intense rainfall events, following severe fires has been the cause of water quality issues in the West Gippsland region.

Maintaining ground cover to protect soils from both water and wind erosion will be greater under a changing climate. Soils without permanent vegetative cover (e.g. cropping lands) will be at higher risk than those with stable protection. Erosion puts the productivity of land at risk and increases the risk of unwanted effects on water quality and aquatic ecosystems through the movement of sediments and nutrients.

Hydrological changes as the result of increased rainfall or rising sea levels may increase the risk of dryland salinity, with adverse impacts on agricultural productivity and native vegetation. Increased salinisation in near-coastal areas is likely to occur if sea levels rise along the coastline.

The broad soil types that were assessed as having the highest potential vulnerability to climate change impacts under a high emissions scenario, by the year 2070 are presented in Appendix 3. An indication of whether the vulnerable assets are a priority asset within the West Gippsland RCS and which RCS Landscape Priority Area the asset relates to is also provided.

5.3 Implications for Aboriginal Cultural values

Traditional Owners have a strong connection to Country and the preservation of cultural heritage sites is extremely important. The Gunaikurnai peoples and Kulin peoples are the traditional custodians of the country covered by the West Gippsland region.[11]

Tribes of the Gunaikurnai peoples within the region include:

- Brataulaung
- Brayakaulung
- Tatungalung

Tribes of the Kulin peoples within the region include:

- Bunurong
- Boon Wurrung
- Wurundjeri

Traditional Owners core values radiate fundamentally from the preservation and protection of their culture. This includes preservation of language, stories, culture, networks, identity and the appropriate management of significant sites. A key objective of the *Aboriginal Heritage Act 2006* is to promote the management of Aboriginal cultural heritage as an integral part of land and natural resource management. There are many areas of Aboriginal cultural sensitivity within the West Gippsland region. Waterways, coastal landscapes and mountainous areas are of particular importance.

The 2015 Gunaikurnai Whole of Country Plan notes that 'climate change poses a further threat to our Country with decreasing rainfall and an increase in temperatures threatening the health of our rivers and land. Our towns and bush will come under threat from increased bushfire events, and the flooding of coastal environments and towns will have a major impact on cultural and natural values as well as the tourism industries'.[28]

Cultural values such as artefacts, scar trees, shell middens or burial sites may be damaged or lost as the result of climate change impacts (i.e. fire, flood, coastal erosion and shoreline retreat).

It will be important to work with Traditional Owners to protect or record cultural values before they may become impacted or lost due to climate change.

5.4 Climate change planning areas

The locations of the most vulnerable assets in the region, which have been identified within each asset class, were mapped and then overlaid to show where clusters of highly vulnerable assets occur in the landscape (Figure 7).[6]

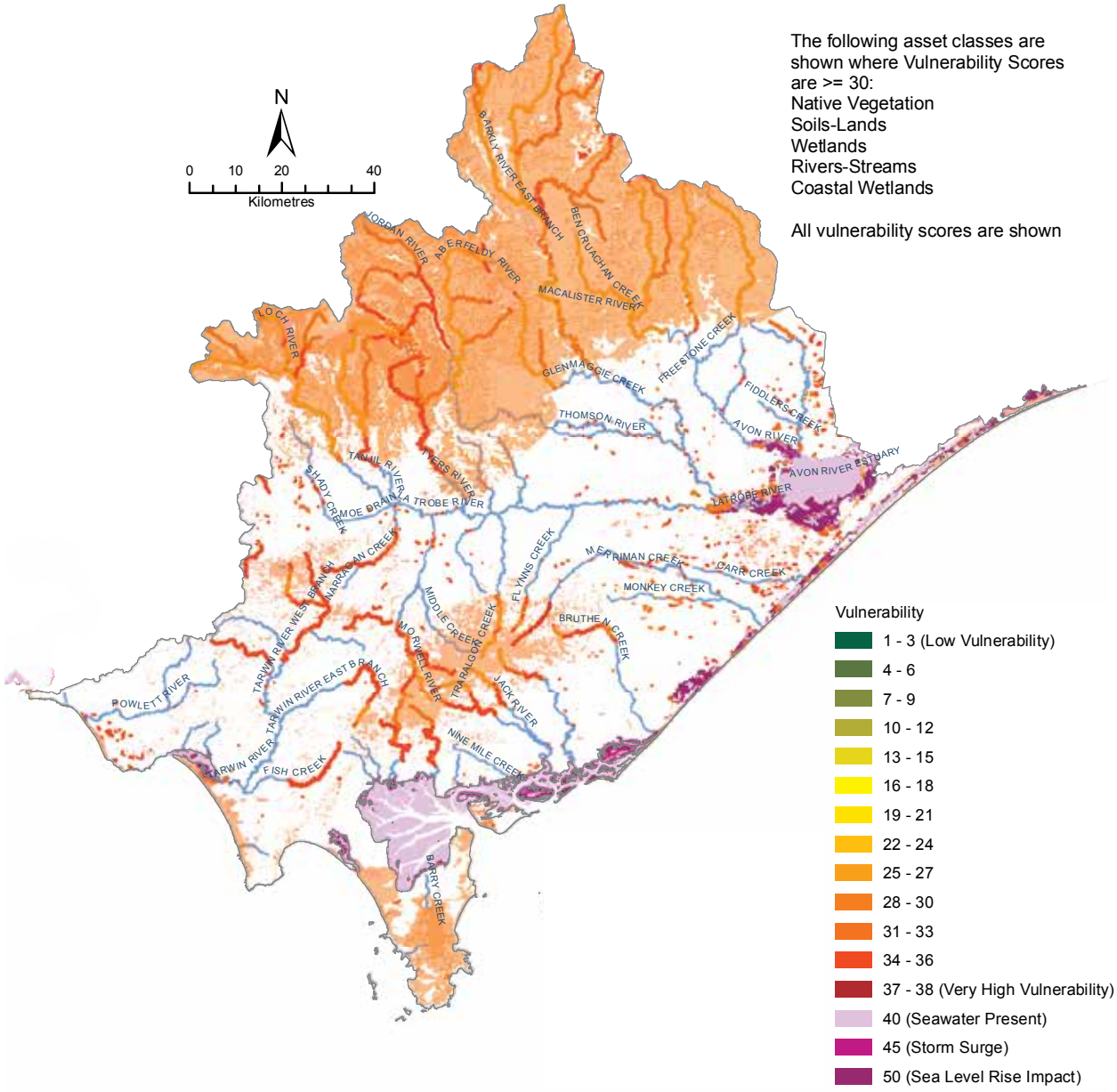

Figure 7: Location of natural assets with a very high vulnerability (including assets impacted by Sea Level Rise & Storm Surge) RCP 8.5 2070 Vulnerability score >= 30

The West Gippsland RCS priority landscape area boundaries were then applied to examine how they relate to the clusters of highly vulnerable assets (Figure 8).

As many of the highly vulnerable assets identified through the impact and vulnerability assessment process fall within the RCS landscape priority areas, a review of the existing threats to natural assets identified in the West Gippsland RCS was undertaken. This is because climate change impacts on natural assets will likely be exacerbated by acting in combination with other threats such as fire, flood, habitat loss and change in land-use and management practices, invasive animals and pests and diseases, and altered water availability and regimes.[19]

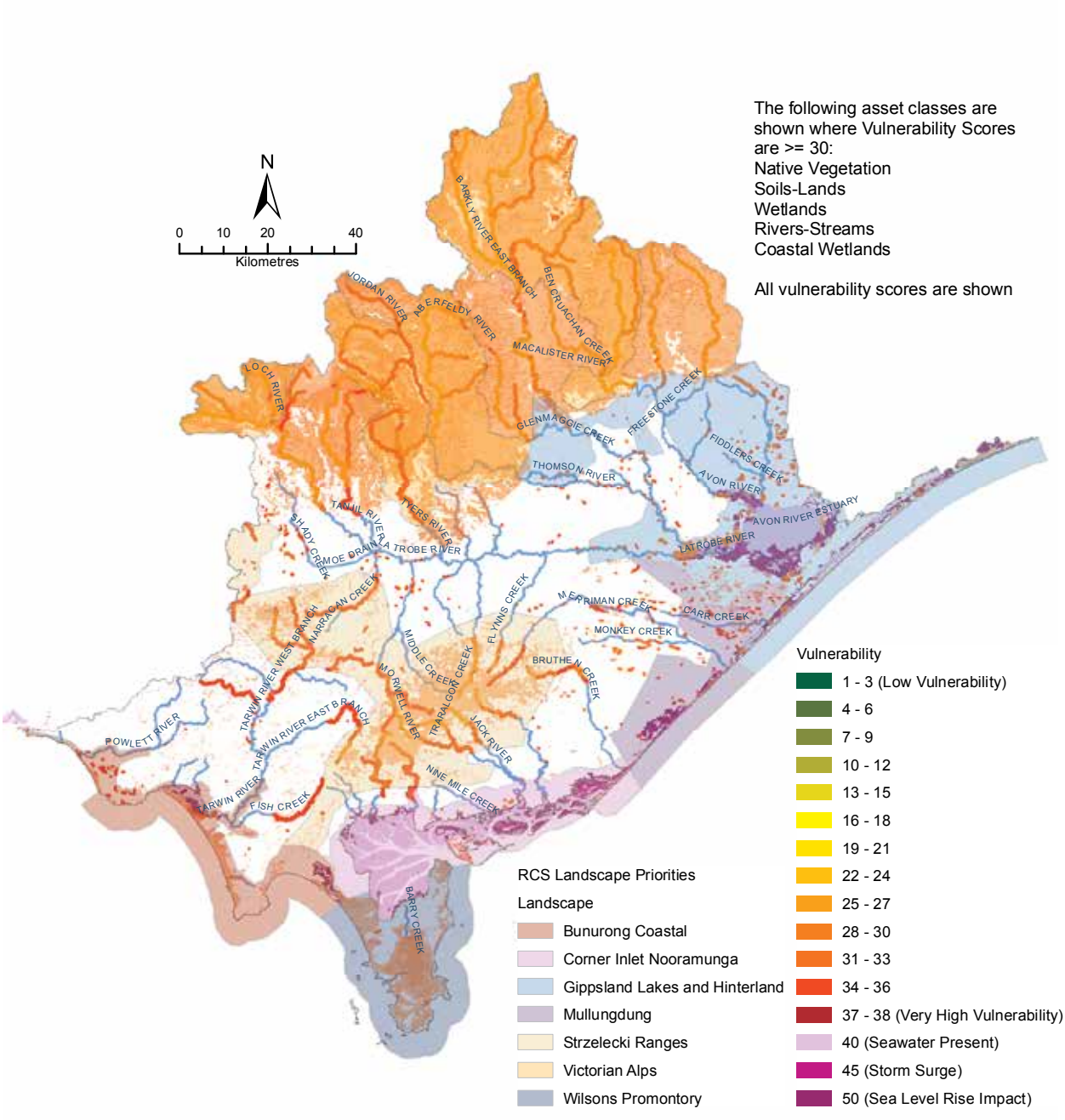

Figure 8: Location of RCS priorities in relation to natural assets with a very high vulnerability (including assets impacted by Sea Level Rise & Storm Surge) RCP 8.5 2070 Vulnerability score >= 30

The review assessed how the projected changes to climate variables may influence existing threats and provided a way of thinking about the likely impacts of climate change whilst considering existing threat levels. For example reduced rainfall and increased temperature are likely to have a direct impact on the threat of fire and when all the climate variables are considered it is likely that there will be a high level of increased impact from fire in the future. For each asset the assessment identified both the current level of threat and the likely change in threat in the future.

The review revealed that climate change will have the highest combined impact on the threats from:

- soil erosion,
- altered fire regimes,
- altered flow regimes,
- degraded water quality,
- livestock impacts/grazing pressure and;
- loss of native vegetation.

Together with the results of the vulnerability assessment and in consultation with regional stakeholders, the review assisted in identifying the most appropriate locations to focus climate change adaptation and mitigation planning efforts within the region. This led to the identification of the following five climate change planning areas (Figure 9):

1. Victorian Alps
2. Gippsland Lakes and Hinterland (including the Latrobe River system)
3. Strzelecki Ranges
4. Coastal landscapes (including Bunurong Coast, Corner Inlet Nooramunga and Mullungdung)
5. Wilsons Promontory

These five broad geographic areas have been used as the basis for the detailed Adaptation and Mitigation Plan described in Section 6. In this section we describe the current situation and issues to consider, along with proposed adaptation and mitigation strategies/options that have been identified with the assistance of regional stakeholders through workshops and further consultation. Each of the strategies and options were assessed for their adaptation or mitigation benefit; social, technical and economic feasibility; potential for maladaptation and relevance over time (i.e. 2030, 2050, 2070 and 2090).

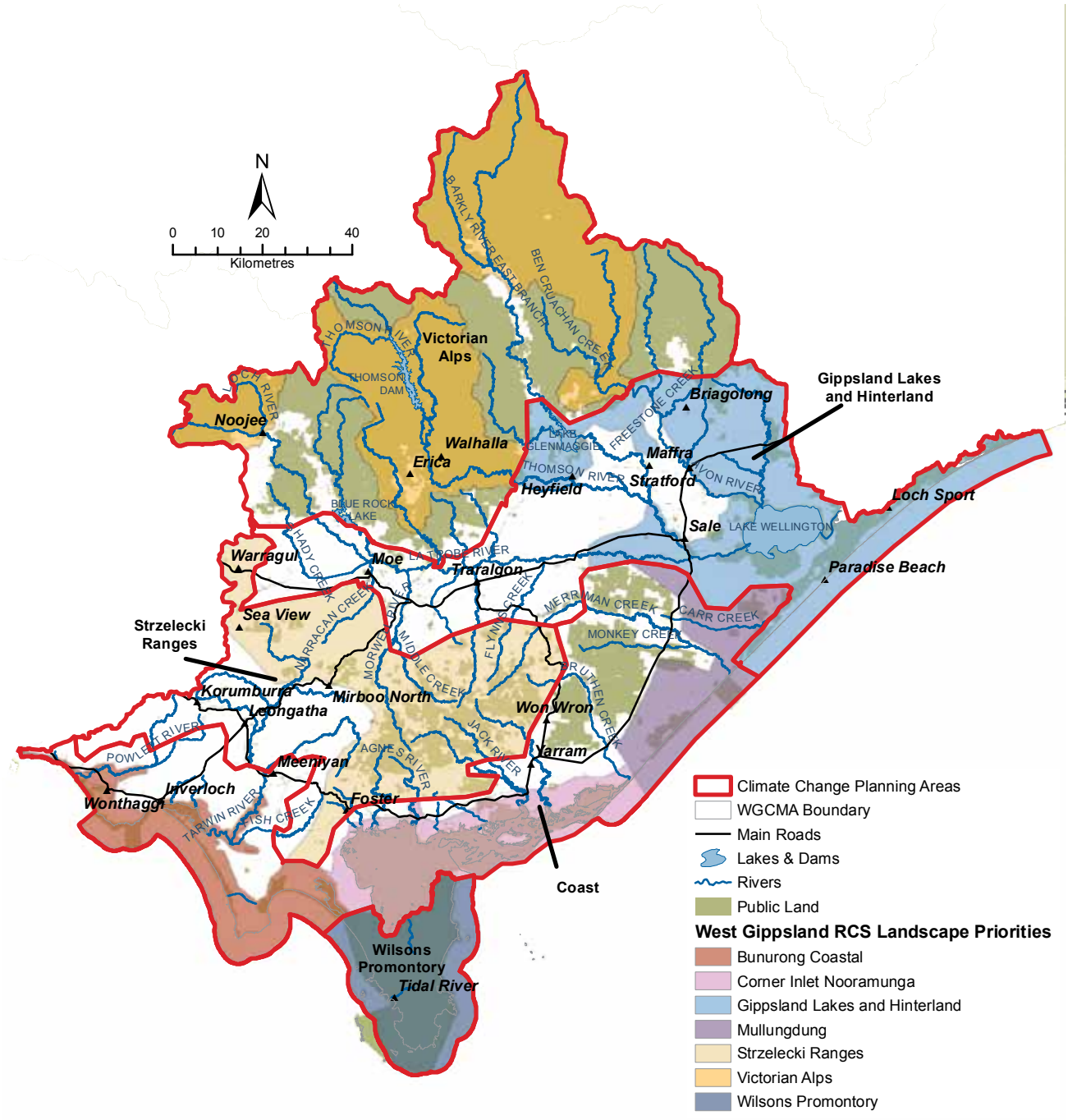

Figure 9: Planning areas for climate change adaptation and mitigation

6 Strategies for adaptation and mitigation

6.1 Summary of adaptation and mitigation strategies

Strategies and options to support adaptation and mitigation were identified through a series of workshops, together with additional regional consultation. Each of the strategies and options were assessed by stakeholders for their adaptation or mitigation benefit; social, technical and economic feasibility; potential for maladaptation and relevance over time (i.e. 2030, 2050, 2070 and 2090). These options are summarised in Table 2 below.

The options are described in detail in subsequent sections for each of the five planning areas, and where relevant for mitigation options the specific sequestration opportunities are highlighted. The rationale for the options and links to RCS objectives are set out in Section 7.1.

Table 2: Summary of adaptation and mitigation strategies

Adaptation and mitigation strategies	Planning area				
	Victorian Alps	Gippsland Lakes & Hinterland	Strzelecki Ranges	Coastal Landscapes	Wilsons Promontory
Cultural heritage					
Preservation of Aboriginal cultural heritage sites.	✓	✓	✓	✓	✓
Land and soil health					
Support the adoption of land management practices that improve soil health and production outcomes on grazing land.		✓	✓	✓	
Support programs that assist private landholders to adapt or make a planned retreat as a result of drier and warmer average conditions, increased salinity, inundation and erosion.		✓			
Support private land managers along the coast to adapt or make a planned retreat in areas impacted by sea level rise and storm surge.				✓	
Native vegetation and habitat					
Improve the adaptive capacity of vegetation communities through works to protect and improve their condition and connectivity.			✓		
Improve the adaptive capacity of remnant vegetation through works to increase connectivity, improve condition and protect high quality remnants.		✓	✓	✓	

Table 2: Summary of adaptation and mitigation strategies *continued*

Adaptation and mitigation strategies	Planning area				
	Victorian Alps	Gippsland Lakes & Hinterland	Strzelecki Ranges	Coastal Landscapes	Wilsons Promontory
Support carbon sequestration through the establishment of targeted biodiverse plantings in areas that address priorities for biodiversity, land and waterway health.		✓	✓	✓	
Improve the condition of Alpine peatlands to mitigate future impacts from drying climate.	✓				
Waterways and environmental water					
Investigate options to improve water security for domestic, industrial and agricultural uses while protecting flows for environmental outcomes.			✓		
Investigate options to improve security of environmental water for high value waterways and wetlands.		✓			
Identify priorities and develop plan of works to improve hydrological regime of floodplain wetlands and fringing wetlands.		✓		✓	
Diversify approaches used for managing environmental water.	✓				
Consider climate change impacts in future estuary management activities.		✓		✓	✓
Investigate options to lessen the offsite impacts to water quality following extreme events (e.g. flood, fire).	✓	✓	✓	✓	✓
Managing threats and adapting NRM programs					
Refine the approaches used by natural resource managers when planning and implementing fencing, weed control and revegetation programs to take account of changing climatic conditions.		✓	✓	✓	
Support fire management agencies to effectively control fires when they occur to reduce risk of fire to sensitive natural assets and support the recovery of communities from bushfire.	✓	✓	✓	✓	✓

Table 2: Summary of adaptation and mitigation strategies *continued*

Adaptation and mitigation strategies	Planning area				
	Victorian Alps	Gippsland Lakes & Hinterland	Strzelecki Ranges	Coastal Landscapes	Wilsons Promontory
Work with Local Government and State agencies to improve environmental outcomes.		✓	✓	✓	
Support coastal NRM agencies to plan for adaptation or retreat in areas impacted by sea level rise and storm surge.		✓		✓	✓
Improve the adaptive capacity of ecosystems by actively managing existing threats.	✓				✓
Support research and investigation to address knowledge gaps.	✓	✓	✓	✓	✓
Manage impacts to ecosystems from future pressures of increased recreational use.	✓		✓	✓	✓
Region wide strategies					
• Refine monitoring and evaluation programs to inform adaptive management under climate change. • Support increased community awareness and participation in climate change adaptation and mitigation programs. • Continue to coordinate partnership approaches for the planning and delivery of climate change adaptation and mitigation programs.					

6.2 Victorian Alps

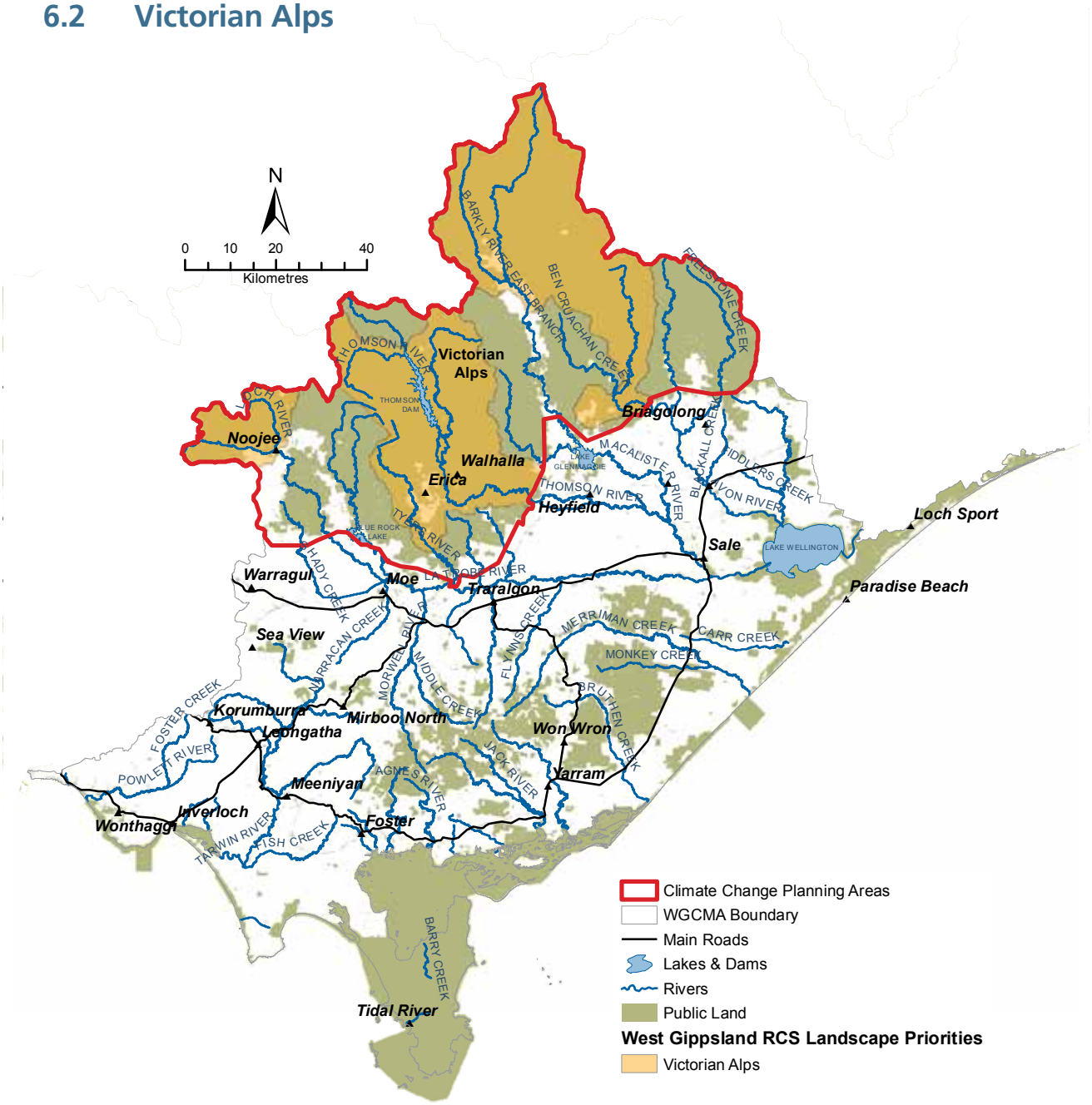

Figure 10: Victorian Alps climate change planning area

The Victorian Alps climate change planning area is characterised by its largely contiguous vegetation and topography. It is valued for its National and State Parks and Wilderness Areas, which provide for a wide array of recreational opportunities. Whilst the snow fields have always been popular, there is a growing trend towards summer recreation. There has been an overall increase in recreational use (e.g. 4WD, cycling, camping, horse-riding and trail bikes) and consequently visitors' desire better road access. Remote areas of the National Parks are now accessible and this will continue to increase. Recreational pressures are likely to increase in both intensity and geographic scope, placing increased pressures on vulnerable ecosystems.

There are relatively limited areas of forest utilisation in the planning area occurring within State forest, which encompass activities such as timber harvesting, licensed grazing and apiary.

Two key reservoirs are situated within the planning area: Blue Rock and Thomson. Blue Rock Reservoir supplies water for industrial, domestic and environmental purposes within the region. The Thomson Reservoir is an extremely important source of water for Melbourne, making up about 60% of Melbourne's total storage capacity.[29] Whilst the upper reaches of the rivers that flow through the landscape are currently in excellent to good condition,[11] these high value waterway systems are vulnerable from exposure to reduced and more episodic rainfall, and higher evapotranspiration rates.

The landscape is underpinned by relatively stable soils and contains largely intact ecological vegetation communities and numerous rare and threatened species. The presence of vegetation cover across much of the area contributes to generally high adaptive capacity of native vegetation and soils in particular, although the impacts associated with a likely increase in the intensity and frequency of large fires is likely to pose a significant future challenge to the values of all natural assets within the planning area.

Wetlands listed in the Directory of Important Wetlands of Australia (DIWA), which are valued for their intact hydrology, geomorphologic significance and habitat provision are a key feature of this landscape.[11] They include sensitive subalpine and alpine wetlands, such as Caledonia Fen and Tali Karng, and EPBC listed Alpine Sphagnum Bogs and associated Fens. Unique and restricted flora and fauna species are reliant upon these alpine peatlands and sphagnum bogs. Alpine Ash (Eucalyptus delegatensis) and Mountain Ash (Eucalyptus regnans) are iconic tree species within this landscape. As the alpine peatlands are fed by groundwater and Ash forests require high rainfall, they would be especially vulnerable to a warming, drying trend and an increase in fire frequency and intensity.

The historic sequence of fires, flood and drought has had a large impact on the landscape to date. The true impact of repeated burning on the make-up of vegetation communities is uncertain. The impact of fire will be felt in relation to natural assets within the planning area and more broadly in terms of increased soil loss and reduced water quality in downstream waterways and coastal ecosystems.

Threats that will be accelerated due to climate change in the Victorian Alps relate to the intensity and frequency of fire, new and emerging invasive plant and animal species, and changes in seasonal timing, which alter animal and plant phenology.

A major risk concerns the reduced extent of refugia for plants and animals that are adapted to (and limited by) the very specialised ecosystems of the Alps.[30] Alpine plant and animal species have evolved to cope with environmental extremes, including low temperatures, high winds, snow cover for long periods and seasonal inundation. Subsequently many species are found only in alpine areas and include species at risk of extinction (e.g. the Baw Baw Frog). Alpine-adapted species are vulnerable to climate change impacts, such as changes in snow cover, stream flows and frequency of large scale wildfire.[30]

Table 3: Strategies for climate change adaptation and mitigation – Victorian Alps

Strategies	Options for strategy implementation		Adaptation	Carbon mitigation		
				Biodiverse carbon plantings	Blue carbon	Soil carbon
VA 1 – Support fire management programs that adopt appropriate fire regimes to manage sensitive natural assets and assist the recovery of ecological communities from bushfire.	a	*Explore alternative fuel management techniques so that tolerable fire intervals are not exceeded by planned burns.*	✓			
	b	*Improve fire planning processes and on ground wildfire management activities to protect sensitive natural assets.*	✓			✓
VA 2 – Improve the adaptive capacity of ecosystems in the Victorian Alps by actively managing existing threats.	a	*Active management of invasive plants and animals in the highest value ecosystems in the sub-alpine and alpine areas.*	✓			
	b	*Fence and revegetate wide riparian buffers along priority waterways where there is a private land interface.*	✓	✓		
	c	*Undertake large scale re-seeding of vegetation communities following wildfire (for example Alpine Ash and Mountain Ash).*	✓	✓		
VA 3 – Improve the condition of Alpine peatlands to mitigate future impacts from drying climate.	a	*Consider options to address threats to the hydrological regime of peatlands (including engineering options, willow control, close, re-align or rehabilitate inappropriate tracks, roads and drainage lines and preventing access). *Focus on Baw Baw peatlands as the highest priority.*	✓			✓
VA 4 – Support research and investigation to address knowledge gaps.	a	*Explore implications of climate change for groundwater dependent ecosystems, including springs.*	✓			
	b	*Identify and protect drought refuges across the planning area.*	✓			
	c	*Monitor the responses of highly susceptible ecological communities and keystone species to a changing climate.*	✓			
	d	*Monitoring of invasive species with a focus on new and emerging species.*	✓			

Table 3: Strategies for climate change adaptation and mitigation – Victorian Alps *continued*

Strategies	Options for strategy implementation		Adaptation	Carbon mitigation		
				Biodiverse carbon plantings	Blue carbon	Soil carbon
VA 5 – Managing impacts to alpine ecosystems from future pressures of increased recreational use.	a	*Continue to collect information on alpine peatland condition to better understand thresholds and response to current management activities.*	✓			
	b	*Manage access to sensitive areas through zoning of public land to concentrate people in designated areas, improving facilities through construction of boardwalks and formal access tracks, and prohibiting access in some places.*	✓			
	c	*Raise visitor awareness of the values of the alpine areas, their sensitivity to human impacts and the rationale for particular management activities.*	✓			
VA 6 – Diversify approaches used for managing environmental water.	a	*Continue to raise awareness of the purpose and need for environmental water in the Gippsland region.*	✓			
	b	*Factor the vulnerability of waterways (including wetlands) to climate change into environmental water planning.*	✓			
	c	*Investigate options to address identified environmental water shortfalls.*	✓			
VA 7 – Investigate options to lessen the offsite impacts to water quality following extreme events (e.g. flood, fire).	a	*Undertake risk management planning for land use management under climate change.*	✓			
VA 8 – Preservation of Aboriginal cultural heritage sites.	a	*Explore how to best incorporate specific management recommendations relating to climate change impacts on Aboriginal sites into Cultural Heritage Management Plans (CHMPs).*	✓			

6.3 Gippsland Lakes and Hinterland (including the Latrobe River system)

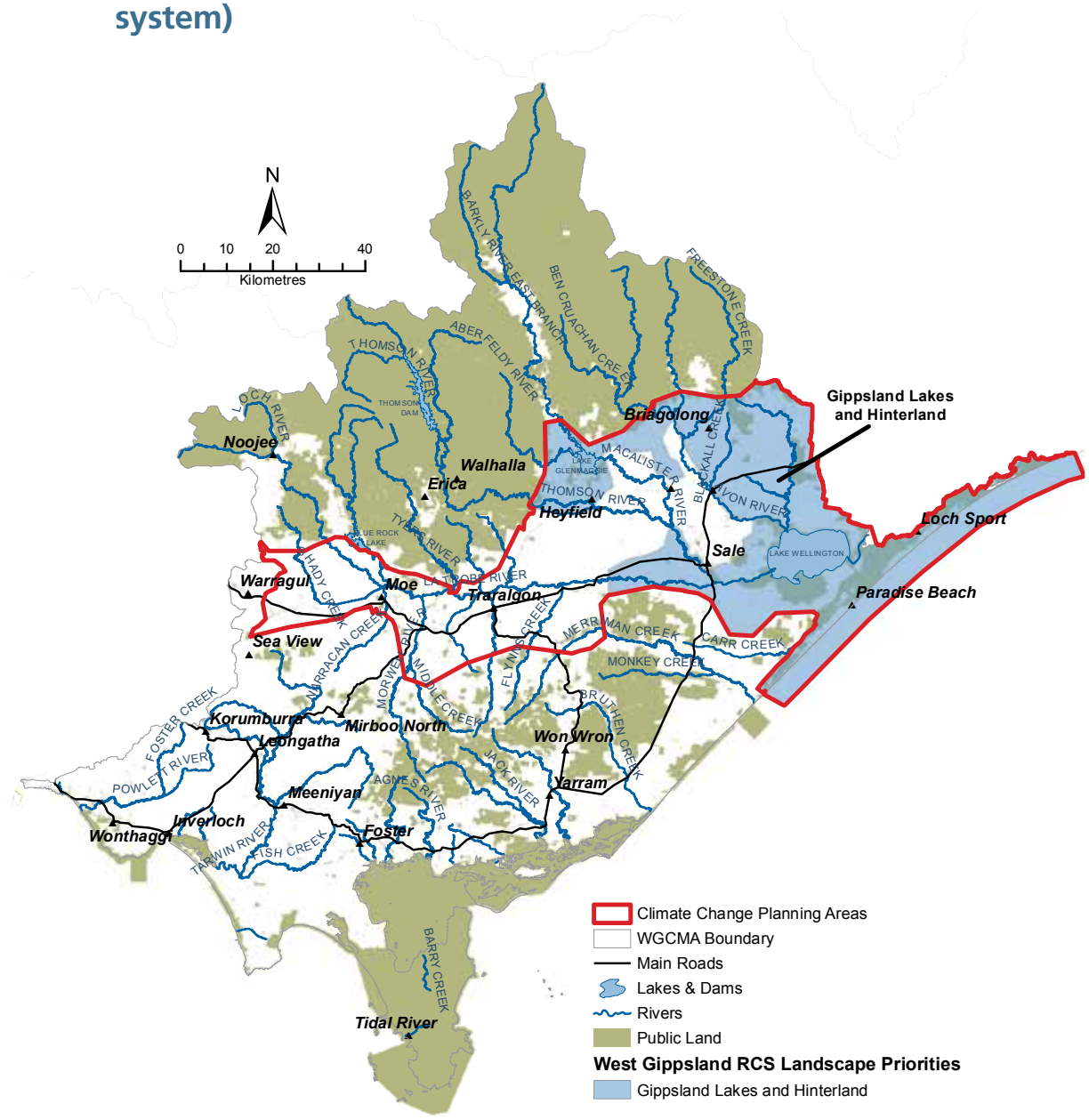

Figure 11: Gippsland Lakes and Hinterland climate change planning area

The Gippsland Lakes and Hinterland climate change planning area is characterised by the iconic Gippsland Lakes and wetlands Ramsar site. The Gippsland Lakes is of high social, economic, environmental and cultural value and is a major drawcard for tourists.

Ongoing protection of the values of significant natural assets within the planning area is of importance, as current threats (e.g. inappropriate fire regimes, invasive plants, flow stress, salinity) are likely to be amplified by climate change.

Natural grassy woodland ecosystems across the planning area have historically been cleared and converted to land used for pasture and cropping. The Gippsland Red Gum Grassy Woodland and associated Native Grassland ecological community is the focus of recent initiatives that are aimed at protecting the high quality areas of the EPBC Act listed community, which may increase their resilience to climate change impacts.

A number of major Gippsland rivers (Latrobe, Thomson, Macalister, Avon and Perry) all drain through floodplains to Lake Wellington and ultimately the Southern Ocean, with the Perry River being one of the few waterways in Victoria to have an intact chain of ponds geomorphology.[11] Many landholders along the major waterways have been involved in programs to remove willows and fence and revegetate riparian areas. Floods have caused major damage to waterways within the planning area, and a program of flood recovery works has also been undertaken over the last 3 - 5 years.

Future climate projections indicate a decline in average rainfall in the upper catchment of the Gippsland Lakes. This is likely to reduce stream flows, posing challenges for the health of waterways flowing into the Gippsland Lakes, as well as exacerbating increasing salinity levels in the lower reaches.

Large areas of floodplain wetlands on the lower Thomson and Macalister Rivers have been fenced and vegetation restored. The management of water regimes in fringing wetlands has received increased attention in recent years, and along with complementary works at sites like the Heart Morass and Sale Common, the condition of these wetlands is improving.

There have been episodic changes in the fringing wetlands and main lakes as a result of increasing salinity of the lakes, changes to river flows and natural events such as drought, fire and flood. Land around Lake Wellington that has been subjected to increased salinisation is already seeing a transition from pasture to saltmarsh.

The predicted increase in sea level and associated impact of storm surges has the potential to profoundly change the values and function of important natural ecosystems of the Gippsland Lakes and hinterland. Changes are already being experienced in some areas as a result of rising sea levels and some values, such as those associated with the Lakes and their fringing wetlands are likely to be rapidly diminished by 2070. This will inevitably mean that difficult trade-off decisions will need to be considered regarding which assets are worthy of protection 'at all costs', or whether there needs to be an acceptance that their future values will be different.

Urban growth is increasing along the western end of the Princes Highway corridor, particularly in Yarragon, Trafalgar, Moe, Morwell and Traralgon. As a result rural drains are becoming formalised and constructed wetlands are being developed for stormwater management.

In addition to urban growth there has been an increase in the number of small lifestyle/hobby farms around the edges of large and small towns. Unlike the urban growth which is concentrated in the west of the planning area (Baw Baw Shire and Latrobe City Council) the increase of hobby farms is occurring across the planning area.

Within the Latrobe Valley the coal industry is a major presence and influence in the landscape. In addition to the land that is taken up by coal mines, the industry holds large water entitlements and discharges water through river systems. AGL have indicated in their Greenhouse Gas Policy released on 17 April 2015 that they will be closing all existing coal-fired power stations in its portfolio by 2050.[31] This may possibly result in the eventual decommissioning of the Loy Yang A coal-fired power station. As noted in the 2011 Gippsland Region Sustainable Water Strategy, any Latrobe Valley open cut mine closure and restoration strategies will need to consider impacts on groundwater and surface water resources.[32]

There is a strong history of large scale commercial farming throughout the planning area, including the Macalister Irrigation District (MID), which is the largest irrigation area south of the Great Dividing Range. A mixture of agroforestry and commercial forestry plantations can be found in the Perry River area and to the south of the Latrobe River around Holey Plains.

Farmers continually adapt to climatic variability in the short and long term and look for opportunities to better use their land. Changes in land use and management practices have been observed throughout the area, particularly since the drought during the early 2000's. Water availability has driven water use efficiency measures on farm and the nutrient reduction focus for the Gippsland Lakes has seen local businesses participating in farm planning and implementation of on farm measures such as reuse dams. In recent years the MID has undergone 'modernisation' with upgrades to irrigation infrastructure both on farm and within the delivery system.

In the MID, the Avon River floodplain and around Seaspray there has been a shift to horticulture from dairy and dryland grazing and cropping. The increase in horticulture includes farms moving from other areas of Australia which have become less reliable in terms of water availability and climate.

A shift from year round high levels of ground cover (pasture) to seasonal cultivation and harvesting practices (i.e. cropping and horticulture) can present an increased risk of sediment and nutrient loss following rainfall events. An increase in farm dams in the catchment (for stock and domestic use and irrigation) can have an impact on catchment yield and contribute to flow stress in rivers.

Fire in the catchment is a major threat to both agriculture and the natural assets. Both wildfire and planned burns are increasing in frequency and area. The impact of large fires on the health of the Gippsland Lakes and the condition and diversity of native vegetation is significant.

Further challenges will be experienced in the hinterland for soils, waterways and floodplain wetlands due to changes in agricultural land uses as a result of both market forces, water availability and a changing climate.

Table 4: Strategies for climate change adaptation and mitigation – Gippsland Lakes and Hinterland

Strategies	Options for strategy implementation		Adaptation	Carbon mitigation		
				Biodiverse carbon plantings	Blue carbon	Soil carbon
GLH 1 – Support programs that assist private landholders to adapt or make a planned retreat as a result of drier and warmer average conditions, increased salinity, inundation and erosion.	a	*Education and awareness programs for private landholders about the impacts and options to manage for drier average conditions, rising sea level, increased erosion and inundation.*	✓			
	b	*Provide incentives to allow for natural regeneration of vegetation communities that are well adapted to increased salinity and inundation (such as saltmarsh and brackish wetland communities).*	✓		✓	
GLH 2 – Work with Local Government and State agencies to improve environmental outcomes.	a	*Explore land use planning mechanisms to protect high value natural assets on agricultural land subject to enterprise change.*	✓			✓
	b	*Explore options to protect high value floodplain and plains wetlands of the Latrobe River valley, Macalister Irrigation District and the Avon and Perry Rivers.*	✓			
GLH 3 – Refine the approaches used by natural resource managers when planning and implementing fencing, weed control and revegetation programs to take account of changing climatic conditions.	a	*Adjust species mixes for revegetation activities to suit changed conditions (drier, warmer, increased salinity, increased inundation).*	✓	✓	✓	
	b	*Consider use of a range of management techniques to maintain diversity within grassy ecosystems.*	✓			
	c	*Consider use of natural regeneration and direct seeding to achieve establishment of native vegetation.*	✓	✓	✓	
	d	*Encourage and provide incentives for landholders to fence and revegetate wider riparian buffers along priority waterways.*	✓	✓	✓	
	e	*Support projects that improve and protect the condition, diversity and structure of existing habitat (particularly Gippsland Grassy Woodland and Seasonal Herbaceous Wetlands).*	✓	✓	✓	
GLH 4 – Improve the adaptive capacity of remnant vegetation through works to increase connectivity, improve condition and protect high quality remnants	a	*Identify appropriate delivery mechanisms to achieve outcomes (including covenants, planning scheme tools and incentives).*	✓			

Table 4: Strategies for climate change adaptation and mitigation – Gippsland Lakes and Hinterland *continued*

Strategies	Options for strategy implementation		Adaptation	Carbon mitigation		
				Biodiverse carbon plantings	Blue carbon	Soil carbon
GLH 5 – Investigate options to improve security of environmental water for high value waterways and wetlands.	a	*Factor the vulnerability of waterways (including wetlands) to climate change into environmental water planning.*	✓			
	b	*Investigate alternate delivery methods to provide environmental water to high value waterways and wetlands (e.g. use of irrigation infrastructure).*	✓			
	c	*Investigate the feasibility of options that address identified environmental water short falls.*	✓			
GLH 6 – Identify priorities and develop plan of works to improve hydrological regime of floodplain wetlands and fringing wetlands.	a	*Construction of treatment wetlands to capture stormwater from existing developed areas.*	✓		✓	
	b	*Investigate partial re-engagement of old river meanders to increase riverine wetland habitat.*	✓		✓	
	c	*Plan of works to consider earthworks and waterway structures and options to work with landholders to manage water for multiple outcomes (e.g. floodplain wetlands upstream of the Swing Bridge).*	✓			
GLH 7 – Support fire management programs that adopt appropriate fire regimes to manage sensitive natural assets and assist the recovery of ecological communities from bushfire.	a	*Potential areas to focus on include rainforest, riparian and wetland habitats.*	✓			
GLH 8 – Support carbon sequestration through the establishment of targeted biodiverse plantings in areas that address priorities for biodiversity, land and waterway health.	a	*Encouraging landholders in peri-urban areas to undertake biodiverse plantings and allow natural regeneration to occur (with consideration to fire risk).*	✓	✓		
	b	*Fence and revegetate wide riparian buffers along priority waterways.*	✓	✓	✓	

Table 4: Strategies for climate change adaptation and mitigation – Gippsland Lakes and Hinterland *continued*

Strategies	Options for strategy implementation		Adaptation	Carbon mitigation		
				Biodiverse carbon plantings	Blue carbon	Soil carbon
GLH 8 – Support carbon sequestration through the establishment of targeted biodiverse plantings in areas that address priorities for biodiversity, land and waterway health *continued*	c	*Improve connectivity and buffer remnant ecosystems, with a focus on rare or unique types including chain of ponds systems.*	✓	✓	✓	
	d	*Improve connectivity and buffer remnant vegetation with a focus on Red Gum Grassy Woodland and Seasonal Herbaceous Wetlands of the temperate plain.*	✓	✓	✓	
GLH 9 – Support research and investigation to address knowledge gaps.	a	*Build on recent knowledge that highlights the potential for blue carbon sequestration in saltmarsh, seagrass and mangrove habitats to explore how restoration programs might be designed to capitalise on opportunities.*	✓		✓	
	b	*Explore implications of climate change for groundwater dependent ecosystems, including springs.*	✓			
	c	*Explore risks and opportunities for water and waterway management in the Latrobe Valley that may arise as the result of any potential decommissioning of the Latrobe Valley coal mines and changes to the power industry in the long-term future.*	✓			
	d	*Identify and protect drought refuges across the planning area.*	✓			
	e	*Improve knowledge of how wetland type and function will change as a result of drier, warmer and more variable climate to inform future management.*	✓		✓	
	f	*Improve knowledge of response of Red Gum Grassy Woodland to warmer, drier conditions to inform future management.*	✓			
	g	*Model future spread of established weeds to inform planning for coordinated control across land tenure.*	✓			
	h	*Monitor the responses of highly susceptible ecological communities and keystone species to a changing climate.*	✓			

Table 4: Strategies for climate change adaptation and mitigation – Gippsland Lakes and Hinterland *continued*

Strategies	Options for strategy implementation		Adaptation	Carbon mitigation		
				Biodiverse carbon plantings	Blue carbon	Soil carbon
GLH 10 – Support the adoption of land management practices that improve soil health and production outcomes on grazing land.	a	*Encourage landholders to adopt practices that:* - *Improve ground cover, moisture retention, and reduce runoff following summer rainfall events.* - *Optimise grazing management systems with consideration to stocking rates, nutrient management, herd composition, breeding times and destocking.* - *Follow best management practice techniques (e.g. flexible grazing techniques, use of summer active perennials in pasture systems, changing cultivars to those better adapted to maintain ground cover at all locations, minimum-till, and controlled traffic farming, etc.).*	✓			✓
GLH 11 – Consider climate change impacts from sea level rise, storm surge and catchment processes in future management of estuaries.	a	*Establish long term monitoring programs for estuaries and associated habitats.*	✓			
	b	*Explicitly factor climate change into estuary management.*	✓			
GLH 12 – Support coastal NRM agencies to plan for adaptation or retreat in areas impacted by sea level rise and storm surge.	a	*Identify location and likely impact on natural assets from increased salinity, inundation and coastal erosion.*	✓			
	b	*Investigate options to add land to the national reserve system to provide for migration of habitats.*	✓	✓	✓	
	c	*Relocate infrastructure impacted by storm surge and sea level rise and rehabilitate to prevent further erosion.*	✓			
GLH 13 – Investigate options to lessen the offsite impacts to water quality following extreme events (e.g. flood, fire).	a	*Undertake risk management planning for land use management under climate change.*	✓			
GLH 14 – Preservation of Aboriginal cultural heritage sites.	a	*Explore how to best incorporate specific management recommendations relating to climate change impacts on Aboriginal sites into Cultural Heritage Management Plans (CHMPs).*	✓			

6.4 Strzelecki Ranges

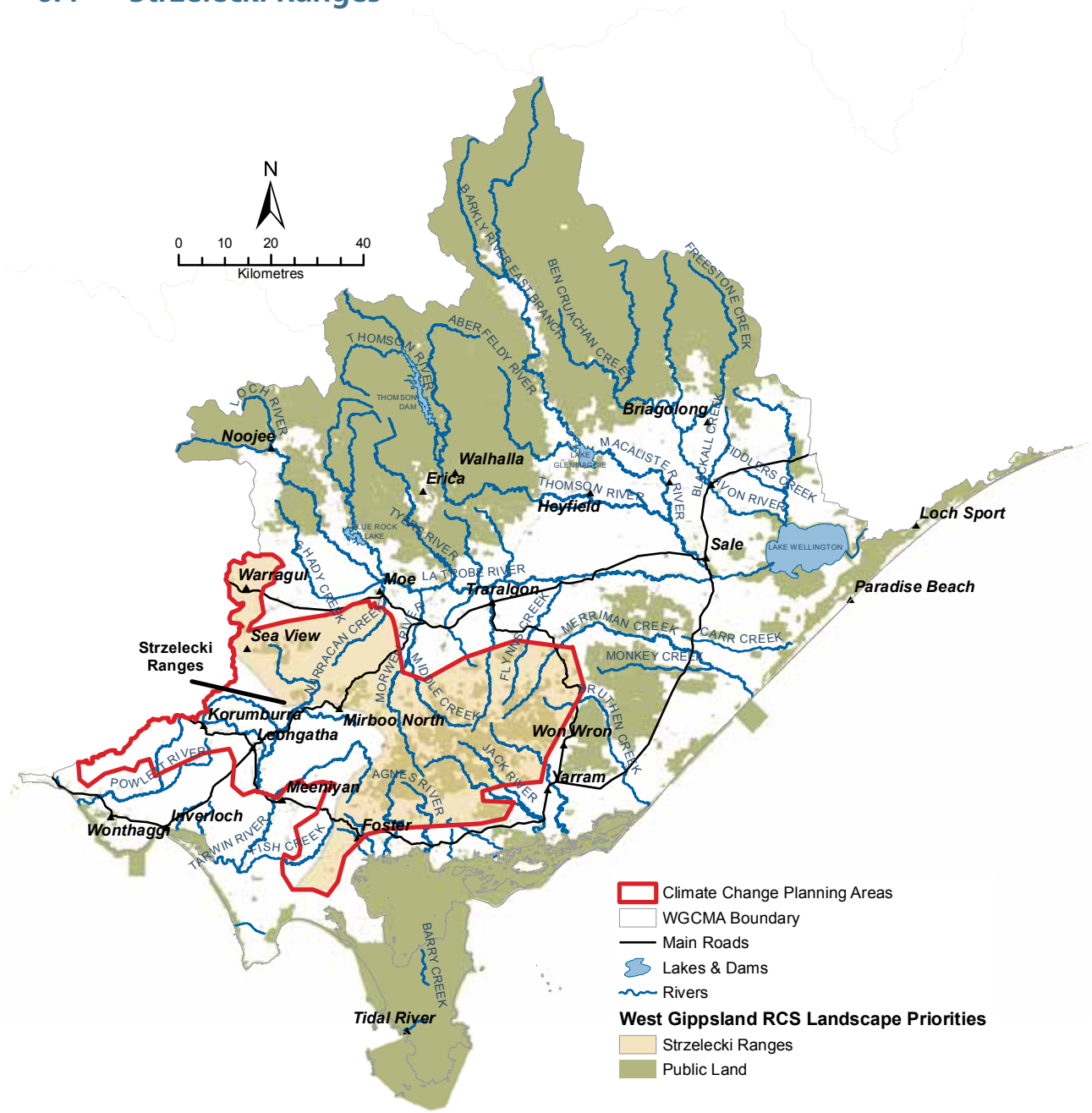

Figure 12: Strzelecki Ranges climate change planning area

The Strzelecki Ranges climate change planning area is characterised by its steep topography, high rainfall and fertile soils. It is a fragmented landscape, containing remnant native vegetation patches of varying sizes. The area is valued for its National Parks and reserves and contains native vegetation of high ecological value (including Cool Temperate and Warm Temperate Rainforests, Wet and Damp Forests), as well as supporting groundwater dependent ecosystems. Within the Strzelecki Ranges, the majestic Tarra Bulga National Park and upper Tarra River attract residents and visitors alike, while also providing habitat for threatened species.[11]

Whilst native vegetation cover across the Strzelecki Ranges is observed to be increasing through revegetation activities (e.g. riparian, steep slopes, shelterbelts), the extent of remnant native vegetation (including mature scattered trees) is still generally declining. New trees planted will take many years to mature and develop habitat hollows which can replace the lost remnant scattered trees. Many invasive plant species have become naturalised across the Strzelecki Ranges. In some cases invasive plants are providing habitat for native fauna and have become novel ecosystems (e.g. hawthorn and blackberry are providing habitat for small birds and mammals within cleared landscapes).

The landscape supports intensive agricultural and forestry production.[11] In general the climate conditions in the Strzelecki Ranges are not as extreme as other places. Deep soils together with reliable rainfall and a mild climate have driven productivity in the area. Mixed grazing, dairy, potatoes and other horticulture, along with an increasing number of lifestyle or small farms, make up the majority of the agricultural land uses.

In recent times there has been substantial change in the mix of enterprises in the Strzelecki Ranges. The area has seen an increase in the number of small producers, particularly in the western part of the Strzelecki Ranges (e.g. garlic, wine, vegetables, eggs); with dairy, beef and sheep still the dominant enterprises in the east. It is likely that the rich red soils (ferrosol) will be sought after for horticulture in the future, with snow peas and bean production having been observed to already be shifting to these areas. For enterprises reliant upon irrigation, there will be a need to alter and match irrigation methods to the soil type, crop type, landform and topography, to minimise water loss under a changing climate.

Steep slopes across the planning area are at risk from tunnel erosion and land slippage. The general trend for dairy is to move to areas lower in the landscape, due to the high costs and additional management issues associated with running enterprises on steep land. There are potential viability issues for potato farming, due to market forces and profitability concerns.

However, the steep slopes and areas of lower productivity across the planning area are suitable for the establishment of vegetation plantings for both carbon sequestration, soil stabilisation and biodiversity benefits.

Extensive willow control, revegetation works and fencing to exclude stock, has been undertaken on the major waterways in the planning area (Tarwin, Powlett, Agnes, Franklin, Albert, Jack, Tarra and Morwell Rivers, and Traralgon Creek). Vegetation quality along waterways in the headwater areas is often very good, including within forestry plantation areas. Water quality is generally poor in the cleared areas and is linked to slope, lack of ground cover, some farm practices, instream erosion and lack of a riparian buffer.

Whilst an increase in fire intensity and frequency, and invasive plants are major threats that are likely to be exacerbated by climate change, future projections of mild warmer winters are seen as being favourable for primary producers due to more pasture growth and less pugging.

Table 5: Strategies for climate change adaptation and mitigation – Strzelecki Ranges

Strategies	Options for strategy implementation		Adaptation	Carbon mitigation		
				Biodiverse carbon plantings	Blue carbon	Soil carbon
SR 1 – Support the adoption of land management practices that improve soil health and production outcomes on grazing land.	a	*Encourage landholders to adopt practices that:* - *Improve ground cover, moisture retention, and reduce runoff following summer rainfall events.* - *Optimise grazing management systems with consideration to stocking rates, nutrient management, herd composition, breeding times and destocking.* - *Follow best management practice techniques (e.g. flexible grazing techniques, use of summer active perennials in pasture systems, changing cultivars to those better adapted to maintain ground cover at all locations, minimum-till, and controlled traffic farming, etc.).*	✓			✓
SR 2 – Support fire management programs that adopt appropriate fire regimes to manage sensitive natural assets and assist the recovery of ecological communities from bushfire.	a	*Explore alternative fuel management techniques so that tolerable fire intervals are not exceeded by planned burns.*	✓			
	b	*Incorporate fire prevention areas (fire breaks, fuel reduction zones, buffers, active patrolling and protection) to protect fire sensitive vegetation communities.*	✓			
SR 3 – Improve the adaptive capacity of remnant vegetation through works to increase connectivity, improve condition and protect high quality remnants.	a	*Encourage landholders to protect small patches of remnant vegetation and single trees on private land.*	✓	✓		
	b	*Increase awareness of the importance and function of small patches of remnant vegetation in the landscape.*	✓			
SR 4 – Improve the adaptive capacity of vegetation communities through works to protect and improve their condition and connectivity.	a	*Identify appropriate delivery mechanisms to achieve outcomes (including covenants, planning scheme tools and incentives).*	✓			
	b	*Implement pest plant and animal control programs for species with a high impact on revegetation works.*	✓	✓		
	c	*Provide a buffer around sensitive vegetation types through revegetation of the target or adjacent vegetation type.*	✓	✓		

Table 5: Strategies for climate change adaptation and mitigation – Strzelecki Ranges *continued*

Strategies	Options for strategy implementation		Adaptation	Carbon mitigation		
				Biodiverse carbon plantings	Blue carbon	Soil carbon
SR 5 – Investigate options to improve water security for domestic, industrial and agricultural uses while protecting flows for environmental outcomes.	a	*Improve on farm water security through restructuring of farm water infrastructure.*	✓			
	b	*Investigate alternative options for farm dams based on audit of use (including decommission and adding habitat features).*	✓			
	c	*Encourage increased reuse and recycling of water by agriculture and industry.*	✓			
	d	*Support connection of urban water supply to desalinisation to improve security of domestic and industrial supply and reduce flow-related risks to the Tarwin River and its tributaries in drought periods.*	✓			
SR 6 – Work with Local Government and State agencies to improve environmental outcomes.	a	*Identify productive land and undertake prioritisation and planning to ensure soil and land health and productivity is maintained.*	✓	✓		✓
	b	*Consider feasibility of planning regulations to allow for house construction with conditions for environmental management in the unproductive steep areas.*	✓	✓		✓
	c	*Explore land use planning mechanisms to protect high value natural assets on agricultural land subject to enterprise change.*	✓			✓
SR 7 – Refine the approaches used by natural resource managers when planning and implementing fencing, weed control and revegetation programs to take account of changing climatic conditions.	a	*Consider different species mixes from the range of EVCs across the Strzelecki's in revegetation projects to improve success rates to retain functioning ecosystems.*	✓	✓		
SR 8 – Support carbon sequestration through the establishment of targeted biodiverse plantings in areas that address priorities for biodiversity, land and waterway health.	a	*Consider a range of options to establish perennial vegetation (including shelter belts, deciduous trees, biodiverse plantings, tree crops) across cleared productive areas on farms.*	✓	✓		✓

Table 5: Strategies for climate change adaptation and mitigation – Strzelecki Ranges *continued*

Strategies	Options for strategy implementation		Adaptation	Carbon mitigation		
				Biodiverse carbon plantings	Blue carbon	Soil carbon
SR 8 – Support carbon sequestration through the establishment of targeted biodiverse plantings in areas that address priorities for biodiversity, land and waterway health *continued*.	b	*Establish large scale biodiverse plantings on steep slopes and areas of lower productivity.*	✓	✓		✓
	c	*Fence and revegetate wide riparian buffers along priority waterways and gullies (30-40m wide). Target to areas of high risk of erosion and sediment loss.*	✓	✓		✓
	d	*Implement on ground works program to increase vegetation extent to 30% cover in landscape whilst retaining productive agricultural land.*	✓	✓		✓
	e	*Investigate the potential to establish native vegetation on disused road reserve and crown water frontage leases.*	✓	✓		✓
	f	*Protect core habitat areas and increase the extent of vegetation by linking areas of habitat.*	✓	✓		✓
SR 9 – Manage impacts to Strzelecki Ranges ecosystems from future pressures of increased recreational use.	a	*Manage access to sensitive areas through zoning of public land to concentrate people in designated areas, improving facilities through construction of boardwalks and formal access tracks, and prohibiting access in some places.*	✓			
	b	*Raise visitor awareness of the values of the Strzelecki Ranges ecosystems, their sensitivity to human impacts, and the rationale for particular management activities.*	✓			
SR 10 – Support research and investigation to address knowledge gaps.	a	*Explore implications of climate change for groundwater dependent ecosystems, including springs.*	✓			
	b	*Identify and protect drought refuges across the planning area.*	✓			
	c	*Monitor the responses of highly susceptible ecological communities and keystone species to a changing climate.*	✓			
SR 11 – Investigate options to lessen the offsite impacts to water quality following extreme events (e.g. flood, fire).	a	*Undertake risk management planning for land use management under climate change.*	✓			
SR 12 – Preservation of Aboriginal cultural heritage sites.	a	*Explore how to best incorporate specific management recommendations relating to climate change impacts on Aboriginal sites into Cultural Heritage Management Plans (CHMPs).*	✓			

6.5 Coastal Landscapes (including Bunurong Coast, Corner Inlet Nooramunga and Mullungdung)

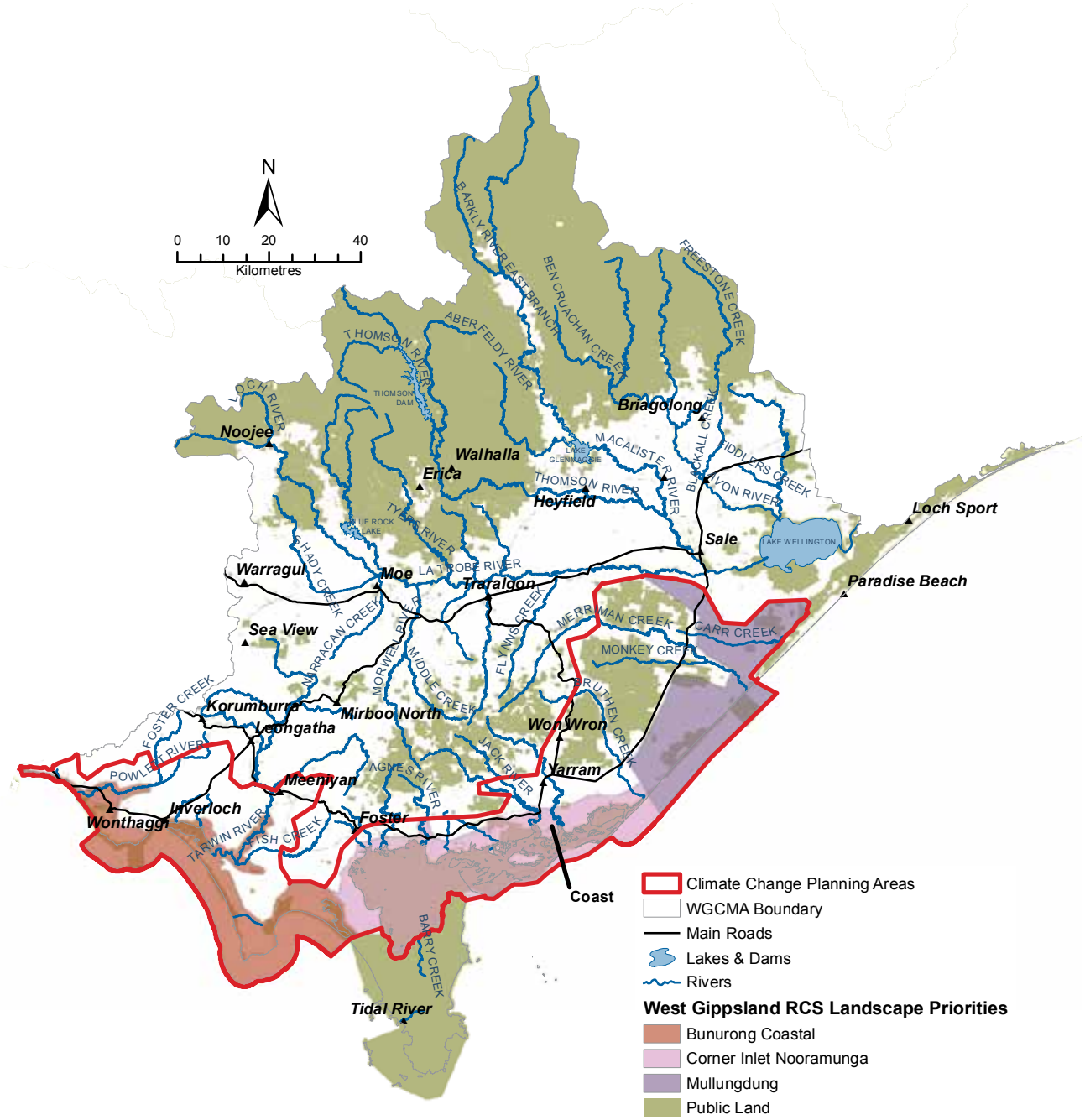

Figure 13: Coastal landscapes climate change planning area

The coastal landscapes climate change planning area encompasses three West Gippsland RCS Landscape Priority Areas (Bunurong Coastal, Corner Inlet Nooramunga and Mullungdung).

The Bunurong Coast is characterised by estuarine and coastal environments containing extensive intertidal rock platforms and sub-tidal rocky reefs, which are home to diverse ecological communities. It contains fossil sites of international and national significance and areas of cultural heritage sensitivity.[11] The Powlett River estuary closes most years and depending on the conditions in summer and autumn it may open naturally or require an artificial opening if public assets and private land becomes impacted. WGCMA and Parks Victoria have been working together to manage estuary openings on the Powlett River and an estuary management plan is currently being developed to help guide overall management of the estuary.

Corner Inlet Nooramunga is characterised by short, dynamic and independent river systems, which drain from the Strzelecki Ranges to the internationally recognised Corner Inlet Ramsar site and Nooramunga Marine and Coastal Park. Corner Inlet is listed in the Directory of Important Wetlands of Australia (DIWA) and is an East Asian-Australasian Shorebird Site, which provides a drought refuge for migratory and resident birds. Corner Inlet supports a commercial fishing industry, as well as recreational fishing and water based activities.[11]

The seagrass and saltmarsh communities found within both the Bunurong Coast and Corner Inlet Nooramunga areas provide habitat for migratory waders, resident birds and native fish. Corner Inlet, Shallow Inlet and Anderson Inlet have been the focus of a range of ongoing NRM programs, including control of Spartina, fencing of saltmarsh and foreshore areas, and pest animal control.

The extensive sandy beaches and marine waters of Ninety Mile Beach are a popular destination for local fishermen, holidaymakers and tourists and have Indigenous cultural heritage significance. Jack Smith Lake and its associated wetlands are listed in the Directory of Important Wetlands of Australia (DIWA) and are valued for the diversity of bird species they support.[11]

The coastal and marine parks and reserves situated along the planning area coastline are valued for their natural scenic values, the recreational opportunities they provide, the range of complex habitats and vegetation communities and numerous threatened species they support.[11] However, storm surge is having an impact on the beaches and coastal vegetation in many places along the coast.

Largely fragmented remnant native vegetation across the entire planning area is of high biodiversity and natural value, though it is poorly connected to larger remnants located within State Parks and conservation reserves (such as the Mullungdung State Forest). Endangered, rare and vulnerable ecological vegetation classes, including the EPBC Act listed Gippsland Red Gum Grassy Woodland and associated Native Grassland ecological community are found within the planning area.[11]

The extent of native vegetation is believed to be increasing throughout the planning area due to NRM programs focused on revegetating waterways and gullies, and creating wildlife corridors and shelter belts. However, extreme events (e.g. fire) and climate conditions over recent years have impacted on the health of vegetation, with tree deaths from extreme heat, loss of coastal vegetation from storm surge, and inland migration of saline tolerant vegetation being observed.

There is an increasing demand for land and urban development along the coast (particularly in Bass Coast and South Gippsland Shires) and recreational use is on the increase due to the proximity to Melbourne. Recreational pressures are likely to increase in both intensity and geographic scope, placing increased pressures on vulnerable ecosystems.

The hinterland surrounding the coast is a largely cleared environment, with fertile and productive soils underpinning a vigorous and varied agricultural sector. In recent times there has been a change in the types of agricultural production with an increase in horticulture, and some intensive production systems (chickens and feedlot cattle operations) in the Bass Coast and South Gippsland Shires.

Further east the trend is different, with a shift from sheep and beef grazing and cropping to forestry (plantation forestry and agroforestry). In general dairy has moved out of the steeper areas to the flatter floodplain areas, while in the hillier areas beef and lifestyle properties dominate.

There is a growing recognition of Gippsland as a 'food bowl' due to a combination of reliable climate, productive soils and proximity to Melbourne. Across the agricultural industries there appears to be an increased awareness of threats to the natural environment from land management practices and an increase in application of best management practices.

Sea walls were built along the coastline to reclaim intertidal areas and these areas are now used for agriculture. Sea walls and their management continue to be a contentious issue for local government and private landholders along the coast.

As sea level rises and storm surge exacerbates coastal erosion, the coastal zone will be squeezed between the ocean and infrastructure. For many coastal ecosystems, the biggest obstacle to migrate naturally inland is the presence of roads, houses and other infrastructure, such as seawalls and levees.

Climate change is likely to increase the frequency, intensity and extent of existing coastal hazards (such as wildfire, flooding, acid sulfate soils, landslips and landslides, coastal erosion processes and inundation).

Table 6: Strategies for climate change adaptation and mitigation – Coastal Landscapes

Strategies		Options for strategy implementation	Adaptation	Carbon mitigation		
				Biodiverse carbon plantings	Blue carbon	Soil carbon
CL 1 – Support coastal NRM agencies to plan for adaptation or retreat in areas impacted by sea level rise and storm surge.	a	*Identify natural assets and infrastructure impacted by increased salinity, inundation and coastal erosion.*	✓			
	b	*Investigate longevity of sea walls in providing protection from sea level rise and consider alternate management arrangements.*	✓			
	c	*Investigate options to add land to the national reserve system to provide for migration of habitats.*	✓		✓	
CL 2 – Support private land managers along the coast to adapt or make a planned retreat in areas impacted by sea level rise and storm surge.	a	*Education and awareness programs for private landholders about the impacts and options to manage for rising sea level, increased erosion and inundation.*	✓			
	b	*Investigate land use planning approaches to protect high value agricultural land and provide opportunities for enterprise change.*	✓			✓
	c	*Provide incentives to allow for mangrove and saltmarsh communities to retreat as a result of sea level rise.*	✓		✓	
CL 3 – Support carbon sequestration through the establishment of targeted biodiverse plantings in areas that address priorities for biodiversity, land and waterway health.	a	*Encourage landholders to use local native species in plantings for shade and shelter.*	✓	✓		
	b	*Fence and revegetate wide riparian buffers along priority waterways.*	✓	✓	✓	
	c	*Investigate the potential to establish native vegetation on disused road reserve and crown water frontage leases.*	✓	✓		✓
	d	*Protect retreating mangrove and saltmarsh communities through fencing.*	✓		✓	
CL 4 – Improve the adaptive capacity of remnant vegetation through works to increase connectivity, improve condition and protect high quality remnants.	a	*Identify appropriate delivery mechanisms to achieve outcomes (including covenants, planning scheme tools and incentives).*	✓			
	b	*Undertake local level planning drawing on vulnerability assessment results, biodiversity planning information to identify candidate areas.*	✓	✓		

Table 6: Strategies for climate change adaptation and mitigation – Coastal Landscapes *continued*

Strategies	Options for strategy implementation		Adaptation	Carbon mitigation		
				Biodiverse carbon plantings	Blue carbon	Soil carbon
CL 5 – Refine the approaches used by natural resource managers when planning and implementing fencing, weed control and revegetation programs to take account of changing climatic conditions.	a	*Consider inclusion of dry tolerant species and pliable vegetation in revegetation programs.*	✓			
CL 6 – Support fire management programs that adopt appropriate fire regimes to manage sensitive natural assets and assist the recovery of ecological communities from bushfire.	a	*Explore alternative fuel management techniques so that tolerable fire intervals are not exceeded by planned burns.*	✓			
	b	*Potential areas to focus on include rainforest, riparian and wetland habitats and coastal heathland.*	✓			
CL 7 – Support research and investigation to address knowledge gaps.	a	*Build on recent knowledge that highlights the potential for blue carbon sequestration in saltmarsh, seagrass and mangrove habitats to explore how restoration programs might be designed to capitalise on opportunities.*	✓		✓	
	b	*Explore implications of climate change for groundwater dependent ecosystems, including springs.*	✓			
	c	*Identify and assess implications of maintaining novel habitats in the landscape.*	✓			
	d	*Identify and protect drought refuges across the planning area.*	✓			
	e	*Monitor and document the effects of warmer and drier average conditions on different vegetation and determine the best species to include in revegetation programs.*	✓			
	f	*Monitor the responses of highly susceptible ecological communities and keystone species to a changing climate.*	✓			
CL 8 – Consider climate change impacts from sea level rise, storm surge and catchment processes in future management of estuaries.	a	*Establish long term monitoring programs for estuaries and associated habitats.*	✓			
	b	*Explicitly factor climate change into estuary management.*	✓			

Table 6: Strategies for climate change adaptation and mitigation – Coastal Landscapes *continued*

Strategies	Options for strategy implementation		Adaptation	Carbon mitigation		
				Biodiverse carbon plantings	Blue carbon	Soil carbon
CL 9 – Support the adoption of land management practices that improve soil health and production outcomes on grazing land.	a	*Encourage landholders to adopt practices that:* - *Improve ground cover, moisture retention, and reduce runoff following summer rainfall events.* - *Optimise grazing management systems with consideration to stocking rates, nutrient management, herd composition, breeding times and destocking.* - *Follow best management practice techniques (e.g. flexible grazing techniques, use of summer active perennials in pasture systems, changing cultivars to those better adapted to maintain ground cover at all locations, minimum-till, and controlled traffic farming, etc.).*	✓			✓
CL 10 – Work with Local Government and State agencies to improve environmental outcomes.	a	*Explore land use planning mechanisms to protect high value natural assets on agricultural land subject to enterprise change.*	✓			✓
CL 11 – Identify priorities and develop plan of works to improve hydrological regime of floodplain wetlands and fringing wetlands.	a	*Construction of treatment wetlands to capture stormwater from existing developed areas.*	✓		✓	
	b	*Plan of works to consider earthworks and waterway structures and options to work with landholders to manage water for multiple outcomes.*	✓			
CL 12 – Managing impacts to sensitive coastal ecosystems from future pressures of increased recreational use	a	*Manage access to sensitive areas through zoning of public land to concentrate people in designated areas, improving facilities through construction of boardwalks and formal access tracks, and prohibiting access in some places.*	✓			
CL 13 – Investigate options to lessen the offsite impacts to water quality following extreme events (e.g. flood, fire).	a	*Undertake risk management planning for land use management under climate change.*	✓			
CL 14 – Preservation of Aboriginal cultural heritage sites.	a	*Explore how to best incorporate specific management recommendations relating to climate change impacts on Aboriginal sites into Cultural Heritage Management Plans (CHMPs).*	✓			

6.6 Wilsons Promontory

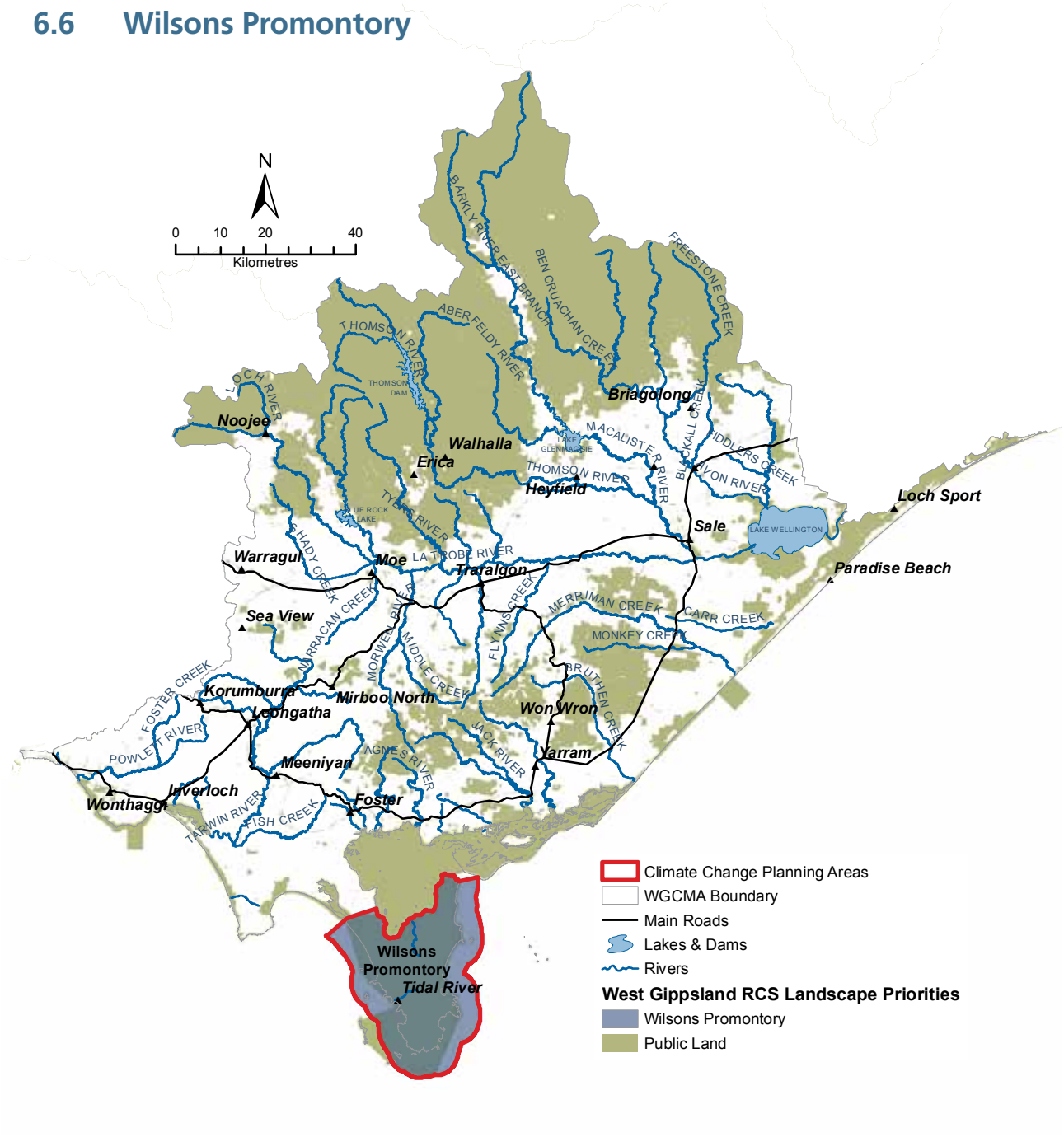

Figure 14: Wilsons Promontory climate change planning area

The Wilsons Promontory climate change planning area is characterised by the largely contiguous native vegetation that is located within the iconic Wilsons Promontory National Park. It is further defined by its marine environment, which contains the Wilsons Promontory Marine National Park. It offers spectacular scenery of huge granite mountains, open forest, rainforest, sweeping beaches and coastlines.[33]

The National Parks are highly valued by both residents and tourists for their natural scenic values, educational and recreational opportunities and Indigenous cultural heritage significance.[11]

The landscape is underpinned by relatively stable soils and contains largely intact and diverse ecological vegetation communities and numerous rare and threatened species.[11]

Warm Temperate and Cool Temperate Rainforest, tall open forests, woodlands, heathlands, swamp and coastal communities are all found within Wilsons Promontory. The heathlands, influenced by the frequency and intensity of fire, are rich in species and provide habitats for a variety of fauna, including many threatened species. Over 30 species of native terrestrial mammals have been recorded in the National Park.[33]

The presence of vegetation cover across much of the area contributes to generally high adaptive capacity of native vegetation and soils in particular, although recent intense fires have had an impact on the landscape. Impacts associated with a likely increase in the intensity and frequency of large fires is likely to pose a significant future challenge to the values of natural assets within the planning area.

Coastal features include expansive intertidal mudflats, sandy beaches and sheltered coves interrupted by prominent headlands and plunging granite cliffs in the south, backed by coastal dunes and swamps. In the intertidal zone adjoining Corner Inlet, large areas of highly productive tidal mudflat are exposed at low tide. The coastal dunes are a near perfect example of coastal succession ranging from bare dunes to protected woodlands.[33]

Tidal River's close proximity to the main day visitor, camping and overnight accommodation is a popular site for activities including walking, sightseeing, swimming, kayaking, boating and recreational fishing.[11] There has been a growth in infrastructure to support visitation to Wilsons Promontory both within and outside the National Park in recent years. Recreational use is likely to increase, placing increased pressures on vulnerable ecosystems. An increase in invasive plant and animal species (e.g. Northern Pacific Seastars that have been found in Tidal River[33]) in response to changing climatic conditions may pose a major threat to the natural ecosystems within the planning area.

Table 7: Strategies for climate change adaptation and mitigation – Wilsons Promontory

Strategies	Options for strategy implementation		Adaptation	Carbon mitigation		
				Biodiverse carbon plantings	Blue carbon	Soil carbon
WP 1 – Support coastal NRM agencies to plan for adaptation or retreat in areas impacted by sea level rise and storm surge.	a	*Identify location and likely impact on natural assets from increased salinity, inundation and coastal erosion.*	✓			
	b	*Increase the width of vegetated riparian buffers in the Tidal River settlement and allow for salt tolerant vegetation to establish.*	✓			
	c	*Relocate infrastructure impacted storm surge and sea level rise and rehabilitate to prevent further erosion.*	✓			
WP 2 – Support fire management programs that adopt appropriate fire regimes to manage sensitive natural assets and assist the recovery of ecological communities from bushfire.	a	*Explore alternative fuel management techniques so that tolerable fire intervals are not exceeded by planned burns.*	✓			
	b	*Improve fire planning processes and on ground wildfire management activities to protect sensitive natural assets.*	✓			✓
WP 3 – Improve the adaptive capacity of ecosystems in Wilsons Promontory by actively managing existing threats.	a	*Active management of invasive plants and animals in the highest value ecosystems in Wilsons Promontory.*	✓			
	b	*Undertake large scale re-seeding of vegetation communities following wildfire.*	✓	✓		
WP 4 – Support research and investigation to address knowledge gaps.	a	*Explore implications of climate change for groundwater dependent ecosystems, including springs.*	✓			
	b	*Identify and protect drought refuges across the planning area.*	✓			
	c	*Monitor the responses of highly susceptible ecological communities and keystone species to a changing climate.*	✓			
	d	*Monitoring of invasive species with a focus on new and emerging species.*	✓			

Table 7: Strategies for climate change adaptation and mitigation – Wilsons Promontory *continued*

Strategies	Options for strategy implementation		Adaptation	Carbon mitigation		
				Biodiverse carbon plantings	Blue carbon	Soil carbon
WP 5 – Manage impacts to Wilsons Promontory ecosystems from future pressures of increased recreational use.	a	*Manage access to sensitive areas through zoning of public land to concentrate people in designated areas, improving facilities through construction of boardwalks and formal access tracks, and prohibiting access in some places.*	✓			
	b	*Raise visitor awareness of the values of Wilsons Promontory, their sensitivity to human impacts and the rationale for particular management activities.*	✓			
WP 6 – Consider climate change impacts from sea level rise, storm surge and catchment processes in future management of estuaries.	a	*Establish long term monitoring programs for estuaries and associated habitats.*	✓			
	b	*Explicitly factor climate change into estuary management.*	✓			
WP 7 – Investigate options to lessen the offsite impacts to water quality following extreme events (e.g. flood, fire).	a	*Undertake risk management planning for land use management under climate change.*	✓			
WP 8 – Preservation of Aboriginal cultural heritage sites.	a	*Explore how to best incorporate specific management recommendations relating to climate change impacts on Aboriginal sites into Cultural Heritage Management Plans (CHMPs).*	✓			

7 Implementation, monitoring and reporting

As a sub-strategy to the RCS, the West Gippsland Regional NRM Climate Change Strategy will support the integration of climate change knowledge, adaptation and mitigation options into the current RCS implementation program, future strategies, sub-strategies and planning tools.

While there is significant uncertainty associated with the magnitude and timing of future climate change, it will be important to use the principles of adaptive management to inform planning and implementation activities.

Over time the relevance, feasibility and robustness of the identified adaptation options should be reviewed in tandem with the monitoring, evaluation and reporting requirements for the RCS.

Implementation of the adaptation and mitigation options outlined within this Strategy will be influenced by available funding and resources.

Progress towards implementation will be monitored and reported through the arrangements established for the West Gippsland Regional Catchment Strategy.

7.1 Adaptation and mitigation strategies – rationale and link to RCS Objectives

This section sets out the link between the adaptation and mitigation strategies that were identified in Section 6 with the 20 year objectives from the RCS. The rationale for each of the strategies has also been described in the table. The tables will be used to inform the implementation of the RCS and the selection and adoption of climate change adaptation and mitigation strategies into NRM programs.

7.7.1 Victorian Alps

Table 8: Victorian Alps adaptation and mitigation strategies rationale and link to RCS objectives

Strategies	Link to RCS 20 year Objectives	Rationale
VA 1 – Support fire management programs that adopt appropriate fire regimes to manage sensitive natural assets and assist the recovery of ecological communities from bushfire.	Improved conservation status of the threatened species and communities in the landscape.	Option addresses potential threat to ecosystems in the alpine area from both wildfire and changed fire regimes.
		Predicted climate change is likely to increase the frequency and intensity of wildfire.
VA 2 – Improve the adaptive capacity of ecosystems in the Victorian Alps by actively managing existing threats.	Improved quality of native vegetation in the landscape. Improved conservation status of the threatened species and communities in the landscape.	Active restoration and threat management will improve the adaptive capacity of these areas.
		Changes in distribution patterns of existing and new weeds and pest animals are likely under climate change. This will require active management and surveillance to protect the values of sensitive ecosystems.
		This ecosystem is highly sensitive to increased frequency of wildfire so active restoration will be required for it to persist.
VA 3 – Improve the condition of Alpine peatlands to mitigate future impacts from drying climate.	Improved conservation status of threatened species and communities in the landscape.	Active restoration and threat management will improve the adaptive capacity of these areas.
VA 4 – Support research and investigation to address knowledge gaps.	Improved conservation status of the threatened species and communities in the landscape.	Changes in distribution patterns of existing and new weeds and pest animals are likely under climate change.
		The nature and intensity of current threats are likely to be amplified under a drying and warming climate.
VA 5 – Managing impacts to alpine ecosystems from future pressures of increased recreational use.	Improved quality of native vegetation in the landscape. Improved conservation status of the threatened species and communities in the landscape.	Alpine peatlands are highly sensitive to disturbance and this is likely to be amplified under future climate change.
		Build on existing monitoring of trends in condition and quality of alpine peatlands to inform adaptive management.

Table 8: Victorian Alps adaptation and mitigation strategies rationale and link to RCS objectives
continued

Strategies	Link to RCS 20 year Objectives	Rationale
VA 6 – Diversify approaches used for managing environmental water.	Improved or maintained environmental condition of waterways, estuaries, wetlands and aquifers.	Climate change impacts on natural flows are predicted to reduce volumes and seasonality, with potential for flow stressed systems.
		Flexible use of environmental water may reduce vulnerability of flow stressed systems.
		Innovative use of environmental water may reduce vulnerability of wetlands and other aquatic ecosystems.
	Improve water quality in the landscape system. Improved or maintained environmental condition of waterways, estuaries, wetlands and aquifers.	Impacts of wildfire are likely to generate large sediment loads if linked to extreme rainfall events.
VA 7 – Investigate options to lessen the offsite impacts to water quality following extreme events (e.g. flood, fire).	Improve water quality in the landscape system. Improved or maintained environmental condition of waterways, estuaries, wetlands and aquifers.	Implementation of best practice land management techniques will potentially lessen the offsite movement of soils, sediment and nutrients following extreme events.
VA 8 – Preservation of Aboriginal cultural heritage sites.	Preservation of Aboriginal cultural heritage sites. Traditional Owners' knowledge and aspirations are incorporated into the management of the landscape.	Cultural values may be damaged or lost as the result of climate change impacts.

7.7.2 Gippsland Lakes and Hinterland

Table 9: Gippsland Lakes and Hinterland adaptation and mitigation strategies rationale and link to RCS objectives

Strategies	Link to RCS 20 year Objectives	Rationale
GLH 1 – Support programs that assist private landholders to adapt or make a planned retreat as a result of drier and warmer average conditions, increased salinity, inundation and erosion.	Improved soil health and sustainable agriculture in Macalister Irrigation District.	Option addresses threat to productivity of land and soil health as a result of from sea level rise, storm surge and warmer and drier conditions.
	Improved quality of native vegetation in the landscape.	Option provides for adaptation and migration of highly vulnerable habitats that will be impacted by increased salinity and sea level rise and storm surge.
	Sustainable management of the Gippsland Lakes system during the long term transition to a saline system.	Option will assist with inland and upstream migration of highly vulnerable habitats (estuaries, wetland and coastal saltmarsh) as a result of sea level rise and storm surge, through provision of additional public land.
GLH 2 – Work with Local Government and State agencies to improve environmental outcomes.	Improved or maintained environmental condition of waterways, estuaries, wetlands and aquifers.	Option will explore land use planning mechanisms to protect high value natural assets on agricultural land subject to enterprise change. Changes in agricultural practices on the productive floodplains (driven by market forces and climate change) has the potential to adversely affect vulnerable wetland types (freshwater marshes and meadows).
GLH 3 – Refine the approaches used by natural resource managers when planning and implementing fencing, weed control and revegetation programs to take account of changing climatic conditions.	Improved or maintained environmental condition of waterways, estuaries, wetlands and aquifers.	Option has benefits for carbon sequestration and will address increased threat from more frequent intense rainfall events (erosion and water quality) as well as provision of refuge habitat in warmer drier average conditions.
	Increased native vegetation extent and connectivity across the landscape.	Impacts of climate change will make it more difficult to establish some species. The inclusion of species more tolerant to changed conditions should increase the success of revegetation programs.
	Improved quality of native vegetation in the landscape.	The impacts of climate change on the regeneration/establishment ability of native species are largely unknown. This approach should be strongly linked to monitoring to evaluate the success and persistence of these strategies in improving vegetation extent and condition.
	Improved quality of native vegetation in the landscape. Improved conservation status of the threatened species and communities in the landscape.	These communities are predicted to be highly vulnerable to climate change. Management of existing high quality remnants is likely to support improved climate resilience.

Table 9: Gippsland Lakes and Hinterland adaptation and mitigation strategies rationale and link to RCS objectives *continued*

Strategies	Link to RCS 20 year Objectives	Rationale
GLH 4 – Improve the adaptive capacity of remnant vegetation through works to increase connectivity, improve condition and protect high quality remnants.	Improved quality of native vegetation in the landscape. Improved conservation status of the threatened species and communities in the landscape.	Fragmented remnant vegetation communities are predicted to be highly vulnerable to climate change. Management of existing high quality remnants is likely to support improved climate resilience.
	Maintained extent and quality of significant native vegetation within the landscape.	Incremental loss of small remnants is still occurring. These provide important nodes from which to build.
GLH 5 – Investigate options to improve security of environmental water for high value waterways and wetlands.	Improved or maintained environmental condition of waterways, estuaries, wetlands and aquifers.	Option addresses risk that existing flow stress will be amplified as a result of warmer and drier conditions.
GLH 6 – Identify priorities and develop plan of works to improve hydrological regime of floodplain wetlands and fringing wetlands.	Improved or maintained environmental condition of waterways, estuaries, wetlands and aquifers.	Options provide a mechanism to improve adaptive capacity of freshwater marshes and meadows. These are highly vulnerable as a result of sensitivity to changes in hydrology from warmer and drier conditions.
	Improve water quality in the landscape system.	Option addresses impacts resulting from increased intense rainfall events (resulting increased erosion and poor water quality) and provides a mechanism to address historic losses of freshwater marshes and meadows as a result of clearing and development.
GLH 7 – Support fire management programs that adopt appropriate fire regimes to manage sensitive natural assets and assist the recovery of ecological communities from bushfire.	Improved quality of native vegetation in the landscape. Improved conservation status of the threatened species and communities in the landscape.	These assets are highly vulnerable to wildfire as a result of their sensitivity, fragmented nature and are slow to recover following disturbance.
GLH 8 – Support carbon sequestration through the establishment of targeted biodiverse plantings in areas that address priorities for biodiversity, land and waterway health.	Improve water quality in the landscape system.	Option has benefits for carbon sequestration and will address increased threat to waterways from more frequent intense rainfall events (erosion and water quality) as well as provision of refuge habitat in warmer drier average conditions.
	Improved quality of native vegetation in the landscape.	Option has benefits for carbon sequestration and will improve the adaptive capacity of fragmented vegetation communities.

Table 9: Gippsland Lakes and Hinterland adaptation and mitigation strategies rationale and link to RCS objectives *continued*

Strategies	Link to RCS 20 year Objectives	Rationale
GLH 9 – Support research and investigation to address knowledge gaps.	Improved or maintained environmental condition of waterways, estuaries, wetlands and aquifers.	Warmer and drier average conditions are likely to be major drivers of change for meadow and marsh wetlands. These wetlands likely to change in function and have different management requirements.
		Recent research[29] has highlighted potential practical demonstration of restoration and protection actions will be required to assess feasibility and benefit.
	Sustainable management of the Gippsland Lakes system during the long term transition to a saline system.	Changes are already being experienced in areas, such as Lake Wellington and its fringing wetlands, as a result of rising sea levels.
	Improved quality of native vegetation in the landscape. Improved conservation status of threatened species and communities in the landscape.	Key knowledge gap that can be addressed through adaptive management and monitoring. Strongly linked to a range of other adaptation options.
		The nature and intensity of current threats are likely to be amplified under a drying and warming climate.
		Threat from established weeds has potential to be amplified by drier and warmer average conditions and more frequent fire.
GLH 10 – Support the adoption of land management practices that improve soil health and production outcomes on grazing land.	Improved or maintained soil health. Improved soil health and sustainable agriculture in Macalister Irrigation District.	Improved management of ground cover through more adaptive grazing practices has the potential to increase soil carbon levels and improve soil health. Can support improved adaptive management of pastures and maintain ground cover during times of drought stress/extreme rainfall periods.
GLH 11 – Consider climate change impacts from sea level rise, storm surge and catchment processes in future management of estuaries.	Improved or maintained environmental condition of waterways, estuaries, wetlands and aquifers.	Combined seaward impacts may have negative synergistic effects with catchment processes. These ecosystems are highly vulnerable to climate change.
GLH 12 – Support coastal NRM agencies to plan for adaptation or retreat in areas impacted by sea level rise and storm surge.	Improved coastal dune system integrity. Improved or maintained environmental condition of waterways, estuaries, wetlands and aquifers. Maintain integrity of biota and habitat in the marine ecosystem.	Options provide for adaptation and migration of highly vulnerable habitats that will be impacted by increased salinity and sea level rise and storm surge.

Table 9: Gippsland Lakes and Hinterland adaptation and mitigation strategies rationale and link to RCS objectives *continued*

Strategies	Link to RCS 20 year Objectives	Rationale
GLH 13 – Investigate options to lessen the offsite impacts to water quality following extreme events (e.g. flood, fire).	Improve water quality in the landscape system. Improved or maintained environmental condition of waterways, estuaries, wetlands and aquifers.	Implementation of best practice land management techniques will potentially lessen the offsite movement of soils, sediment and nutrients following extreme events.
GLH 14 – Preservation of Aboriginal cultural heritage sites.	Preservation of Aboriginal cultural heritage sites. Traditional Owners' knowledge and aspirations are incorporated into the management of the landscape.	Cultural values may be damaged or lost as the result of climate change impacts.

7.7.3 Strzelecki Ranges

Table 10: Strzelecki Ranges adaptation and mitigation strategies rationale and link to RCS objectives

Strategies	Link to RCS 20 year Objectives	Rationale
SR 1 – Support the adoption of land management practices that improve soil health and production outcomes on grazing land.	Improved or maintained soil health. Improved soil health and sustainable agriculture in the Strzelecki Ranges. Red Soils.	Improved management of ground cover through more adaptive grazing practices has the potential to increase soil carbon levels and improve soil health. Can support improved adaptive management of pastures and maintain ground cover during times of drought stress/extreme rainfall periods.
SR 2 – Support fire management programs that adopt appropriate fire regimes to manage sensitive natural assets and assist the recovery of ecological communities from bushfire.	Improved quality of native vegetation in the landscape.	These assets are highly vulnerable to wildfire as a result of their sensitivity, fragmented nature and are slow to recover following disturbance.
SR 3 – Improve the adaptive capacity of remnant vegetation through works to increase connectivity, improve condition and protect high quality remnants.	Improved quality of native vegetation in the landscape. Improved conservation status of the threatened species and communities in the landscape.	Fragmented remnant vegetation communities are predicted to be highly vulnerable to climate change. Management of existing high quality remnants is likely to support improved climate resilience.
	Maintained extent and quality of significant native vegetation within the landscape.	Incremental loss of small remnants is still occurring. These provide important nodes from which to build.
SR 4 – Improve the adaptive capacity of vegetation communities through works to protect and improve their condition and connectivity.	Improved quality of native vegetation in the landscape. Increased native vegetation extent and connectivity across the landscape.	Improve success rate of revegetation activities and increased natural regeneration.
	Maintained extent and quality of significant native vegetation within the landscape.	Incremental loss of small remnants is still occurring. These provide important nodes from which to build.
SR 5 – Investigate options to improve water security for domestic, industrial and agricultural uses while protecting flows for environmental outcomes.	Improved or maintained environmental condition of waterways, estuaries, wetlands and aquifers.	Option addresses risk that existing flow stress will be amplified as a result of warmer and drier conditions. Potential to reduce flow stress on waterways.
	Improved water quality in the landscape system.	Option may reduce impact on waterway flows and increase water use efficiency on farms.

Table 10: Strzelecki Ranges adaptation and mitigation strategies rationale and link to RCS objectives *continued*

Strategies	Link to RCS 20 year Objectives	Rationale
SR 6 – Work with Local Government and State agencies to improve environmental outcomes.	Improved water quality in the landscape system.	Socio-demographic change has the potential to increase pressure on natural resources. Improved NRM on small holdings can improve carbon, biodiversity and water quality outcomes. Limited current knowledge (at least at finer scales) of land suitability/capability. Filling this knowledge gap will enable improved optimisation of carbon and traditional agricultural activities.
	Maintained extent and quality of significant native vegetation within the landscape.	Climate change is likely to see significant changes in land use as new enterprises (e.g. intensive horticulture) expand placing pressure on high value natural assets.
SR 7 – Refine the approaches used by natural resource managers when planning and implementing fencing, weed control and revegetation programs to take account of changing climatic conditions.	Improved quality of native vegetation in the landscape. Increased native vegetation extent and connectivity across the landscape.	Impacts of climate change will make it more difficult to establish some species. The inclusion of species more tolerant to changed conditions should increase the success of revegetation program activities and natural regeneration.
SR 8 – Support carbon sequestration through the establishment of targeted biodiverse plantings in areas that address priorities for biodiversity, land and waterway health.	Increased native vegetation extent and connectivity across the landscape. Improved water quality in the landscape system.	Option has benefits for carbon sequestration and will improve the adaptive capacity of fragmented vegetation communities as well as provision of refuge habitat in warmer drier average conditions.
		Option has benefits for carbon sequestration and will address increased threat from more frequent intense rainfall events (erosion and water quality) as well as provision of refuge habitat in warmer drier average conditions.
		Impacts of climate change will make it more difficult to establish some species. The inclusion of species more tolerant to changed conditions should increase the success of revegetation programs.

Table 10: Strzelecki Ranges adaptation and mitigation strategies rationale and link to RCS objectives *continued*

Strategies	Link to RCS 20 year Objectives	Rationale
SR 9 – Manage impacts to Strzelecki Ranges ecosystems from future pressures of increased recreational use.	Improved quality of native vegetation in the landscape. Improved conservation status of the threatened species and communities in the landscape.	Rainforest ecosystems are highly sensitive to disturbance and this is likely to be amplified under future climate change.
SR 10 – Support research and investigation to address knowledge gaps.	Improved quality of native vegetation in the landscape. Improved conservation status of threatened species and communities in the landscape.	Key knowledge gap that can be addressed through adaptive management and monitoring. Strongly linked to a range of other adaptation options.
		The nature and intensity of current threats are likely to be amplified under a drying and warming climate.
SR 11 – Investigate options to lessen the offsite impacts to water quality following extreme events (e.g. flood, fire).	Improve water quality in the landscape system. Improved or maintained environmental condition of waterways, estuaries, wetlands and aquifers.	Implementation of best practice land management techniques will potentially lessen the offsite movement of soils, sediment and nutrients following extreme events.
SR 12 – Preservation of Aboriginal cultural heritage sites.	Preservation of Aboriginal cultural heritage sites. Traditional Owners' knowledge and aspirations are incorporated into the management of the landscape.	Cultural values may be damaged or lost as the result of climate change impacts.

7.7.4 Coastal Landscapes

Table 11: Coastal Landscapes adaptation and mitigation strategies rationale and link to RCS objectives

Strategies	Link to RCS 20 year Objectives	Rationale
CL 1 – Support coastal NRM agencies to plan for adaptation or retreat in areas impacted by sea level rise and storm surge.	Improved coastal dune system integrity. Improved or maintained environmental condition of waterways, estuaries, wetlands and aquifers. Understand the implications of the transition of Jack Smith Lake from a freshwater system to a marine system.	Options provide for adaptation and migration of highly vulnerable habitats that will be impacted by increased salinity and sea level rise and storm surge.
	Maintain integrity of biota and habitat in the marine ecosystem.	
	Understand the threats that seawalls pose to the coast and marine system in the long term.	
CL 2 – Support private land managers along the coast to adapt or make a planned retreat in areas impacted by sea level rise and storm surge.	Improved or maintained soil health.	Currently there is low appreciation of future impacts, possible options and their implications for private landholders and NRM agencies.
		Need to ensure high value agricultural land is identified and its protection is supported by planning schemes/ mechanisms.
	Maintain integrity of biota and habitat in the marine ecosystem.	Financial support will be required to support implementation of habitat protection/restoration works by private landholders.
CL 3 – Support carbon sequestration through the establishment of targeted biodiverse plantings in areas that address priorities for biodiversity, land and waterway health.	Improved or maintained environmental condition of waterways, estuaries, wetlands and aquifers.	Riparian areas have high carbon sequestration potential and generate significant allied NRM outcomes.
		Establishment of shade and shelter is a possible adaptation option for landholders in response to increased temperatures. Inclusion of local native species (with broad provenance characteristics) will ensure biodiversity benefits from this option.
	Maintain integrity of biota and habitat in the marine ecosystem.	These ecosystems have high capacity for carbon sequestration.
	Improved quality of native vegetation in the landscape.	Impacts of climate change will make it more difficult to establish some species. The inclusion of species more tolerant to changed conditions should increase the success of revegetation programs.

Table 11: Coastal Landscapes adaptation and mitigation strategies rationale and link to RCS objectives *continued*

Strategies	Link to RCS 20 year Objectives	Rationale
CL 4 – Improve the adaptive capacity of remnant vegetation through works to increase connectivity, improve condition and protect high quality remnants.	Improved quality of native vegetation in the landscape.	Targeted works informed by vulnerability assessment and Biodiversity Blueprint guidelines will support cost-effective strategies for vegetation management.
		Build on current incentive and delivery programs.
CL 5 – Refine the approaches used by natural resource managers when planning and implementing fencing, weed control and revegetation programs to take account of changing climatic conditions.	Improved quality of native vegetation in the landscape.	Impacts of climate change will make it more difficult to establish some species. The inclusion of species more tolerant to changed conditions should increase the success of revegetation programs. Flexible and adaptive approaches, including use of different species/ provenances.
CL 6 – Support fire management programs that adopt appropriate fire regimes to manage sensitive natural assets and assist the recovery of ecological communities from bushfire.	Improved quality of native vegetation in the landscape. Improved conservation status of the threatened species and communities in the landscape.	These assets are highly vulnerable to wildfire as a result of their sensitivity, fragmented nature and are slow to recover following disturbance.
		Integrate understanding of ecosystem vulnerability with finer scale planning of fuel reduction burning and associated strategies. It will be important to monitor outcomes and adaptively manage.
CL 7 – Support research and investigation to address knowledge gaps.	Improved quality of native vegetation in the landscape.	Long-term monitoring programs are required to understand trends in vegetation condition – these are likely to be specific to different landscape types/ revegetation mixes.
		Establishment of novel ecosystems may improve carbon sequestration, connectivity and habitat value but carries associated risk of pest plant and animal spread.
	Improved or maintained environmental condition of waterways, estuaries, wetlands and aquifers.	Further research and demonstrations are required to better understand potential outcomes, feasibility and costs associated with these options.
CL 8 – Consider climate change impacts from sea level rise, storm surge and catchment processes in future management of estuaries.	Improved or maintained environmental condition of waterways, estuaries, wetlands and aquifers.	Combined seaward impacts may have negative synergistic effects with catchment processes. These ecosystems are highly vulnerable to climate change.

Table 11: Coastal Landscapes adaptation and mitigation strategies rationale and link to RCS objectives *continued*

Strategies	Link to RCS 20 year Objectives	Rationale
CL 9 – Support the adoption of land management practices that improve soil health and production outcomes on grazing land.	Improved or maintained soil health.	Improved management of ground cover through more adaptive grazing practices has the potential to increase soil carbon levels and improve soil health. Can support improved adaptive management of pastures and maintain ground cover during times of drought stress/extreme rainfall periods.
CL 10 – Work with Local Government and State agencies to improve environmental outcomes.	Maintained extent and quality of significant native vegetation within the landscape.	Climate change is likely to see significant changes in land use as new enterprises (e.g. intensive horticulture) expand placing pressure on high value natural assets.
CL 11 – Identify priorities and develop plan of works to improve hydrological regime of floodplain and fringing wetlands.	Improved or maintained environmental condition of waterways, estuaries, wetlands and aquifers.	Options provide a mechanism to improve adaptive capacity of freshwater marshes and meadows. These are highly vulnerable as a result of sensitivity to changes in hydrology from warmer and drier conditions.
	Improve water quality in the landscape system.	Option addresses impacts resulting from increased intense rainfall events (resulting increased erosion and poor water quality) and provides a mechanism to address historic losses of freshwater marshes and meadows as a result of clearing and development.
	Improved quality of native vegetation in the landscape. Improved conservation status of the threatened species and communities in the landscape.	Many coastal ecosystems are highly sensitive to disturbance and this is likely to be amplified under future climate change.
CL 12 – Managing impacts to sensitive coastal ecosystems from future pressures of increased recreational use.	Improved quality of native vegetation in the landscape. Improved conservation status of the threatened species and communities in the landscape.	Many coastal ecosystems are highly sensitive to disturbance and this is likely to be amplified under future climate change.
CL 13 – Investigate options to lessen the offsite impacts to water quality following extreme events (e.g. flood, fire).	Improve water quality in the landscape system. Improved or maintained environmental condition of waterways, estuaries, wetlands and aquifers.	Implementation of best practice land management techniques will potentially lessen the offsite movement of soils, sediment and nutrients following extreme events.
CL 14 – Preservation of Aboriginal cultural heritage sites.	Preservation of Aboriginal cultural heritage sites. Traditional Owners' knowledge and aspirations are incorporated into the management of the landscape.	Cultural values may be damaged or lost as the result of climate change impacts.

7.7.5 Wilsons Promontory

Table 12: Wilsons Promontory adaptation and mitigation strategies rationale and link to RCS objectives

Strategies	Link to RCS 20 year Objectives	Rationale
WP 1 – Support coastal NRM agencies to plan for adaptation or retreat in areas impacted by sea level rise and storm surge.	Improved or maintained environmental condition of waterways, estuaries, wetlands and aquifers.	Options provide for adaptation and migration of highly vulnerable habitats that will be impacted by increased salinity and sea level rise and storm surge.
WP 2 – Support fire management programs that adopt appropriate fire regimes to manage sensitive natural assets and assist the recovery of ecological communities from bushfire.	Improved conservation status of the threatened species and communities in the landscape.	Option addresses potential threat to ecosystems in the alpine area from both wildfire and changed fire regimes.
		Predicted climate change is likely to increase the frequency and intensity of wildfire.
WP 3 – Improve the adaptive capacity of ecosystems in Wilsons Promontory by actively managing existing threats.	Improved quality of native vegetation in the landscape. Improved conservation status of the threatened species and communities in the landscape.	Active restoration and threat management will improve the adaptive capacity of these areas. Changes in distribution patterns of existing and new weeds and pest animals are likely under climate change. This will require active management and surveillance to protect the values of sensitive ecosystems.
		This ecosystem is highly sensitive to increased frequency of wildfire so active restoration will be required for it to persist.
WP 4 – Support research and investigation to address knowledge gaps.	Improved conservation status of the threatened species and communities in the landscape.	Changes in distribution patterns of existing and new weeds and pest animals are likely under climate change.
		The nature and intensity of current threats are likely to be amplified under a drying and warming climate.
WP 5 – Manage impacts to Wilsons Promontory ecosystems from future pressures of increased recreational use.	Improved quality of native vegetation in the landscape. Improved conservation status of the threatened species and communities in the landscape.	Many coastal ecosystems are highly sensitive to disturbance and this is likely to be amplified under future climate change.
WP 6 – Consider climate change impacts from sea level rise, storm surge and catchment processes in future management of estuaries.	Improved or maintained environmental condition of waterways, estuaries, wetlands and aquifers.	Combined seaward impacts may have negative synergistic effects with catchment processes. These ecosystems are highly vulnerable to climate change.

Table 12: Wilsons Promontory adaptation and mitigation strategies rationale and link to RCS objectives *continued*

Strategies	Link to RCS 20 year Objectives	Rationale
WP 7 – Investigate options to lessen the offsite impacts to water quality following extreme events (e.g. flood, fire).	Improve water quality in the landscape system. Improved or maintained environmental condition of waterways, estuaries, wetlands and aquifers.	Implementation of best practice land management techniques will potentially lessen the offsite movement of soils, sediment and nutrients following extreme events.
WP 8 – Preservation of Aboriginal cultural heritage sites.	Preservation of Aboriginal cultural heritage sites. Traditional Owners' knowledge and aspirations are incorporated into the management of the landscape.	Cultural values may be damaged or lost as the result of climate change impacts.

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Appendices

Appendix 1
Climate change vulnerability assessment process

A vulnerability assessment was completed for natural assets in the West Gippsland region as part of a project completed for a number of Catchment Management Authorities in Victoria by Spatial Vision and Natural Decisions.[6] The assessment was completed for multiple natural asset classes and included the use of available data on the characteristics, values and condition of the assets. The assets considered in the assessment were consistent with those used in the RCS development process and included: native vegetation, rivers and streams, wetlands, estuaries, coasts and soil. The assessment included climate change projection scenarios based on selected exposure surfaces available from research and development activities.

The approach used to assess potential impacts and vulnerability required consideration of the sensitivity and adaptive capacity of the relevant asset. The assessment incorporated multiple projection scenarios (based on different global emissions scenarios) over multiple time frames and considered the potential climate change impact and vulnerability using the assessment framework described below.

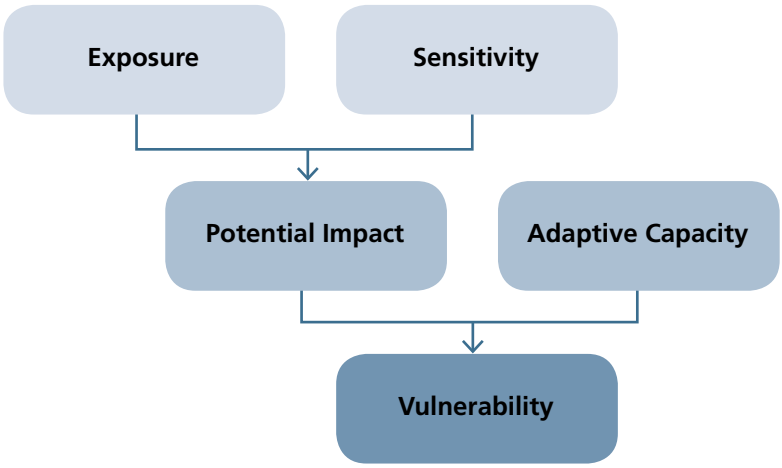

Figure 15: Climate change impact and vulnerability assessment framework

The process involved identifying the sensitivity of an asset type to two different climate exposures (or climatic stressors under a particular climate scenario) and using this information to determine the potential impact. The adaptive capacity of the asset was then used to determine its vulnerability.

While the climate stressors vary based on the climate scenario chosen in terms of the climate model used and particular timeframe, the sensitivity relationship or profile for an asset type is applicable for any anticipated climate scenario and timeframe under consideration.

The general steps undertaken for each natural asset type in application of the vulnerability assessment process were as follows:

1. Identify two key **Climate Stressors/Exposures** (and potential changes).
2. Identify **Asset Classes** relevant to Stressors.
3. Assign likely **Sensitivity** to Climate Stressors (likely response to change).
4. Calculate **Potential Impact** for each Climate Stressor (Exposure) for the change anticipated for a given climate scenario and time frame.
5. Calculate the worst **Potential Impact** for each combination of Climate Stressors (Exposure) for a given climate scenario and time frame.
6. Develop a likely **Adaptive Capacity** measure (based on current condition) for NRM asset.
7. Calculate **Vulnerability** based on potential impact and intrinsic adaptive capacity based on current state for a given climate scenario and time frame.
8. Assets with a **vulnerability score of equal to or greater than 30** were deemed to be the most vulnerable to climate change impacts.

Parameters used in the vulnerability assessment to determine the exposure, sensitivity and adaptive capacity of each asset class are presented below.

Table 13: Summary of Climate Stressors (Exposures), Climate Stressor Sensitivity considerations and Adaptive Capacity inputs

Asset Type	Climate Stressor	Sensitivity	Adaptive Capacity
Native Vegetation	Total Rainfall Nov to April – daily Max Temp	EVC sub-groups	Site condition Landscape connectivity
Wetlands	Mar to Nov – Rainfall Nov to April – daily Max Temp	Wetland type (FW meadows, marshes etc.) Water Source (river, groundwater) Alpine/non-alpine Within 2100 SLR and storm surge extent	% native veg presence within 100m Quality of native veg within 100m Land use within 100m Presence of drain, levee or cropping
Coastal wetlands	Mar to Nov – Rainfall Sea Level Rise & Storm Surge	Wetland type (Freshwater meadows, marshes etc.) Wetlands Regime – Supratidal Water Source (river, groundwater) Within 2100 SLR and storm surge extent	%native veg presence within 100m Dominant native veg quality within 100m Dominant land use within 100m Presence of drain, levee or cropping
Estuaries	Mar to Nov – Rainfall Sea Level Rise & Storm Surge	Open – Permanent & Intermittent Regulated catchment or not Mouth type – bay / coast	%native veg within catchment Quality of native veg within catchment Population & population density within catchment

Table 13: Summary of Climate Stressors (Exposures), Climate Stressor Sensitivity considerations and Adaptive Capacity inputs *continued*

Asset Type	Climate Stressor	Sensitivity	Adaptive Capacity
Rivers and Streams	Mar to Nov – Rainfall Nov to April – daily Max Temp	Regulated or not Perennial / permanent Terrain category – plains, intermediate, upper	% native veg presence within 100m Quality of native veg within 100m ISC – hydrology & streamside zone rating
Soils and Land	Total Rainfall Nov to April – daily Max Temp	Land system based soils Susceptibility to wind erosion Susceptibility to water erosion & terrain type	Native vegetation cover/ground cover Site condition & landscape context Land degradation (salinity, erosion)

The results from the vulnerability assessment using the RCP 4.5 scenario indicated that there may only be moderate levels of impact on natural assets in the West Gippsland region until the 2090 time period. Whereas the RCP 8.5 emission scenario (where emissions continue to rise throughout the 21st century) indicated moderate to high levels of impact on natural assets from 2070 onward. Taking into account the results of the impact and vulnerability assessment, it was decided that the RCP 8.5 emission scenario for the 2070 time period would be used to inform this Strategy. This scenario has been chosen because it provides a longer planning horizon than the Regional Catchment Strategy (55 years compared with 20 years), and has been judged to provide a plausible picture of possible moderate to high level impacts, under specific changes in climate factors, particularly changes in temperature and rainfall.

It is important to note that the results for the RCP 8.5 emission scenario for the 2030, 2050 and 2090 timeframes were used to help assess how robust and feasible each of the adaptation and mitigation options may possibly be over time.

Appendix 2
Climate change vulnerability assessment maps

Native vegetation

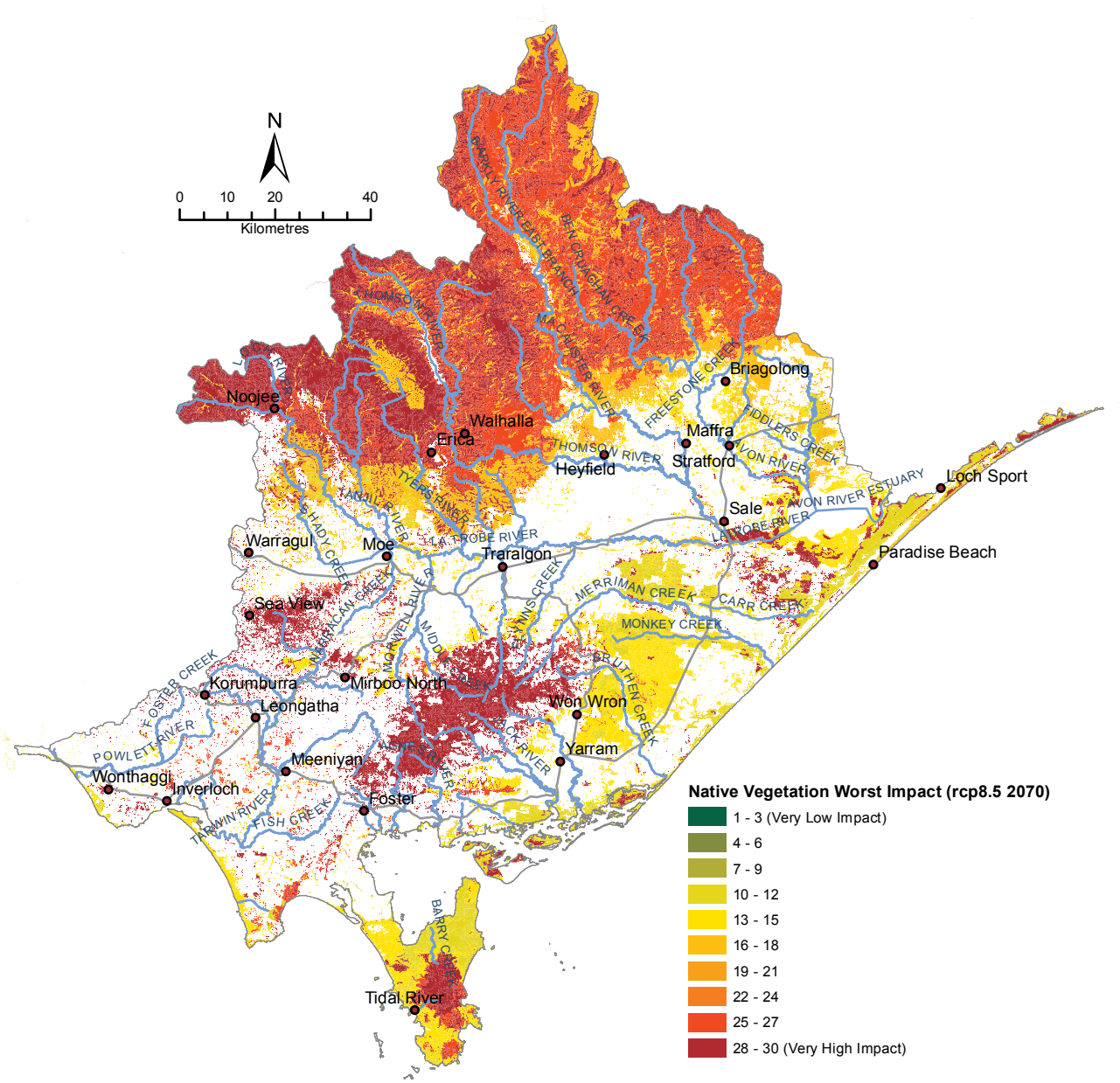

Figure 16: Vulnerability assessment results: native vegetation worst impact (RCP 8.5 2070)

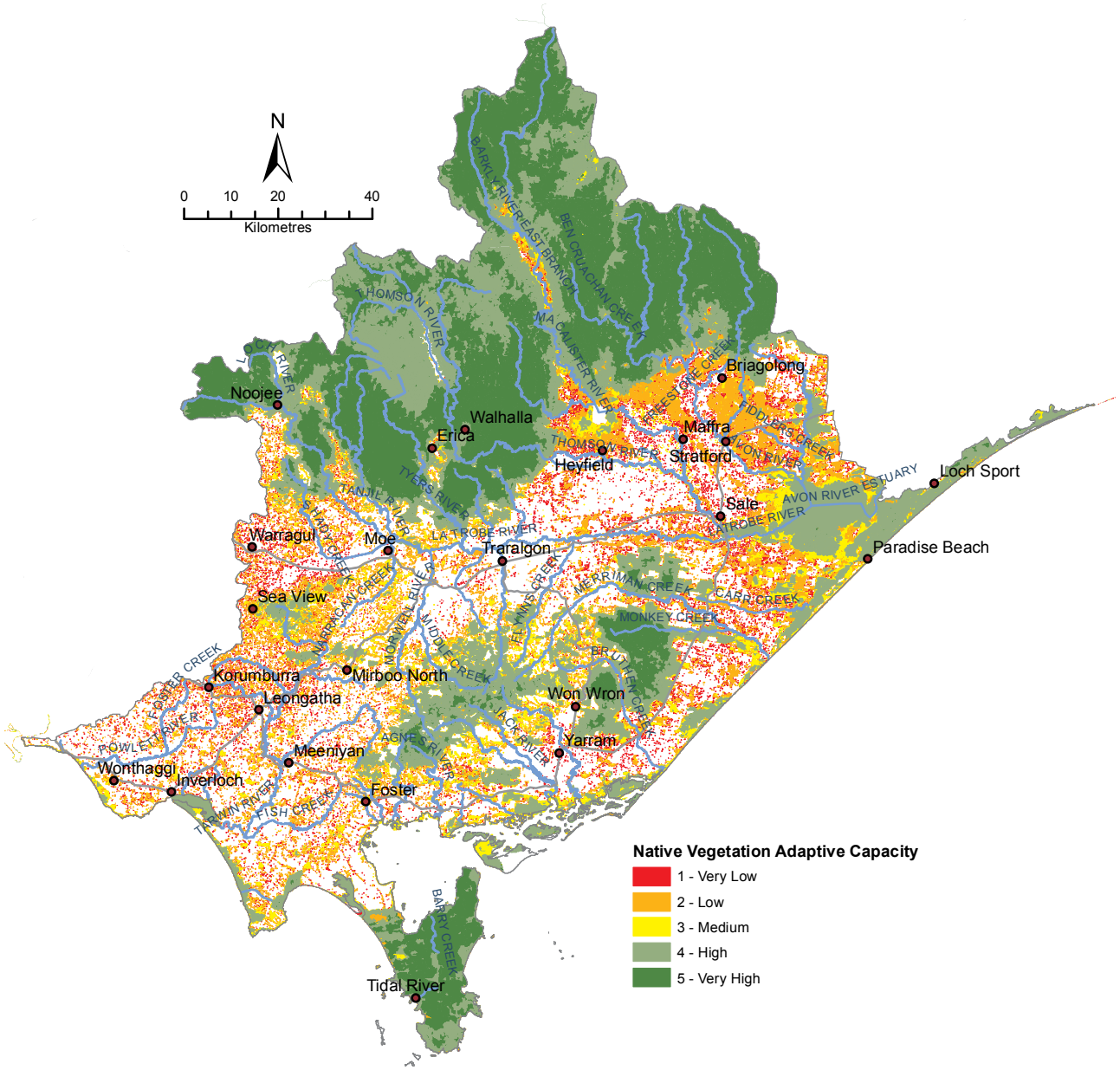

Figure 17: Vulnerability assessment results: native vegetation adaptive capacity

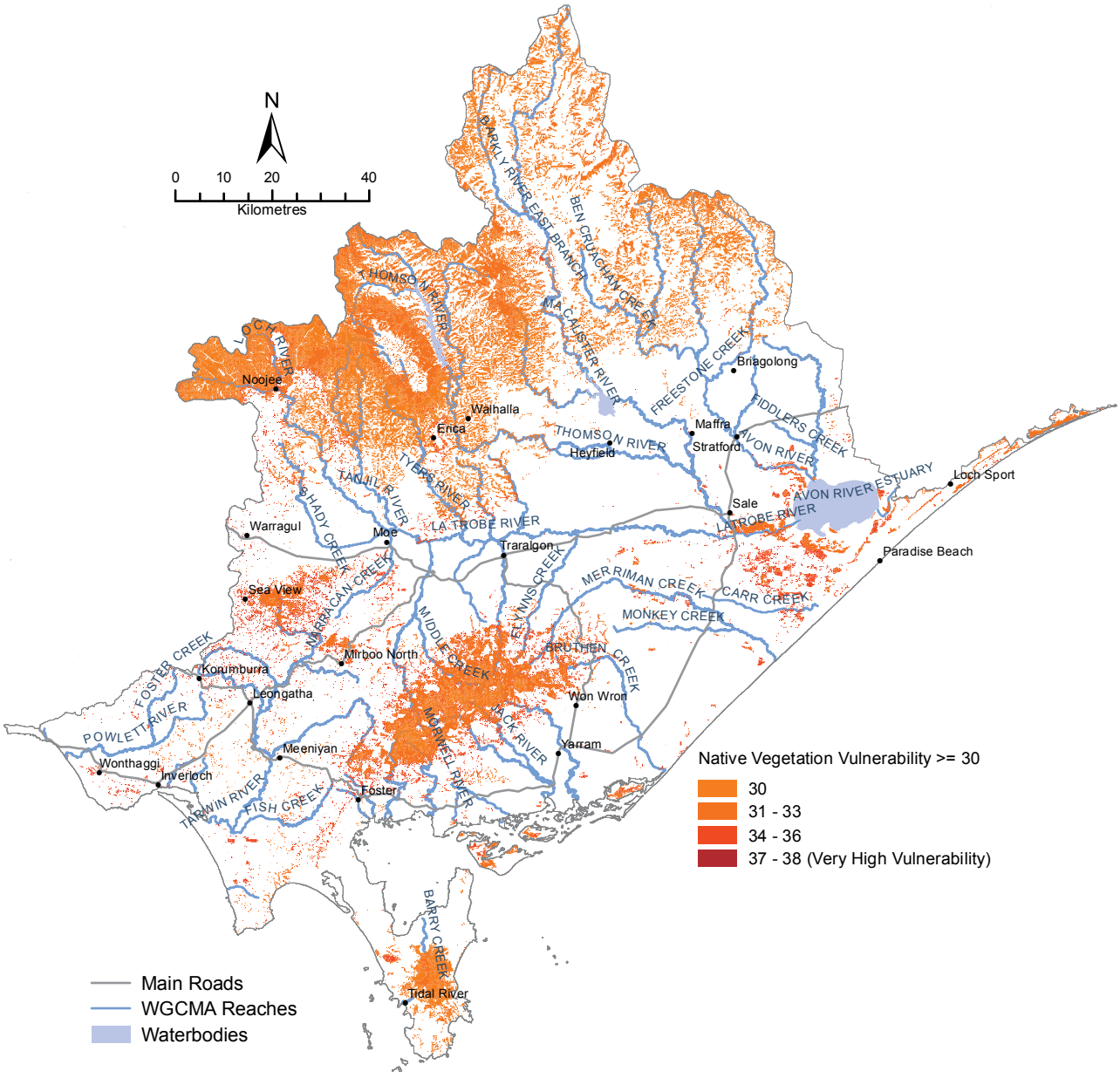

Figure 18: Location of native vegetation with a very high potential vulnerability in West Gippsland (RCP 8.5 2070)

Soils and land

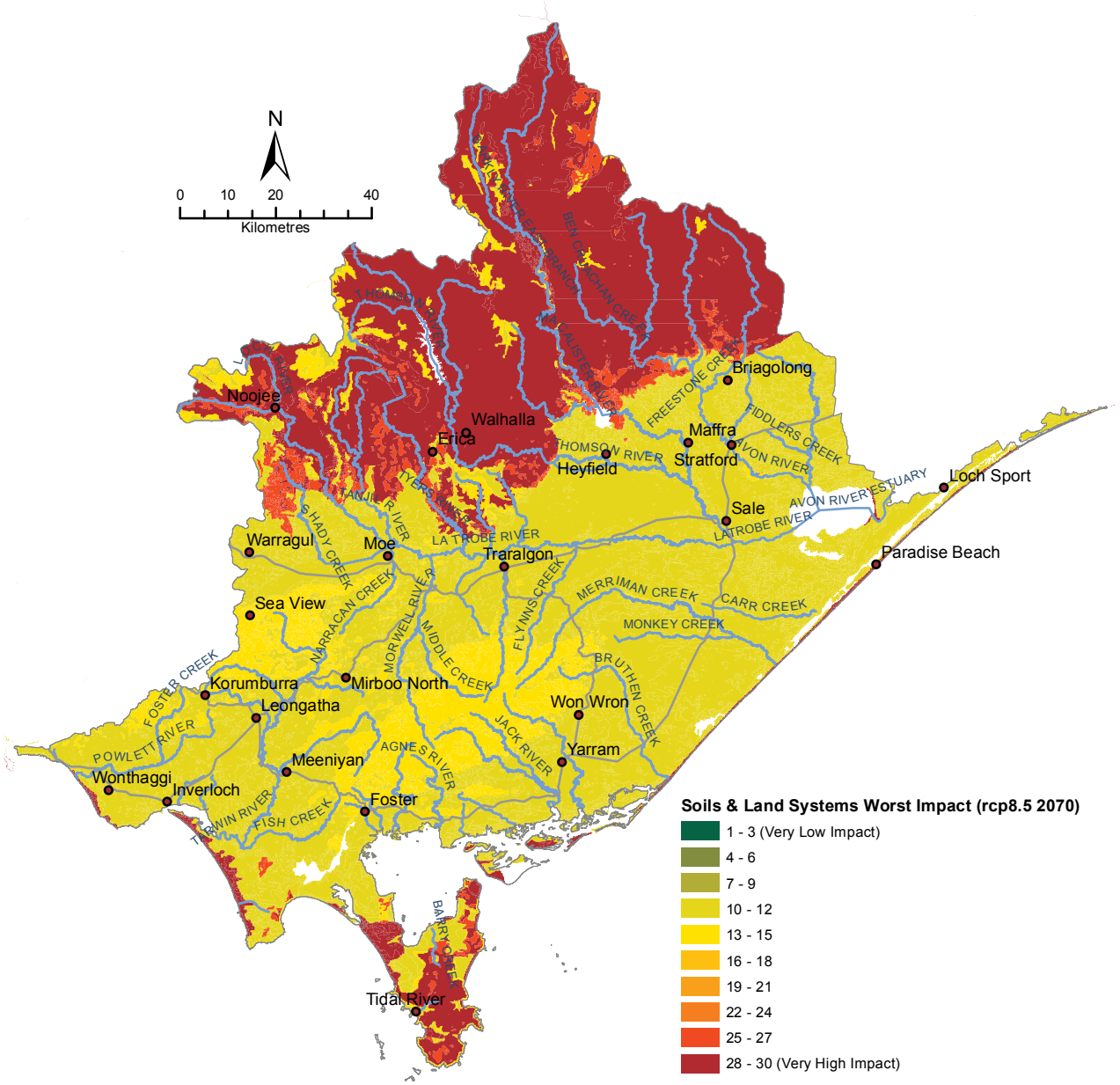

Figure 19: Vulnerability assessment results: soils and land worst impact (RCP 8.5 2070)

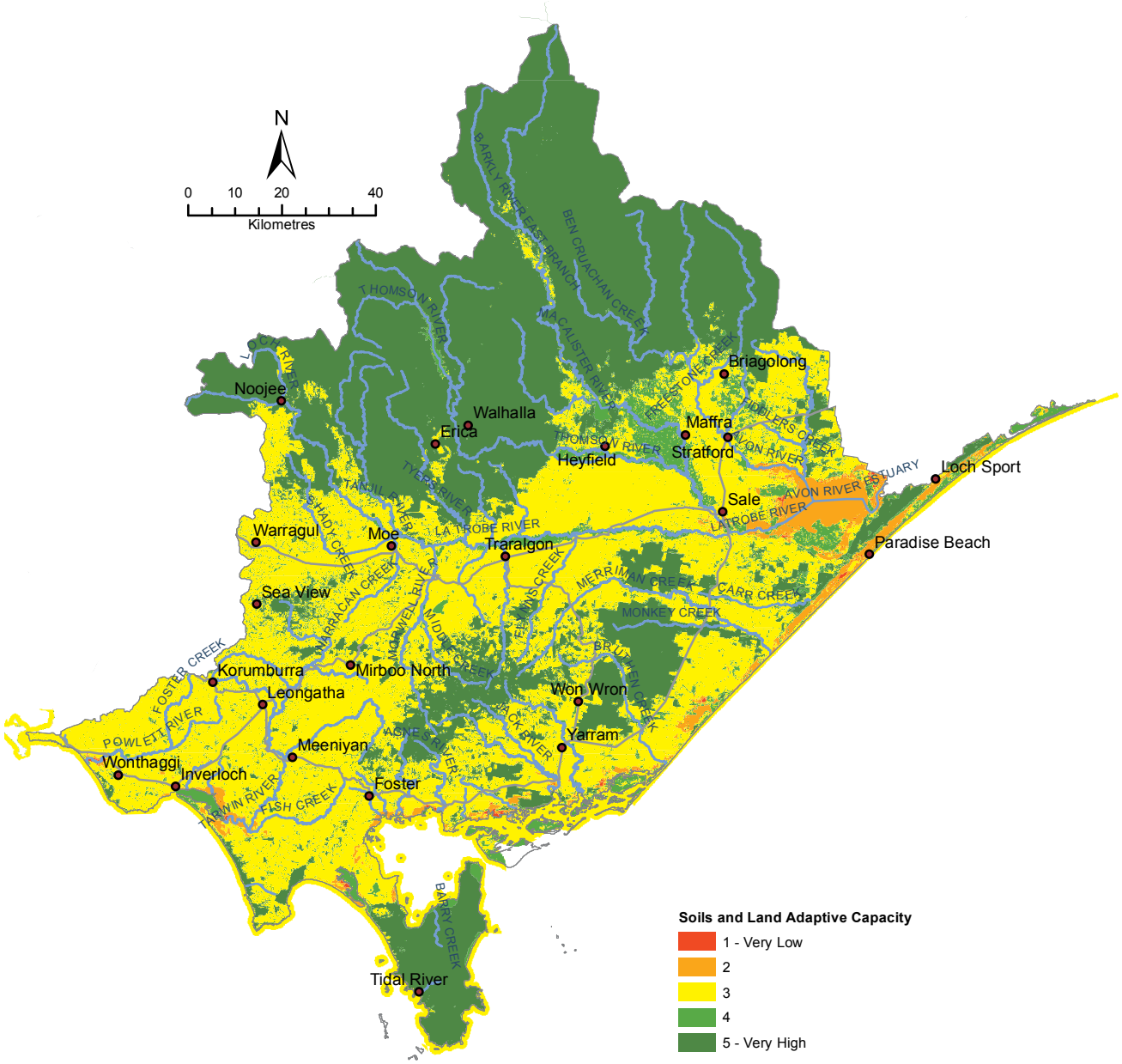

Figure 20: Vulnerability assessment results: soils and land adaptive capacity

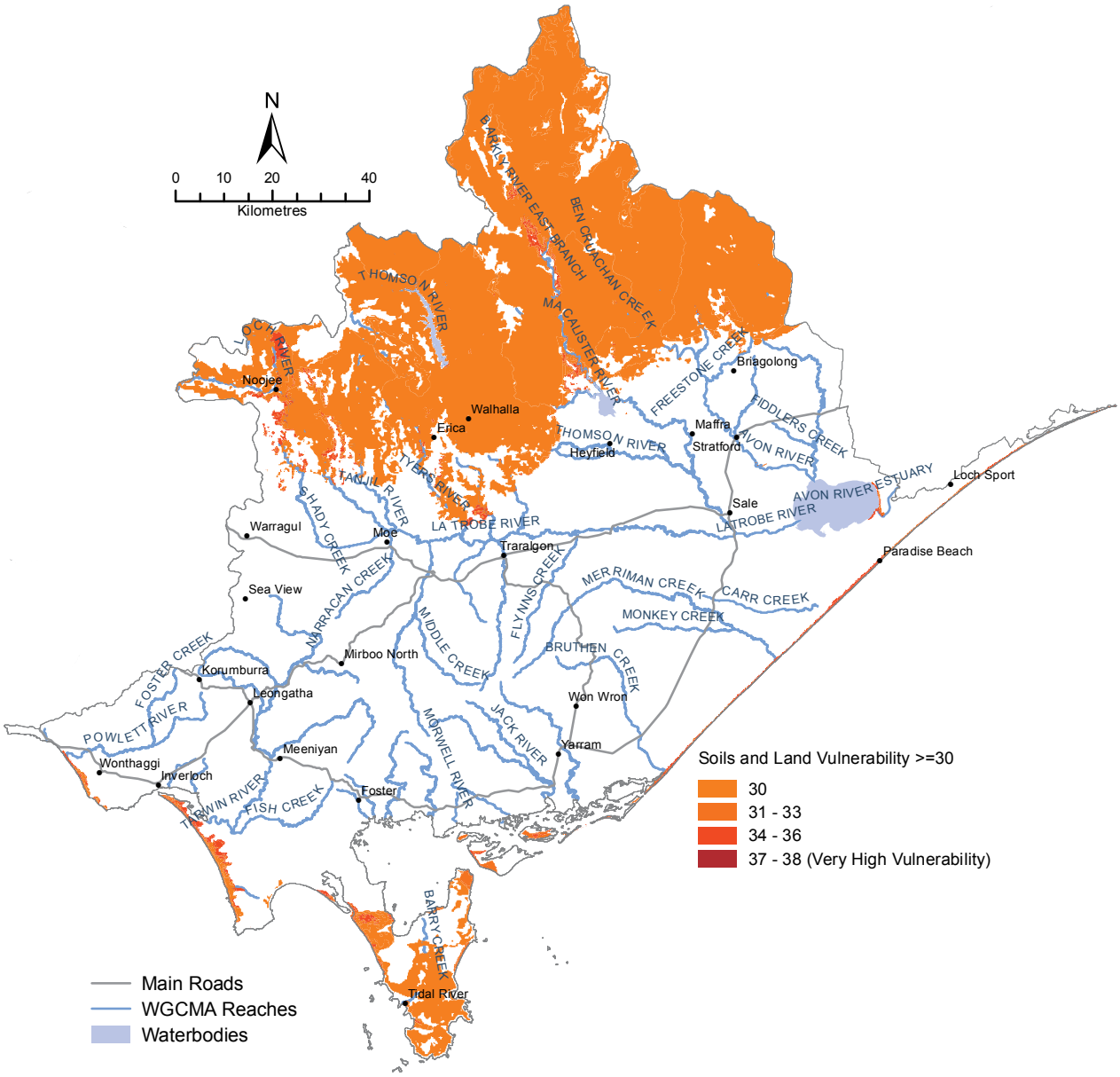

Figure 21: Location of soils with a very high potential vulnerability in West Gippsland (RCP 8.5 2070)

Rivers and streams

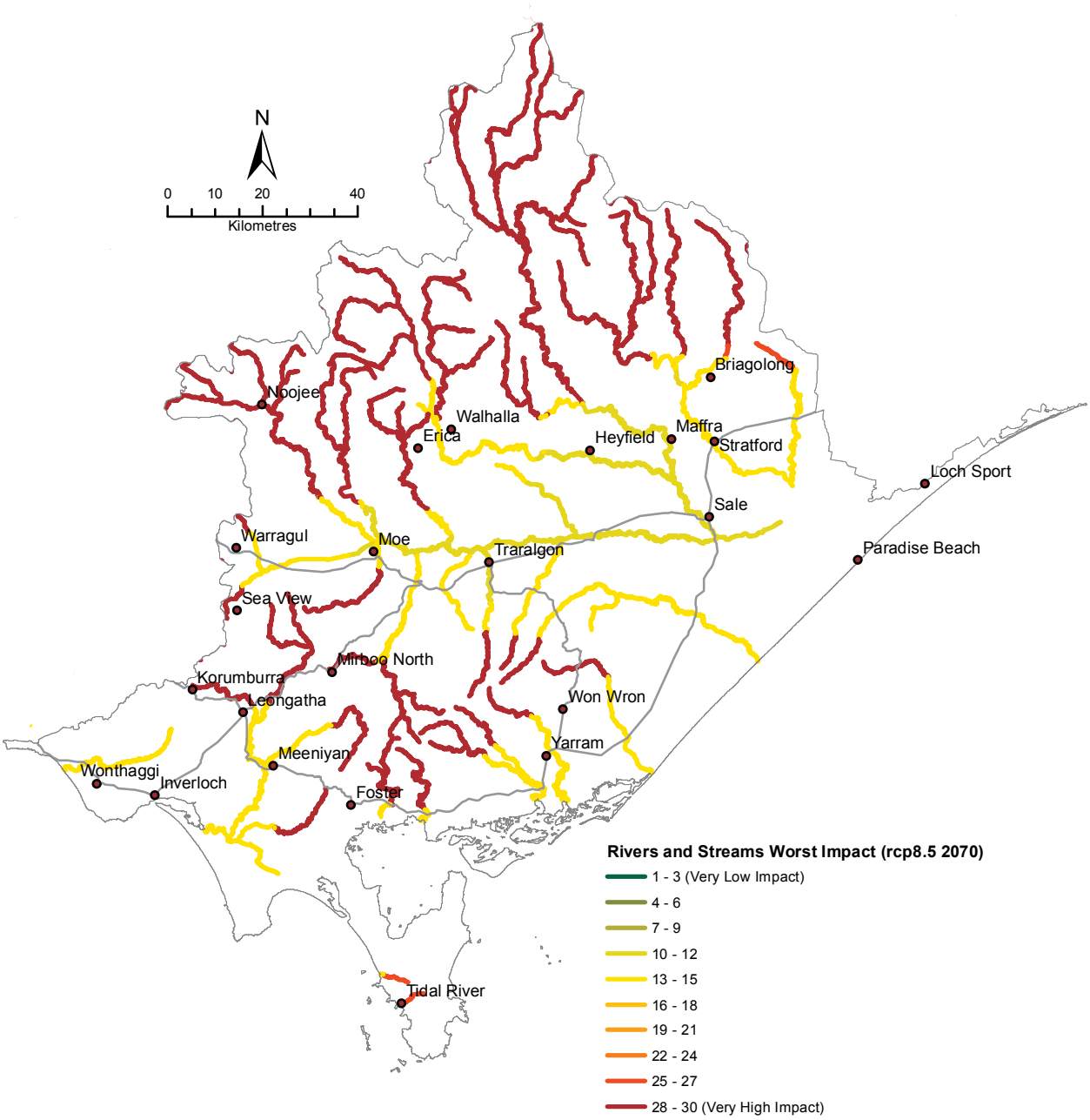

Figure 22: Vulnerability assessment results: rivers and streams worst impact (RCP 8.5 2070)

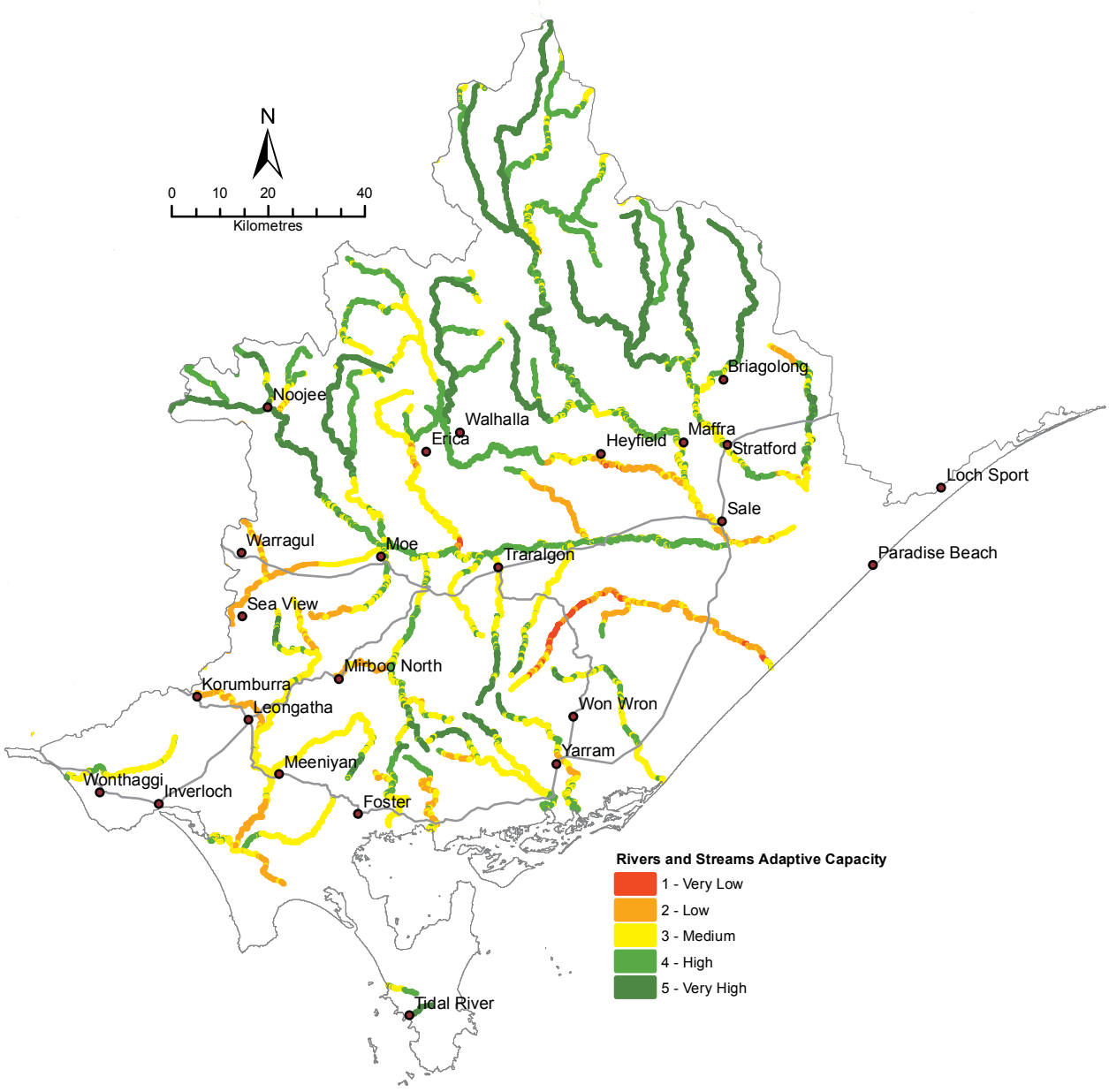

Figure 23: Vulnerability assessment results: rivers and streams adaptive capacity

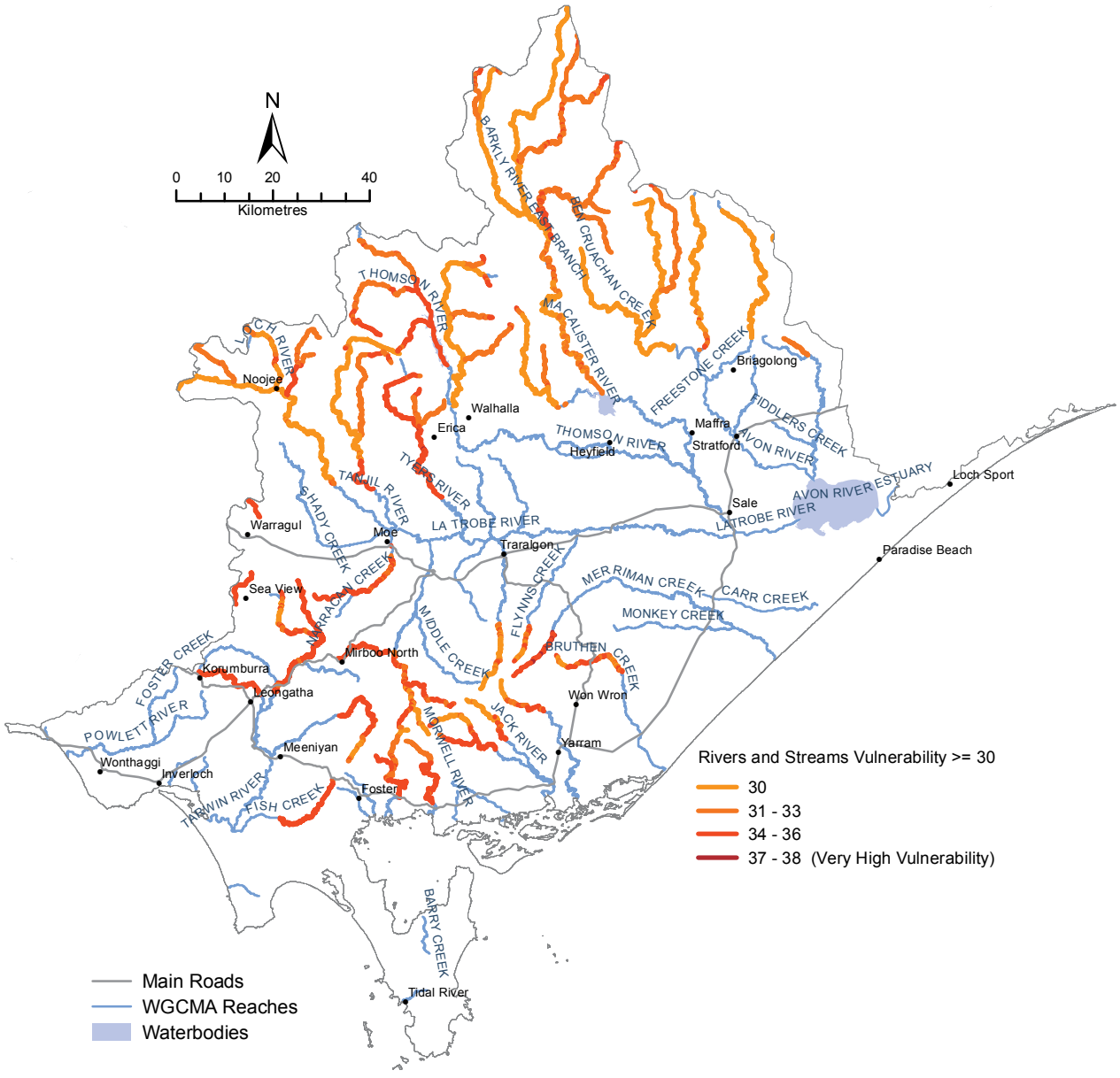

Figure 24: Location of rivers and streams with a very high potential vulnerability in West Gippsland (RCP 8.5 2070)

Estuaries

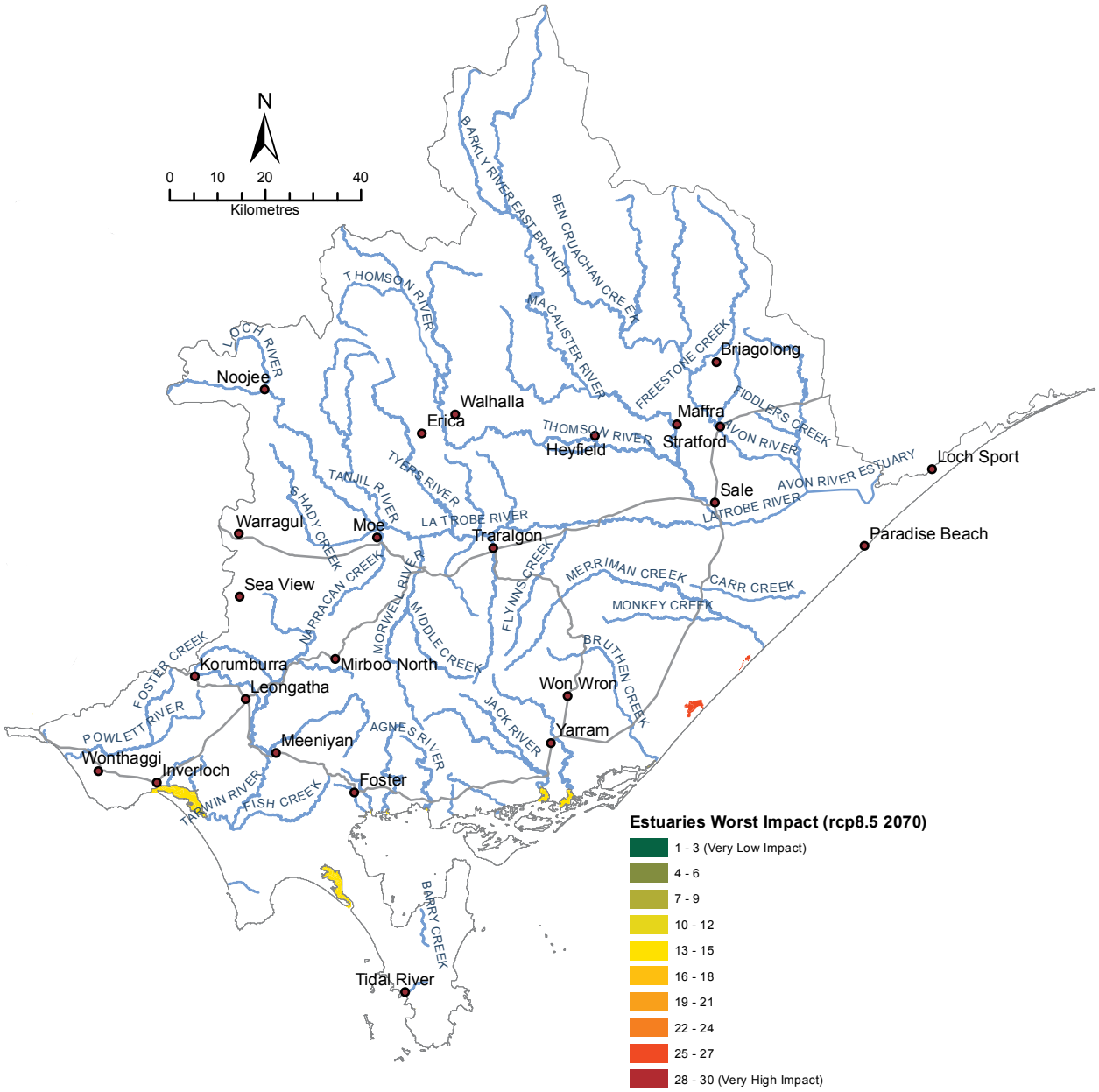

Figure 25: Vulnerability assessment results: estuaries worst impact (RCP 8.5 2070)

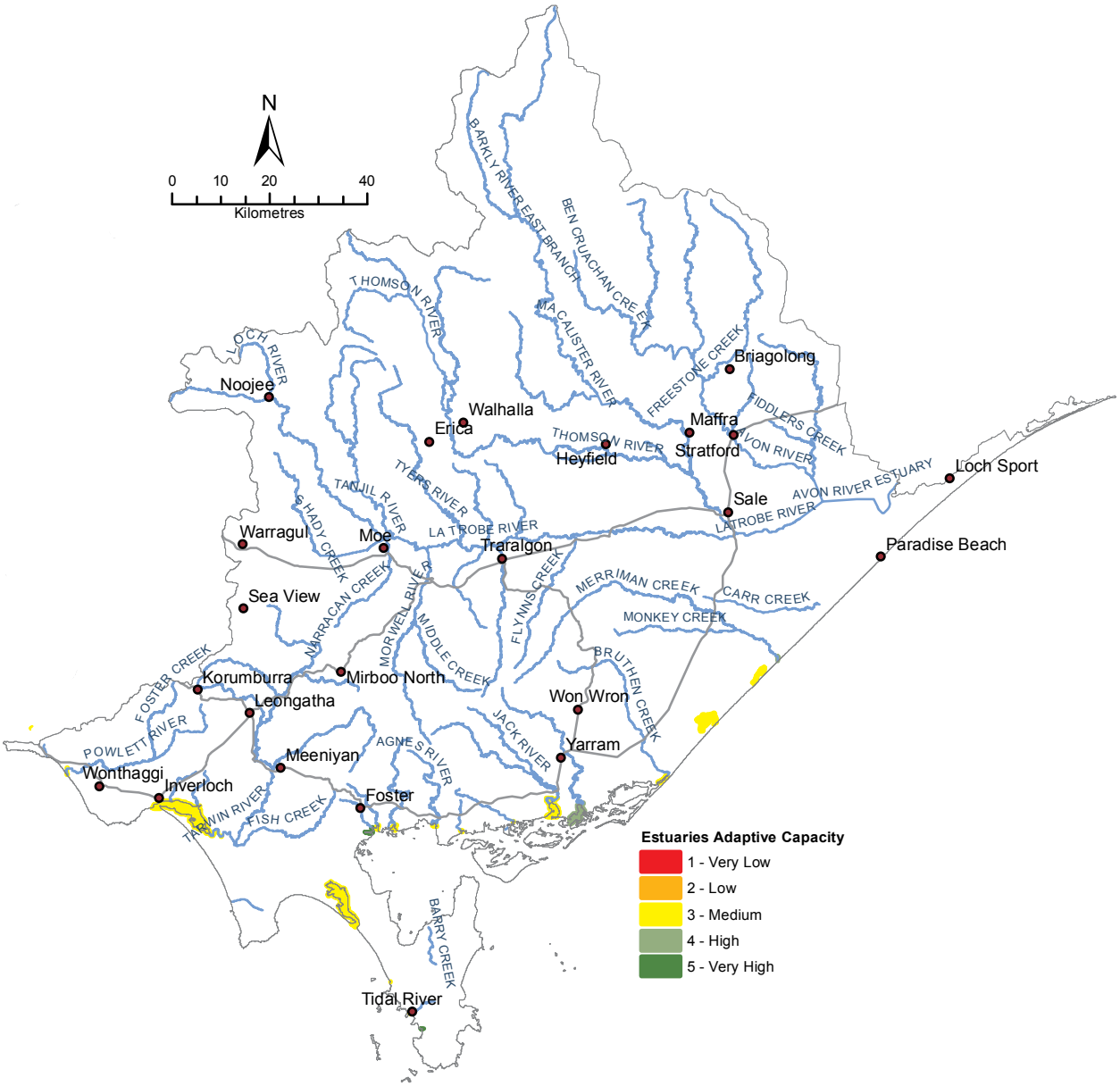

Figure 26: Vulnerability assessment results: estuaries adaptive capacity

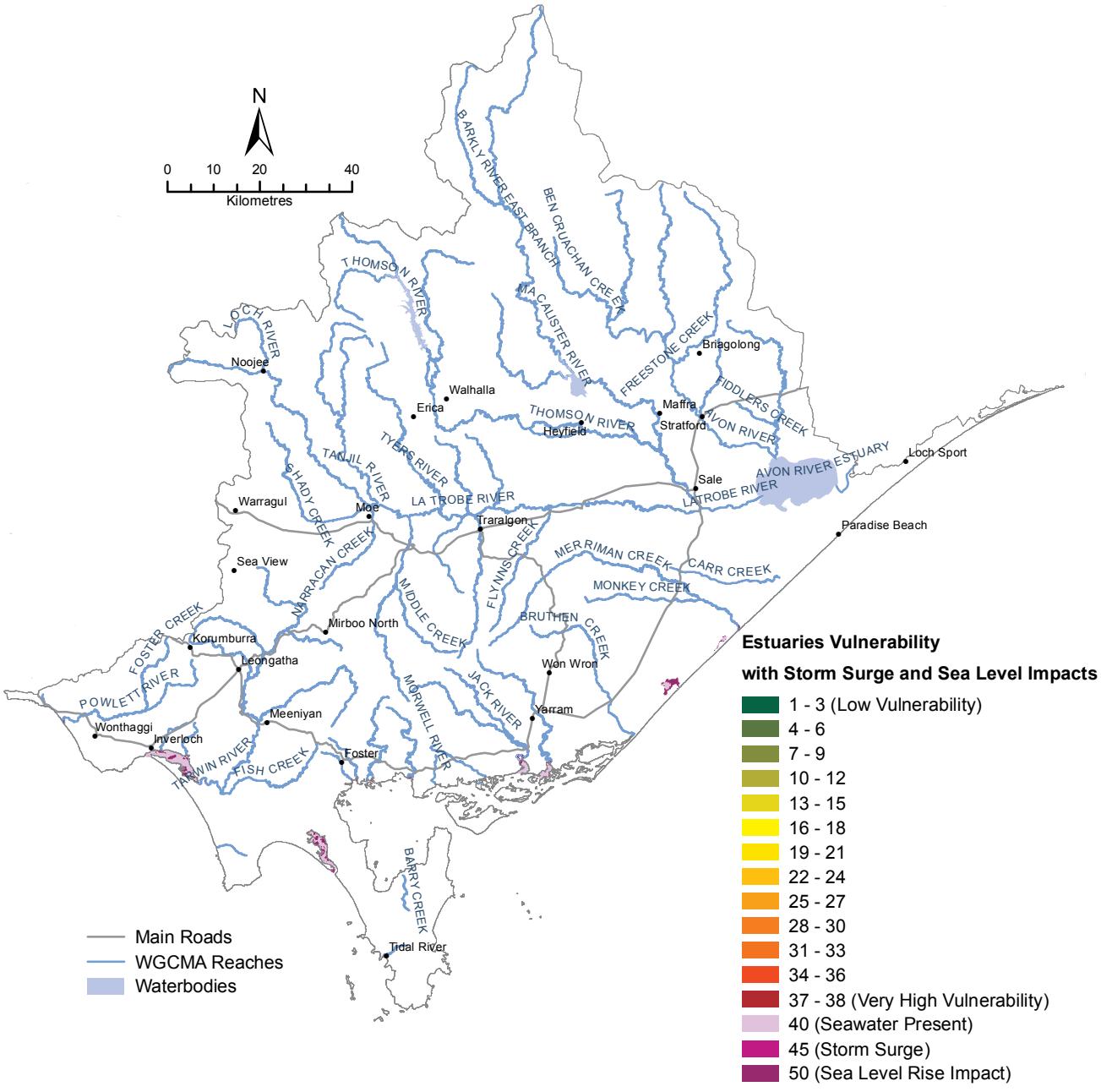

Figure 27: Vulnerability of estuaries in West Gippsland overlaid with storm surge and sea level rise impacts (RCP 8.5 2070)

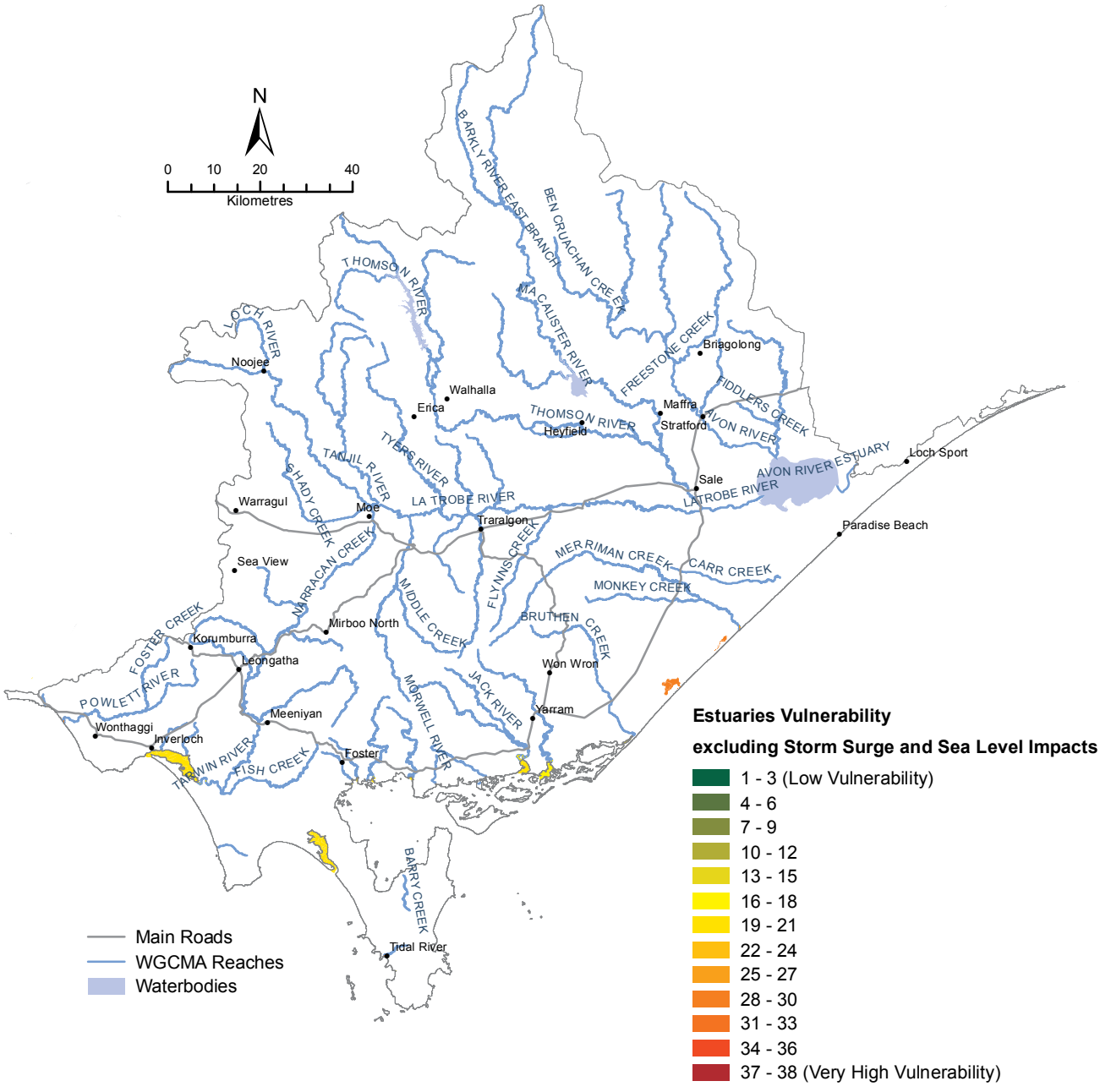

Figure 28: Vulnerability of estuaries in West Gippsland (excluding storm surge and sea level rise impacts) (RCP 8.5 2070)

Inland wetlands

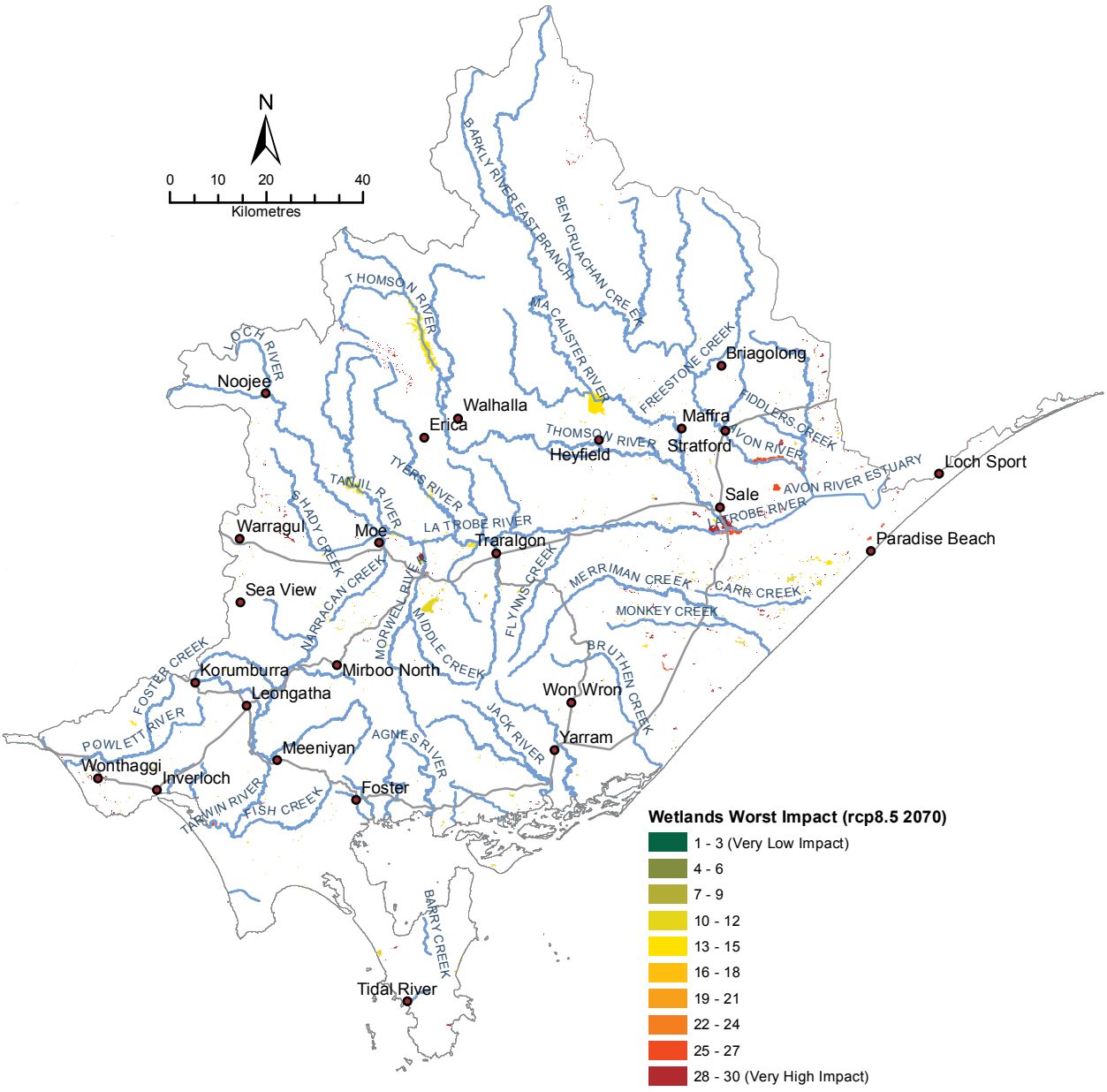

Figure 29: Vulnerability assessment results: inland wetlands worst impact (RCP 8.5 2070)

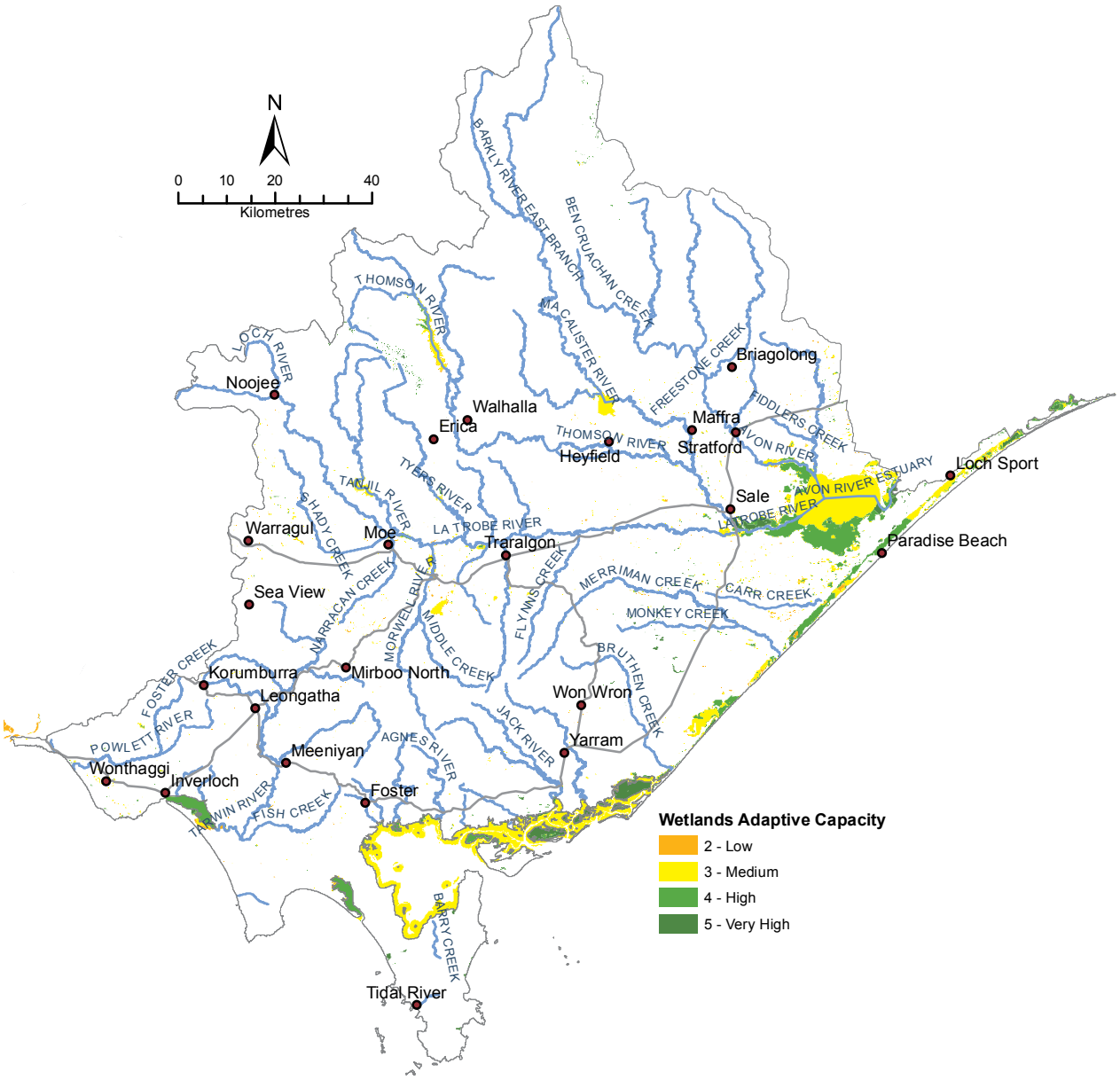

Figure 30: Vulnerability assessment results: inland wetlands adaptive capacity

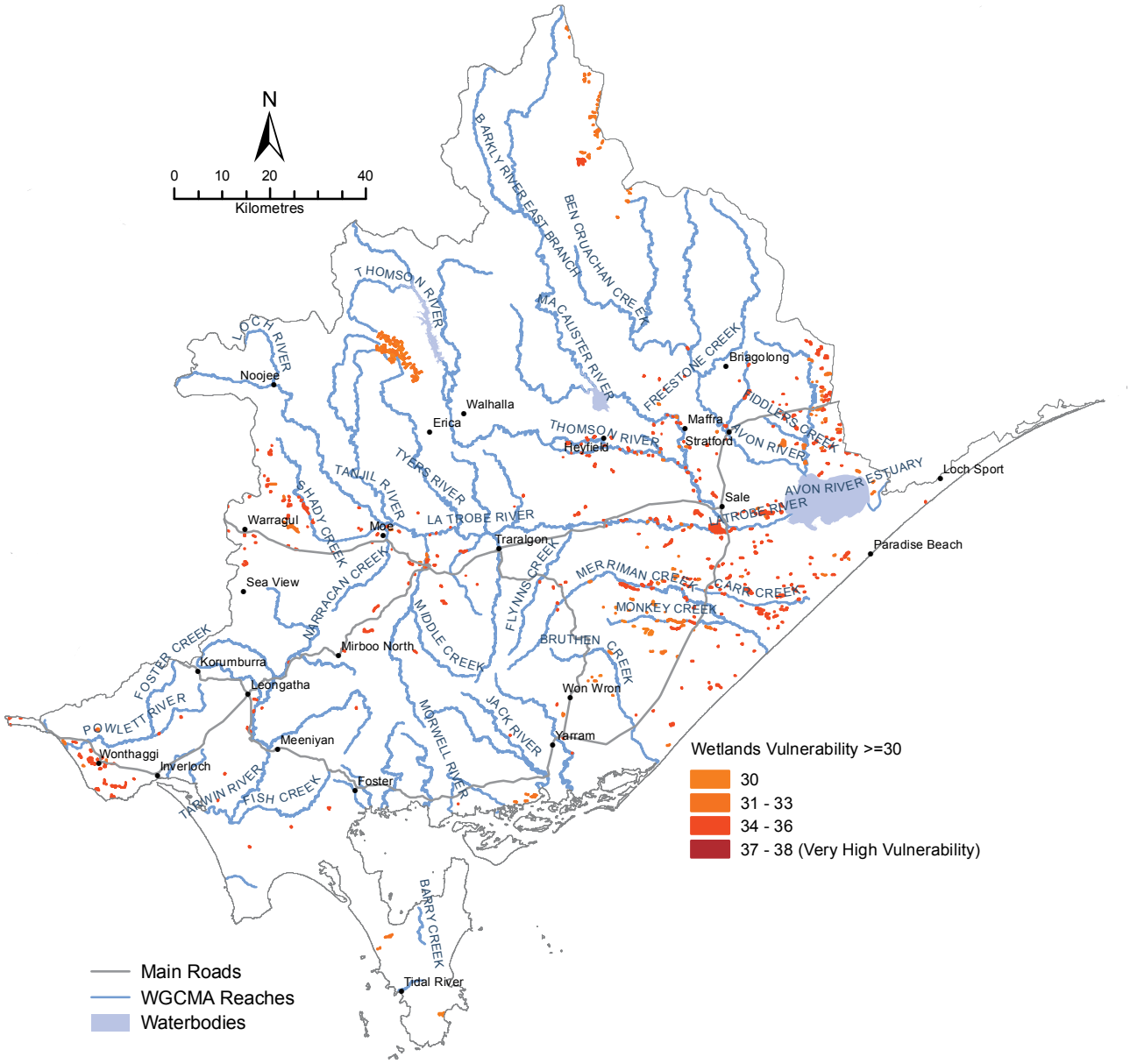

Figure 31: Location of inland wetlands with a very high potential vulnerability in West Gippsland (RCP 8.5 2070)

Coastal wetlands

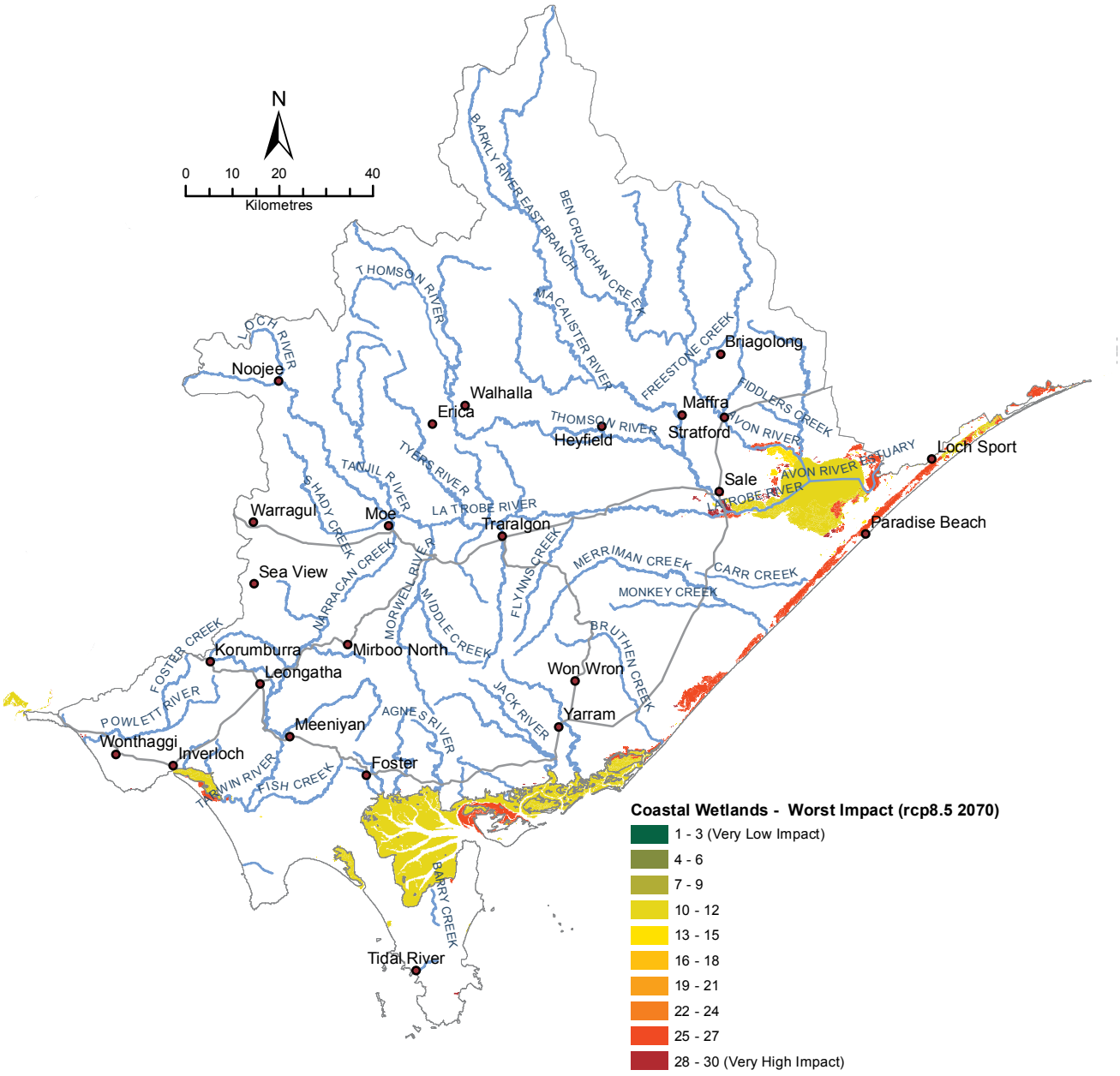

Figure 32: Vulnerability assessment results: coastal wetlands worst impact (RCP 8.5 2070)

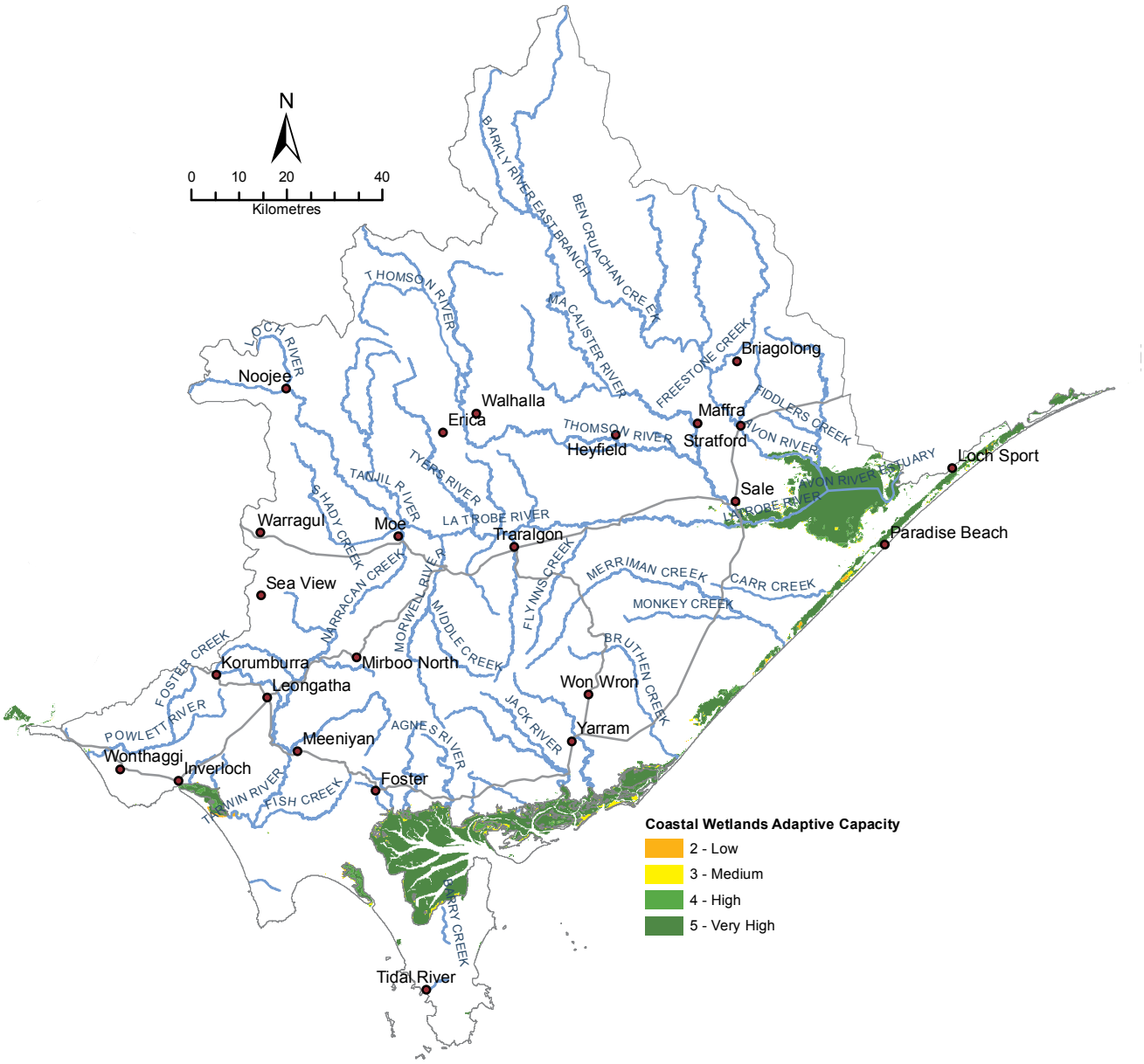

Figure 33: Vulnerability assessment results: coastal wetlands adaptive capacity

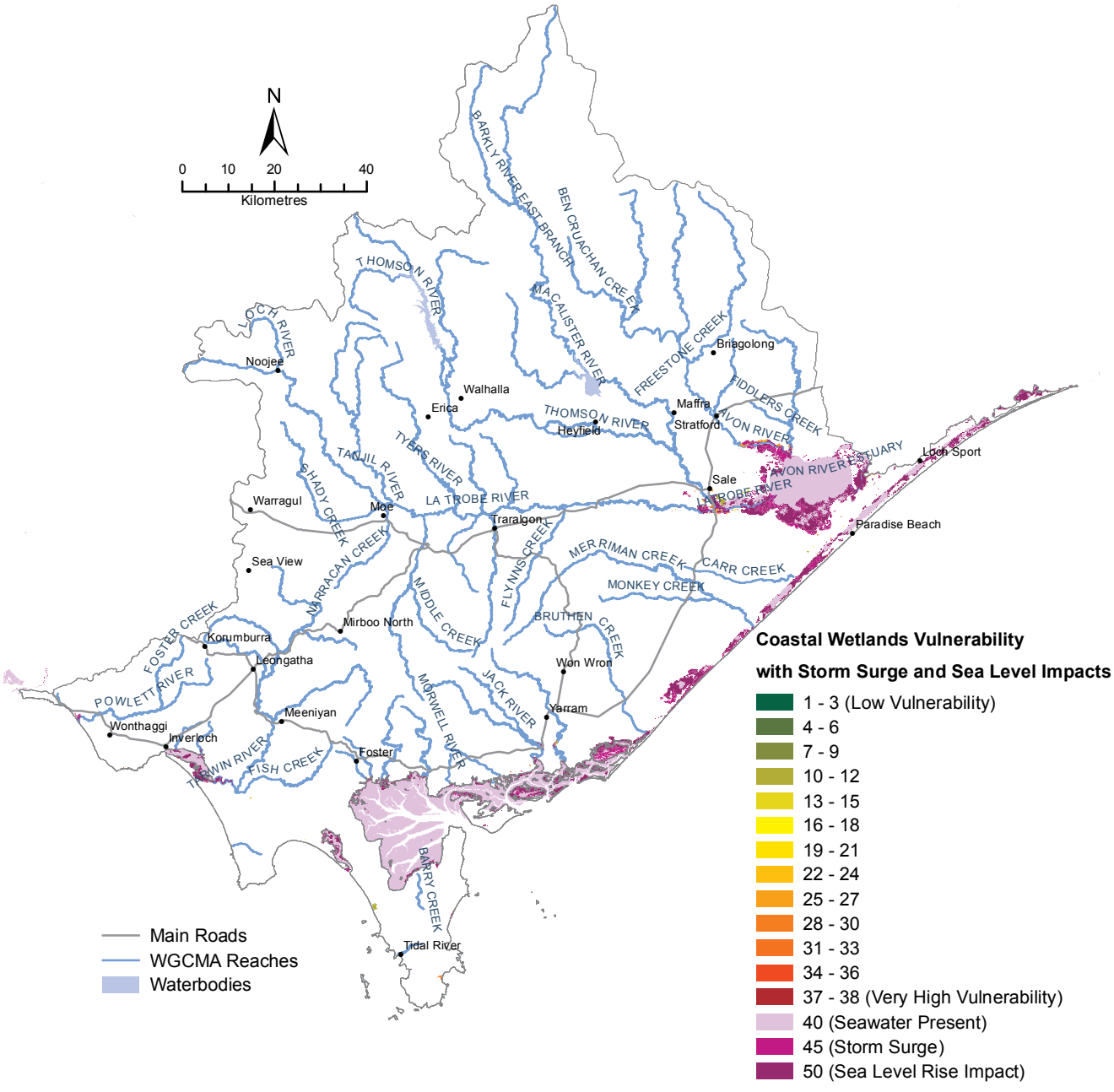

Figure 34: Vulnerability of coastal wetlands in West Gippsland overlaid with storm surge and sea level rise impacts (RCP 8.5 2070)

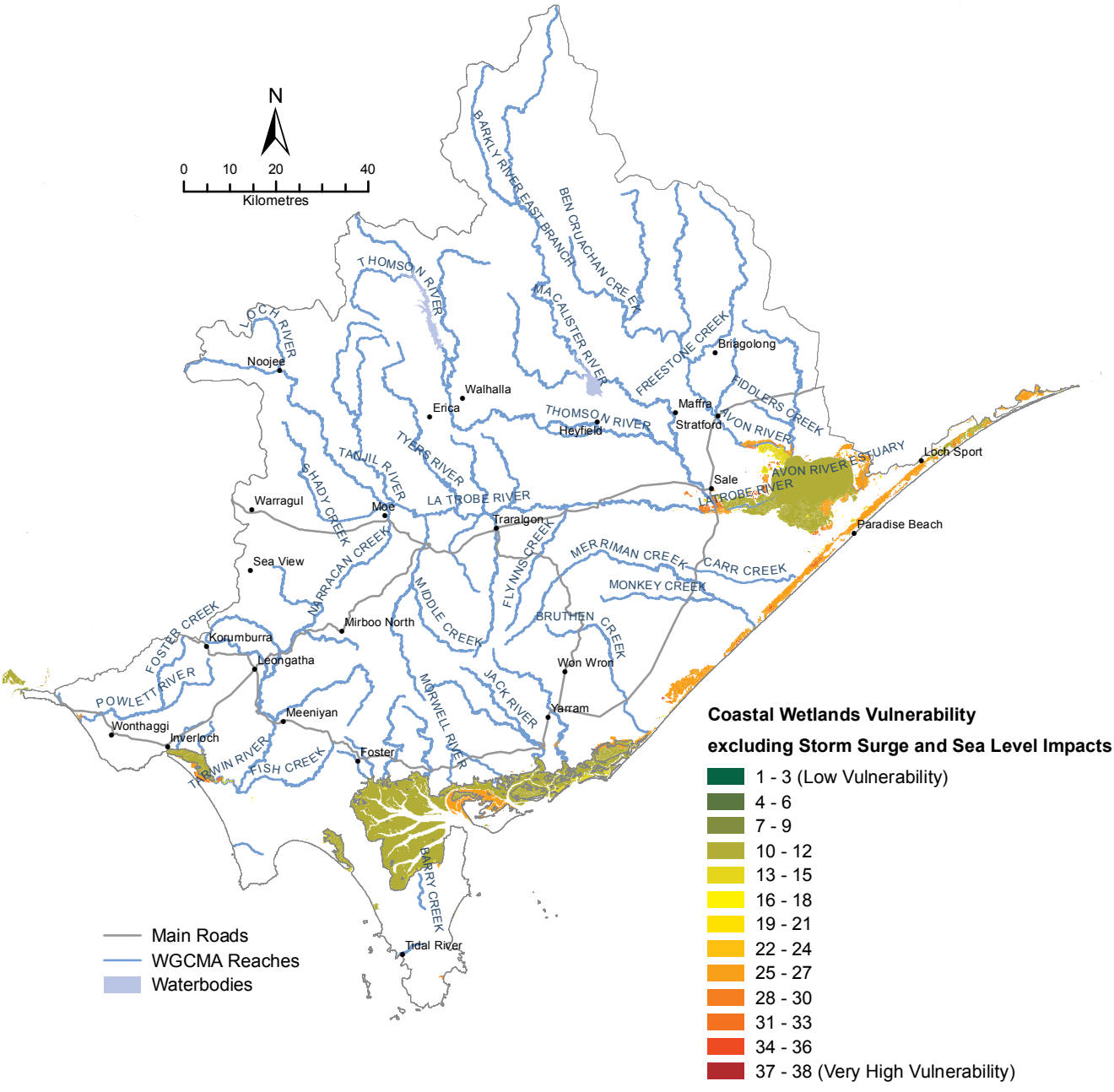

Figure 35: Vulnerability of coastal wetlands in West Gippsland (excluding storm surge and sea level rise impacts) (RCP 8.5 2070)

Appendix 3
Summary of assets with highest vulnerability to climate change across the West Gippsland region

Table 14: Highest potentially vulnerable rivers and streams in West Gippsland (RCP 8.5, 2070)

Name	Reach	Priority RCS Asset	RCS Landscape Priority Area						
			BC	CIN	GLH	MUL	STR	VA	WP
Aberfeldy River	25-18	Yes						x	
Ada River	-	No						x	
Agnes River	27-26	No					x		
Agnes River	27-25	Yes		x			x		
Albert River	27-30	No					x		
Albert River	27-29	No					x		
Avon River	25-22	Yes						x	
Barkly River East Branch	25-13	Yes						x	
Bear Creek	-	No					x		
Ben Cruachan Creek	25-31	No						x	
Berry's Creek	27-19	No					x		
Bruthen Creek	27-38	No				x	x		
Coalition Creek	27-17	No					x		
Fish Creek	27-14	No					x		
Flynns Creek	26-8	No					x		
Franklin River	27-22	No					x		
Franklin River	27-21	No		x			x		
Freestone Creek	25-28	No						x	
Glenmaggie Creek	25-15	No						x	
Glenmaggie Creek	25-14	No			x			x	
Jack River	27-32	No					x		
Jordan River	25-6	No						x	
Latrobe River	26-7	Yes						x	
Latrobe River	26-6	No						x	
Latrobe River	26-5	No						x	
Loch River	26-30	Yes						x	
Macalister River	25-12	Yes						x	
Macalister River	25-11	No						x	
Macalister River	25-10	No						x	

BC = Bunurong Coastal; CIN = Corner Inlet Nooramunga; GLH = Gippsland Lakes & Hinterland; MUL = Mullungdung; STR = Strzelecki Ranges; VA = Victorian Alps; WP = Wilsons Promontory.

Table 14: Highest potentially vulnerable rivers and streams in West Gippsland (RCP 8.5, 2070) *continued*

Name	Reach	Priority RCS Asset	RCS Landscape Priority Area						
			BC	CIN	GLH	MUL	STR	VA	WP
Macalister River	25-9	No			x			x	
Merriman Creek	27-41	No					x		
Merriman Creek	27-40	No					x		
Moe River	-	No					x		
Morwell River	26-20	No					x		
Morwell River	26-19	No					x		
Narracan Creek	26-26	No					x		
Tanjil River West Branch	26-25	No						x	
Tanjl River East Branch	26-24	No						x	
Tarra River	27-35	Yes					x		
Tarra River	27-34	No					x		
Tarwin River East Branch	27-16	No					x		
Tarwin River East Branch	27-15	No					x		
Tarwin River West Branch	27-12	No					x		
Tarwin River West Branch	27-11	No					x		
Thomson River	25-99	Yes						x	
Traralgon Creek	26-12	No					x		
Traralgon Creek	26-11	No					x		
Tyers River	26-17	Yes						x	
Tyers River	26-16	No						x	
Valencia Creek	25-30	No						x	
Valencia Creek	25-29	No			x			x	

BC = Bunurong Coastal; CIN = Corner Inlet Nooramunga; GLH = Gippsland Lakes & Hinterland; MUL = Mullungdung; STR = Strzelecki Ranges; VA = Victorian Alps; WP = Wilsons Promontory.

Table 15: Highest potentially vulnerable inland wetland assets in West Gippsland (RCP 8.5, 2070)

Wetland complex	Priority RCS Asset	RCS Landscape Priority Area						
		BC	CIN	GLH	MUL	STR	VA	WP
Baw Baw Plateau Wetlands	Yes						x	
Bunurong Coast Wetlands	Yes	x						
Lake Wellington Wetlands	No			x				
Lower Avon Wetlands	Yes			x				
Lower Latrobe Wetlands	No			x	x			
Lower Macalister Wetlands	No			x				
Lower Tarra River Wetlands	No				x			
Lower Tarwin River Wetlands	No	x				x		
Lower Thomson Wetlands	No			x				
Merriman Creek Wetlands	No				x	x		
Perry River Wetlands	Yes			x				
Upper Macalister Wetlands	Yes						x	
Wilsons Promontory Wetlands	Yes							x

BC = Bunurong Coastal; CIN = Corner Inlet Nooramunga; GLH = Gippsland Lakes & Hinterland; MUL = Mullungdung; STR = Strzelecki Ranges; VA = Victorian Alps; WP = Wilsons Promontory.

Table 16: Highest potentially vulnerable coastal wetland assets in West Gippsland (RCP 8.5, 2070)

Wetland complex	Sea level rise impact	Storm surge impact	Priority RCS Asset	RCS Landscape Priority Area						
				BC	CIN	GLH	MUL	STR	VA	WP
Bunurong Coast Wetlands		Yes	Yes	x						
Corner Inlet and Nooramunga Wetlands	Yes		Yes		x					
Gippsland Lakes Fringing Wetlands	Yes	Yes	Yes			x				
Jack Smith Lake	Yes	Yes	Yes				x			
Lake Wellington Wetlands	Yes	Yes	No			x				
Lower Avon Wetlands	Yes	Yes	Yes			x				
Lower Latrobe Wetlands	Yes	Yes	No			x				
Lower Tarra River Wetlands			No		x					
Lower Thomson Wetlands		Yes	No			x				
Merriman Creek Wetlands	Yes	Yes	No				x			
Perry River Wetlands	Yes	Yes	Yes			x				
Shallow Inlet and Venus Bay Wetlands	Yes	Yes	No	x						
Wilsons Promontory Wetlands	Yes	Yes	Yes							x

BC = Bunurong Coastal; CIN = Corner Inlet Nooramunga; GLH = Gippsland Lakes & Hinterland; MUL = Mullungdung; STR = Strzelecki Ranges; VA = Victorian Alps; WP = Wilsons Promontory.

Table 17: Highest potentially vulnerable estuary assets in West Gippsland (RCP 8.5, 2070)

Name	Subject to sea level rise	Subject to Storm Surge	Sea/coastal water level increase	Priority RCS Asset	RCS Landscape Priority Area
Darby River	Not subject to change from sea level rise			Yes	Wilsons Promontory
Jack Smith Lake	Yes		Yes	Yes	Mullungdung
Lake Denison	Yes		Yes	No	Mullungdung
Powlett River	Yes			Yes	Bunurong Coastal
Tidal River	Yes			Yes	Wilsons Promontory
Merriman Creek	Yes	Yes		Yes	Mullungdung
Agnes River	Yes		Yes	Yes	Corner Inlet Nooramunga
Albert River	Yes	Yes	Yes	Yes	Corner Inlet Nooramunga
Anderson Inlet	Yes	Yes	Yes	Yes	Bunurong Coastal
Bennison Creek	Yes			Yes	Corner Inlet Nooramunga
Bruthen Creek	Yes		Yes	Yes	Corner Inlet Nooramunga
Franklin River	Yes		Yes	Yes	Corner Inlet Nooramunga
Nine Mile Creek	Yes			Yes	Corner Inlet Nooramunga
Shady Creek Estuary	Yes			No	Corner Inlet Nooramunga
Shallow Inlet	Yes	Yes	Yes	Yes	Bunurong Coastal
Tarwin River	Yes		Yes	Yes	Bunurong Coastal
Tarra River	Yes	Yes	Yes	Yes	Corner Inlet Nooramunga
Growler Creek Estuary	Yes		Yes	No	Wilsons Promontory
Old Hat Creek	Yes		Yes	Yes	Corner Inlet Nooramunga
Stockyard Creek	Yes			Yes	Corner Inlet Nooramunga

Table 18: Highest potentially vulnerable broad native vegetation communities in West Gippsland (RCP 8.5, 2070)

Vegetation Group	Priority RCS Asset	RCS Landscape Priority Area						
		BC	CIN	GLH	MUL	STR	VA	WP
Herb-rich Woodlands – Damp Sands	Yes	x	x	x	x			x
Lower Slopes or Hills Woodlands – Seasonally inundated and/or shrubby	Yes			x				
Rocky Outcrop or Escarpment Scrubs	Yes			x			x	x
Wet or Damp Forest	Yes	x	x	x	x	x	x	x
Rainforests	Yes		x	x		x	x	x
Wetlands – Freshwater	Yes	x	x	x	x			x
Montane Grasslands, Shrublands or Woodlands	Yes						x	x
Heathlands subalpine	Yes						x	
Dry Forests – Sheltered and/or higher altitude	Yes	x	x	x		x	x	x
Heathy Woodlands – Damp and/or less well-drained	Yes	x	x			x		
Herb-rich Woodlands – Alluvial terraces and/or creeklines	No				x			

BC = Bunurong Coastal; CIN = Corner Inlet Nooramunga; GLH = Gippsland Lakes & Hinterland; MUL = Mullungdung; STR = Strzelecki Ranges; VA = Victorian Alps; WP = Wilsons Promontory.

Table 19: Highest potentially vulnerable broad soil types in West Gippsland (RCP 8.5, 2070)

Soil Type	Priority RCS Asset	RCS Asset name	RCS Landscape Priority Area						
			BC	CIN	GLH	MUL	STR	VA	WP
Pale/calcareous sands, Duplex soils, Saline soils	Yes	Bengworden flats			x				
	Yes	Giffard Plains			x	x			
	Yes	Wilsons Prom and coastal soils	x	x	x	x			x
	No	South Gippsland	x						
	Yes	Tarwin and Powlett catchments	x						
Friable earths stony loams	Yes	Alps						x	
	Yes	Bengworden Flats			x				
	Yes	Red Gum Plains			x				
	Yes	Wilsons Prom and coastal soils							x
	No	South Gippsland	x						
	No	MID			x				
	No	Upper Latrobe catchment			x				
Organic loams	Yes	Bengworden Flats			x				
	Yes	Red Gum Plains			x				
	Yes	Alps						x	
	No	MID			x				

BC = Bunurong Coastal; CIN = Corner Inlet Nooramunga; GLH = Gippsland Lakes & Hinterland; MUL = Mullungdung; STR = Strzelecki Ranges; VA = Victorian Alps; WP = Wilsons Promontory.

Back cover: Powlett River by WGCMA, above: Overlooking Corner Inlet and the catchment by InDetail Comms & PR

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