



Catchment Condition and Management Report 2012

Rating criteria

Data quality rating

- ◆ Data are statewide, using a rigorous methodology, accessible, ground-truthed
- ◆ Some of these criteria met
- ◆ Few or none of these criteria met

Data available to assess change

- Data are available to assess change at the statewide level
- Data are available, but unable to assess change at the statewide level
- No new data available since 2007

N/A New data system developed since 2007

Statewide condition

- Overall resource condition determined to be in generally good to excellent condition
- Resource determined to be in moderate or somewhat variable condition
- Overall resource determined to be in generally poor condition
- ? Condition unknown or unable to be determined

Statewide trend*

- ▲ Improving and continuing to improve
- Generally stable and likely to remain so
- ▼ Declining and likely to continue to decline
- ? Trend unknown or unable to be assessed

(assume) Quantitative assessment of statewide condition and/or trend cannot be undertaken. Condition and/or trend determined through qualitative assessment by experts/specialists in DSE, DPI, DPCD or EPA

* For the purposes of this report, statewide trend is a qualitative analysis of change - it is not based on statistical analysis.

Published by the Victorian Catchment Management Council, October 2012

www.vcmc.vic.gov.au

© The State of Victoria, Victorian Catchment Management Council 2012

This publication is copyright. No part may be reproduced by any process except in accordance with the provisions of the *Copyright Act 1968*.

ISBN 978-1-74287-654-2 (print)
ISBN 978-1-74287-655-9 (online)

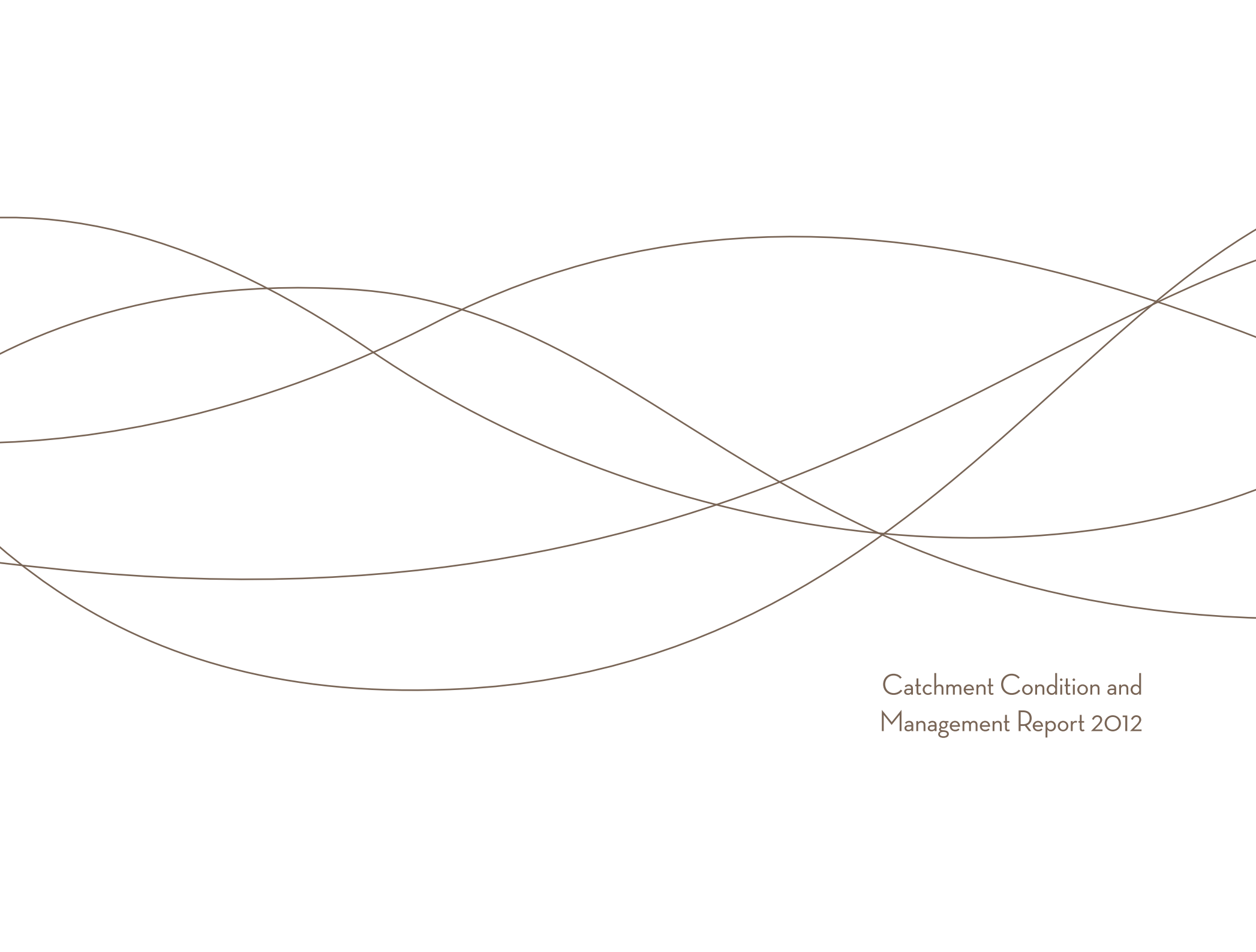
Disclaimer:

This publication may be of assistance to you but the State of Victoria and its employees do not guarantee that the publication is without flaw of any kind or is wholly appropriate for your particular purposes and therefore disclaims all liability for any error, loss or other consequence which may arise from you relying on any information in this publication.

Cover images: Tracey Koper, Neil Meyers, Alison Pouliot

Designed by: Designgrant

Printed by: Adams Print



Catchment Condition and
Management Report 2012

PART 1

Overview	5	Chapter 5 – Current Condition and Management	21
Chapter 1 – Introduction	7	Theme 1: Native vegetation	22
Finding 1: The need for effective processes for condition assessment	7	Theme 2: Threatened species and populations	24
Finding 2: The need for an ICM plan	9	Theme 3: Soils	25
Chapter 2 – About This Report	10	Theme 4: Rivers and streams	26
Chapter 3 – Discussion	12	Theme 5: Wetlands	28
Chapter 4 – A Way Forward	16	Theme 6: Groundwater	30
Monitoring, evaluation and review	16		
A State Integrated Catchment Management (ICM) plan	17		
Vision 2030	19		

Land Resources

Water Resources

Related Issues

PART 2

Theme 1: Native vegetation	33	Theme 4: Rivers and streams	55	Climatic variability	73
Indicator 1.1 – Native vegetation extent	33	Indicator 4.1 – Stream flow	55	Land use change	78
Indicator 1.2 – Native vegetation quality	36	Indicator 4.2 – River and stream condition	58	Agricultural productivity	81
Theme 2: Threatened species and populations	38	Theme 5: Wetlands	61	Social and economic change in the agricultural sector	83
Indicator 2.1 – Conservation status of native plants and animals	38	Indicator 5.1 – Wetland extent	61	Community participation in catchment management	85
Indicator 2.2 – Threatened plant and animal populations	44	Indicator 5.2 – Wetland condition	63	Indigenous involvement in catchment management	86
Theme 3: Soils	48	Theme 6: Groundwater	66	Expenditure in catchment management	88
Indicator 3.1 – Soil health	48	Indicator 6.1 – Groundwater level	66		
		Indicator 6.2 – Groundwater quality	69		

PART 3

References	93
Acknowledgements	96



Overview	5
Chapter 1 - Introduction	7
Chapter 2 - About This Report	10
Chapter 3 - Discussion	12
Chapter 4 - A Way Forward	16
Chapter 5 - Current Condition and Management	21

Chairman's Foreword

Every five years, the Victorian Catchment Management Council is required to report to the Minister/s responsible for the *Catchment and Land Protection Act 1994* on the condition and management of land and water resources in Victoria. This report is the fourth such assessment made by Council and provides a snapshot of the condition of our catchments and just how well we are managing and maintaining those crucial land and water resources and the many services they provide.

The key findings which Council derived from the assessment of available information on the State's land and water resources focus broadly on the lack of clarity around the overall objectives for those resources; what condition they should be in to maintain and enhance long term land productivity while also conserving the environment; and on the lack of processes in place for Council to carry out its assessment in a meaningful and consistent way. Assessment of management is even more difficult, with even fewer data than for condition.

Data on condition continue to be problematic since there is very little ongoing monitoring, reporting and evaluating of the condition of our land and water resources on a systematic, statewide basis. Therefore, Council can in most cases make qualified interpretations of condition, based on available information and expert opinion, and even more qualified assessments of any trends in condition.

This situation must be remedied if it is agreed that a statewide assessment of our land and water resources is important. There are various means by which a solution could be reached, and these are outlined in the report. One frustration is the lack of alignment of the timeframes for various aspects of monitoring land and water resources condition. There are several programs reporting in 2013, which will be too late for this report and possibly too early for the next in 2017.

A Steering Committee led by Chris Arnott, with members Dr Sandra Brizga, Rod Gowans and Cullen Gunn oversaw the development of this report over the period July 2009 through to June 2012. The project team of Neil Meyers (Project Manager), Fiona Donohoue, Sarah

Ewing, Patricia Geraghty and Tracey Koper was ably supported by a broad range of people from DSE, DPI, DPCD, EPA and CMAs who provided the information underpinning the report, found in Part 2.

Council has made three recommendations in this report which it believes would make a significant difference, and lead to improvements in policy and practice of integrated catchment management in Victoria.

Council is keen that those interested in improving the condition and management of the land and water resources in Victoria will take these messages and recommendations seriously, and that Government and stakeholders work together with the Victorian community to achieve success.



Mick Murphy OAM
Chair

This report is a requirement of the *Catchment and Land Protection Act 1994* (CaLP Act).

The core objectives of the CaLP Act (the Act) are to:

- i. *maintain and enhance long term land productivity while also conserving the environment* (s.4 (a)(i)); and
- ii. *ensure that the quality of the State's land and water resources and their associated plant and animal life are maintained and enhanced* (s. 4 (a)(ii)).

The Victorian Catchment Management Council (Council) is the State's peak independent advisory body on catchment management. In order to determine if the objectives of the CaLP Act are being met, the Act requires Council to deliver an assessment of the condition and management of land and water resources in Victoria every five years (s. 9 (a) (ii)). The last report was in 2007.

This 2012 assessment has been made with reference to six themes, selected to provide an overview across Victoria's land and water resources. It is an incomplete assessment, for the following reasons:

- 1. The processes that can be used to assess the condition of the State's land and water resources and the effectiveness of land protection measures, are either absent or insufficient.**
- 2. There remains a lack of clarity about the quality of land and water resources required to maintain and enhance long term land productivity while also conserving the environment.**

These weaknesses have produced a range of inefficiencies, in particular a lack of clarity about priorities for investment, a lack of consistency and continuity of monitoring and a lack of continual adjustment and improvement over time.

A qualitative assessment of catchment condition, across the State, is shown in Figure 1. It is Council's attempt to show the current status of resource condition, notwithstanding some limitations of currently available data. It has been compiled with the help of expert opinion across each of the themes. It should be noted that there is a dual rating for the condition of some themes. For example, in the Mallee, native vegetation is assessed as both 'poor' and 'good', because there are significant areas of each rating across the region.

This map cannot be compared directly with a similar map in Council's previous report (2007), because of the qualitative nature of the interpretation and because of the scope and quality of the information behind it (see Chapter 3).

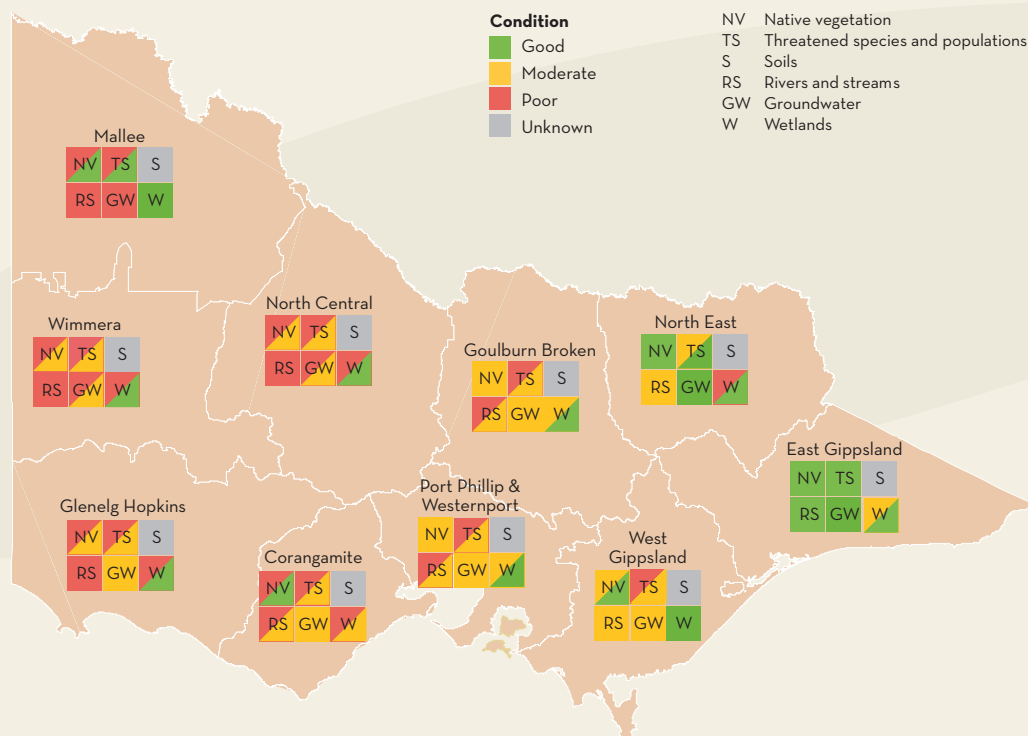


Figure 1
Qualitative summary of catchment condition 2012,
based on condition data (where available) and expert opinion.

Council makes the following recommendations:

1. That robust processes be established to determine the condition of the State's land and water resources and the effectiveness of land protection measures.
2. That this crucial function be assigned to an independent and appropriately resourced entity, with the task of reporting annually on progress towards the implementation of these processes, and every six years on overall condition.
3. That a State Integrated Catchment Management (ICM) plan be developed to define, explicitly, the quality of the land and water resources that will maintain and enhance long term land productivity, while also conserving the environment.

In making these recommendations, Council recognises that, as a body, it is neither appropriately resourced, nor equipped with the requisite skills, to determine the detail in either the State ICM plan or the monitoring program. Council would be pleased to provide further advice on a suitable process for the implementation of these recommendations.

Chapter 1 — Introduction

Victoria is blessed with many beautiful landscapes. Some are untamed – others have been transformed into landscapes for agricultural production, production forestry, rural amenity, urban settlement, or somewhere in between. But these landscapes now face new pressures and uncertainties driven by factors such as population, consumption and climate change. It is into this rapidly changing complexity that Council submits this *Catchment Condition and Management Report 2012*.

Council is the State's peak independent advisory body on catchment management. It is responsible for providing expert advice on land and water management issues to the Minister for Environment and Climate Change and the Minister for Water. The CaLP Act requires Council to report to Parliament, every five years, on the condition and management of Victoria's land and water resources.

As part of this report, Council offers a vision for Victoria's landscape in 2030. How we respond will determine whether the vision is within reach or not. It will *not* be achievable with a fractured, short-term project-based response to our landscape.

It *could* be achievable if we capitalise on the opportunities to develop an integrated whole-of-state, strategic approach to the ongoing management of Victoria's land, water and biodiversity.

This is the fourth report produced by Council which, collectively, now span a period of 15 years. It is made up of two parts. This Part (1) presents Council's findings and recommendations (Chapters 1 to 4) and gives a brief overview of catchment condition across the State (Chapter 5). Supporting documentation, giving greater detail of resource condition and management, across the six themes, can be found in Part 2.

The key findings of this report are outlined on the following pages.

Finding 1: The need for effective processes for condition assessment

Victoria's land and water resources are vital assets upon which the wellbeing of current and future Victorians depend. The purpose of the CaLP Act is to ensure that these resources are used in a way that allows for long-term productive use, whilst also conserving the environment. The Act also reinforces the importance of community involvement in the management and protection of land and water resources.

In order to plan for the long term, we need a clear understanding of both the current condition of land and water resources, and that required to sustain both productivity and environmental objectives. On each of these counts, our understanding is wanting. To understand whether we are likely to meet the objectives of the CaLP Act, we need to know firstly, whether our interventions are working and, secondly, if progress is at a pace commensurate with the realities of threats (and opportunities) such as climate change.

This report is based on best available scientific, social and economic data. However, a meaningful analysis of catchment condition depends upon access to information that will help reveal trends and enable us to report across a broad

suite of indicators relevant to our task. This has not been the case. We find this to be due to an underlying lack of long-term resourcing, responsibility and accountability, for data capture, management and review.

This is not a new issue. A decade ago, in its second report, Council reported that a key constraint on community and government efforts in the management of land and water resources was the lack of knowledge on resource condition¹. Again, in 2007, Council reported that *'lack of a strong foundation of data and knowledge, with benchmarks, statewide coverage [and] consistent methods ... is a key obstacle to the adaptive management of our resources'*².

We recognise that implementing a robust system of monitoring, evaluation and reporting is challenging. However, to a large extent, monitoring efforts in Victoria continue to occur in an *ad hoc* manner using different methods and standards, or in response to short-term funding requirements. This has resulted in ongoing variability and inconsistency in the quality of data and information. A strategic and well-supported approach to monitoring, evaluation and review needs to be seen as central to effective investment in integrated catchment management.

A standardised approach to monitoring, evaluation and review would help overcome these limitations and help capitalise on synergies between monitoring programs operating at different scales and with different purposes. In this respect Council finds environmental accounting and the idea of common 'currency' a compelling idea and supports the movement across the country to further trial and develop a national framework for environmental accounting (see Section 4.1).

We also need an effective system of sharing information and knowledge across the range of sectors, organisations and communities involved in land and water management. Council supports the idea of a knowledge management framework to guide the manner in which knowledge is identified, created, captured, stored and used³. This would ensure that the best available knowledge is used to identify priority tasks and inform effective decision making. It would also support a State ICM plan (see Section 1.2).

Recommendations associated with Finding 1

Council recommends that the design and implementation of an effective monitoring system be assigned to an independent and appropriately resourced entity that reports annually on progress. This entity would also report on overall condition of land and water resources every six years. It should offer independent advice on what is working well in land and water management, what needs fixing and how we are tracking against the goals and targets articulated in a State ICM plan. It would have access to the best-available knowledge and would have the requisite resourcing, skills and authority to do its work. It is recognised that other monitoring, evaluation and reporting activities will continue and that these will inform, and be informed, by the statewide monitoring system.

Catchment management in Victoria should be centred on the principle of adaptive management. Ongoing learning is an explicit part of adaptive management. It acknowledges that the natural resources we seek to manage will always change – as will the interactions between the societies and economies that depend on them – and our management approaches must reflect these changes. An effective system of knowledge management is central to an adaptive approach.

¹ VCMC (2002) *The health of our catchments: a Victorian report card 2002*, VCMC, Melbourne.

² VCMC (2007) *Catchment Condition Report 2007*, VCMC, Melbourne (p. 5).

³ VCMC (2011) *Strategic framework for integrated natural resource knowledge management*, VCMC, Melbourne.

Finding 2: The need for an ICM plan

Council finds that a robust, state-scale assessment of catchment condition is compromised by the fact that, in Victoria, we have not yet developed explicit, long-term targets for resource condition.

Strictly speaking, the development of statewide resource condition targets is not a requirement of the CaLP Act – but, in practice, the absence of a statewide strategic plan for ICM, with explicit condition targets, is a major weakness of our current approach. This is less the case at the regional scale, since the Act requires regional Catchment Management Authorities (CMAs) to each prepare a Regional Catchment Strategy and identify objectives for the quality of the land and water resources of the catchments in the region (s. 24(2)(c)). However, a statewide plan would also have the function of helping guide regional priorities at the CMA scale.

Recommendations associated with Finding 2

Council proposes that, as a first step, Victoria should develop a clear view of what we wish for the future of Victoria's land and water resources and the landscapes which support them. In the absence of an alternative, Council has been using the following vision to inform its work:

'... healthy rivers flowing through ecologically sustainable and productive catchments'⁴.

Achieving this vision will require a long-term, considered approach to the management of our land and water resources, which recognises the long time frames involved and which:

- responds actively to the impacts of climate variability and demographic change;
- protects and restores the ecological processes that underpin the health of Victoria's land and water resources; and
- recognises that our current quality of life has often been at the expense of natural environments and the ecosystem services they support.

It will also require a plan to get us there. Council has been advocating a statewide, integrated approach for catchment management for over a decade. What is required is an overarching strategy that brings together disparate theme-based land and water policies and strategies, into a coherent whole and which clearly articulates the targets and priorities for the State. Such a plan is possible. The recently released Living Melbourne, Living Victoria Implementation Plan advocates just such a holistic, integrated approach to planning; although its focus is on Melbourne's water system, its imperative is just the same⁵.

A State ICM plan would have clearly articulated goals and targets against which we can measure progress towards the future we envision. Its development would give clarity to the statewide priorities for investment.

⁴ An expanded version of this vision can be found on p19.

⁵ Living Victoria Ministerial Advisory Council (2012) *Living Melbourne, Living Victoria Implementation Plan*, DSE, Melbourne.

Chapter 2 — About This Report

As stated earlier, this report meets a requirement of the CaLP Act. At the time of the Act being drafted, State of the Environment reporting in Victoria was in abeyance. Under these circumstances, it was considered that a useful function of the proposed Catchment and Land Protection Council would be to help fill this gap, and report on land and water condition (Hunter, pers. comm.). This is the fourth such report. Key findings of previous reports are discussed in Chapter 3.

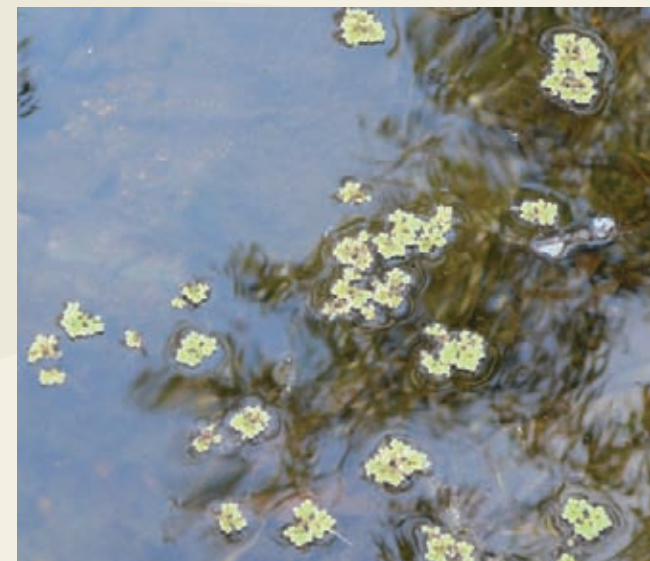
The CaLP Act also requires CMAs to provide an annual report on the condition and management of land and water resources in their region. These reports offer a measure of progress, measured against the CMAs' Regional Catchment Strategies. CMAs have reported annually on catchment condition since 1997.

This 2012 statewide condition and management report has been compiled from multiple sources of evidence, and expert advice, provided to us by the Department of Sustainability and Environment (DSE), Department of Primary Industries (DPI), Parks Victoria (PV), the Environment Protection Authority (EPA) and the Australian Bureau of Statistics. It is just one example of periodic reporting on

Victoria's environment. There are also issue-specific reports on parks, forests, water, regional issues and waste – and the five yearly State of the Environment report (the next of which is due in 2013)⁶.

Our assessment of resource condition is based on the use of condition 'indicators', where 'condition' refers to the quality or state of an environmental asset⁷. The use of indicators is well established in reporting of this kind. Given that we will never have enough money to systematically measure everything, indicators provide a practical and economical means to represent key aspects of complex environmental systems, such as catchments. When used well, they not only supply information on the problem but also support policy development and priority setting by policy makers and monitor the effects of policy responses⁸.

Our assessment is organised around six themes and 11 indicators (Table 1). The themes are generally consistent with those developed in previous reports. Four new indicators have been used, relating to soil health, streamflow and the extent and condition of Victoria's wetlands. The choice of themes and indicators was influenced by the availability of data and our wish for continuity from previous reports.



⁶ For example: Parks Victoria (2007) *Victoria's State of the Parks*, Parks Victoria, Melbourne; Commissioner for Environmental Sustainability (2008) *State of the Environment – Victoria 2008*, CES, Melbourne.

⁷ Australian Natural Resource Management Groups (2012) *Australian Regional Environmental Accounts Trials Stage 1: Draft Guidelines*

⁸ Smeets, E. and Weterings, R. (1999) *Environmental indicators: Typology and overview*, European Environment Agency, Copenhagen.

Table 1

Catchment condition indicators used in this report

	Theme	Indicator
Land Resources	1 Native vegetation	1.1 Native vegetation extent
		1.2 Native vegetation quality
	2 Threatened species and populations	2.1 Conservation status of native plants and animals
		2.2 Threatened plant and animal populations
	3 Soils	3.1 Soil health
Water Resources	4 Rivers and streams	4.1 Streamflow
		4.2 River and stream condition
	5 Wetlands	5.1 Wetland extent
		5.2 Wetland condition
	6 Groundwater	6.1 Groundwater level
		6.2 Groundwater quality

One of the constraints of resource condition reporting is the manner in which it demands a relatively narrow focus on information that can be readily accessed and quantified. However, there are many driving forces which affect our land and water resources such as climate variability, demographic change and the nature of agricultural production. These issues are explored further in Part 2 of this report.

The assessment period here includes the latter part of the 'Millennium Drought' that lasted for over a decade. In addition, two of the State's most serious natural disasters have occurred in the past three years; the Black Saturday bushfires of February 2009 and the widespread floods of late 2010 and early 2011.

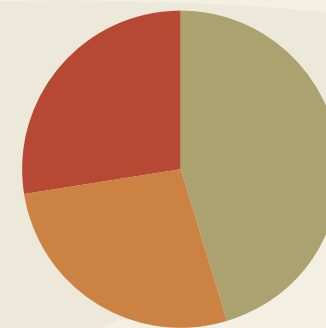
Chapter 3 — Discussion

As will be evident from a close reading of Chapter 5 and Part 2, it has proved difficult to report on the condition and management of Victoria's land and water resources, other than in very general terms. The lack of a robust set of indicators and a systematic, purposeful approach to data collection remains a persistent issue.

In its first condition report (1997), Council used a set of 33 'interim' indicators to report on catchment condition⁹. There were no pre-existing indicators so it was necessary to first determine those issues for which data were available. In 1998, the Department of Natural Resources and Environment launched a project to develop statewide catchment indicators¹⁰. Thirty indicators were developed, 27 of which were used in the second condition report (2002)¹. To these, Council added five of its own relating to community awareness, estuaries and climate change. As before, developing the indicators required compromise between what was possible and what was desirable. In 2007, with the exception of stream condition and native vegetation data, it was often the case that the data custodians were generating information for the first time, using a new indicator².

Council finds that, in 2012, it remains a case of 'making do' with the data available; in effect, this has driven the form of the final indicator set. Rather than having an indicator set which supports a higher objective of long-term reporting, against a clear set of targets, we report where we can. Even then, the currency, quality and coverage of the data are less than desirable (Figure 2).

The lack of continuity and consistency in data collection is vexing. Data from only one of the 11 indicators used here can be compared with data from previous years (Figure 3). For six of the indicators, comparison with data from previous years is not possible. This is due to issues around data aggregation to the statewide scale, updating of modelling systems and changes in data capture. Clearly, the design of new data capture systems should include the design of an 'overlap' or transition plan, so that data comparison can continue between the old and the new. There is great value in information already collected, if we could only access it more efficiently and effectively. This is discussed further in Chapter 4.



■ **Data are statewide, using a rigorous methodology, accessible, ground-truthed**

Indicators:

- 1.1 Native vegetation extent;
- 4.1 Stream flow;
- 4.2 River and stream condition;
- 5.1 Wetland extent;
- 5.2 Wetland condition

■ **Some of these criteria met**

Indicators:

- 2.1 Conservation status of native plants and animals;
- 2.2 Threatened plant and animal populations;
- 6.1 Groundwater level

■ **Few or none of these criteria met:**

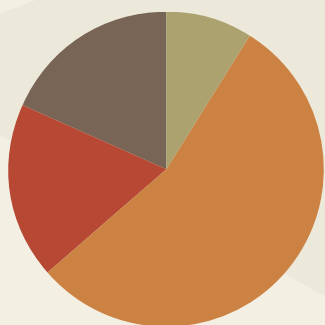
Indicators:

- 1.2 Native vegetation quality;
- 3.1 Soil health;
- 6.2 Groundwater quality

Figure 2
Data quality of 2012 indicator set

⁹ Department of Natural Resources and Environment, Environment Protection Authority & Victorian Catchment and Land Protection Council (1997) *Know your catchments, Victoria 1997: An assessment of catchment condition using interim indicators*, DNRE, Melbourne.

¹⁰ Department of Natural Resources and Environment & Natural Heritage Trust (Australia) & Victorian Catchment Management Council (2001) *Victorian catchment indicators, 2001: Our commitment to reporting on catchment condition*, DNRE, Melbourne. This project lapsed subsequently.



■ Data are available to assess change at the statewide level (updated datasets can be directly compared with previous datasets)

Indicator:
4.1 Stream flow

■ Data are available, but unable to assess change at the statewide level (updated datasets cannot be directly compared with previous datasets)

Indicators:
1.1 Native vegetation extent;
2.1 Conservation status of native plants and animals;
4.2 River and stream condition;
5.1 Wetland extent;
6.1 Groundwater level;
6.2 Groundwater quality

■ No new data available since 2007

Indicators:
1.2 Native vegetation quality;
3.1 Soil health

■ New data system developed since 2007 (new indicator, data collection now underway)

Indicators:
2.2 Threatened plant and animal populations;
5.2 Wetland condition

Figure 3

Capacity of indicators to assess condition change

Another recurrent finding of Council's catchment condition reports relates to the need for a strategic, statewide, landscape scale approach to ICM (Table 2). Unlike the CMAs, which are guided by Regional Catchment Strategies, there is no overarching strategy to inform the Council's statewide condition report. In its absence, without a clear articulation of the State's long-term goals and targets for land and water condition, this report sits in somewhat of a vacuum. Council finds that this remains a critical weakness of the current framework for ICM in Victoria.

Knowledge management has also been a persistent issue. If our investment in catchment management effort is to be effective, it is not sufficient to attend just to monitoring and reporting of resource condition. We also need a system to guide the manner in which knowledge, in its broadest sense, is identified, captured, stored and shared. This means not only conventional sources of knowledge but also, informal, tacit knowledge, that rests with local people and communities.



Table 2

Findings of previous catchment condition reports

Report date	Conclusions	Is this still relevant?
1997 2002 2007	Monitoring and reporting <ul style="list-style-type: none"> • Lack of consistent and comparable long-term monitoring data at a statewide level for condition of land and water resources, so difficult to compare data across time. • Lack of coordination and clear commitment to monitoring, evaluation and reporting. • Need to strengthen links between regional and state evaluation and reporting processes. 	<ul style="list-style-type: none"> • Yes. While there have been some efforts to improve data availability through databases (Victorian Resources Online, Catchment Indicators Online), these databases have not been maintained over time. • Information on biophysical condition and trend is still not readily available for many land and water resources.
2002 2007	Knowledge management <ul style="list-style-type: none"> • Improved knowledge sharing required. Recommended the development of a Victorian ICM Knowledge Strategy. 	<ul style="list-style-type: none"> • Yes. Some very preliminary work towards an integrated knowledge management system, but there is little apparent ongoing impetus to continue this work. Council has continued to be active in this area, developing a strategic framework for knowledge management³.
2002 2007	Statewide ICM plan <ul style="list-style-type: none"> • Victoria needs a vision for its regional landscape underpinned by an NRM strategy, investment plan and whole-of-government implementation plan. 	<ul style="list-style-type: none"> • Yes. While Council has developed a vision, there is still a lack of a statewide vision for ICM, a strategy, investment plan and planning for implementation of ICM at a statewide level.
2007	Market-based instruments <ul style="list-style-type: none"> • Develop and increase investment opportunities through market-based instruments. 	<ul style="list-style-type: none"> • Yes. A number of market-based instruments have been developed (<i>Ecotender</i>, <i>Bushtender</i>) and successfully implemented. • Carbon initiatives are providing new opportunities in this area.

Council considers that now, perhaps more than ever, it is vital that the State has access to a sound knowledge base to underpin long-term planning and investment in catchment management. There are a number of pressures, both current, and on the horizon, which if played out across the Victorian landscape, could have a profound effect on our land and water resources.

The most confronting of these is that of climate variability. Victoria is getting warmer and drier. Since the 1950s, each decade has been warmer than the one before and this is consistent with global-scale warming that has been measured during recent decades¹¹. By 2030, runoff into most of our waterways is projected to decrease between 5% and 45%. By 2070, the flow in rivers and streams may be reduced by half across much of the State¹². Climate change may also lead to changes in the distribution, intensity and frequency of severe weather events such as bushfires and floods and it is projected that the extent and frequency of droughts in Victoria may more than double by 2050¹³.

The prospect of a changing climate has profound implications for both the natural environment and for primary production. Small and fragmented populations of native flora and fauna, and those at the limits of their range, are at particular risk. Agricultural production, farming practice and food supply chains will all be affected and as water availability declines, competition between consumptive and environmental uses will intensify.

There are also the pressures of demographic change and changing land use. In some parts of the State, new land uses, such as forestry and urban development, are driving change. In others, such as cropping and irrigation regions, declining terms of trade have demanded new methods of producing more food or fibre for less cost. Many of the productivity gains have depended on farms getting larger. This means fewer family farms, coinciding with a long standing decline in the numbers of young people in farming and in rural areas¹⁴.

Large family farms and corporate farmers are positioning themselves in the landscape to service the projected food and fibre needs of the growing world population. Global population growth is predicted to be 47% higher in 2050 compared to 2000, and growth in the demand for grain will double over the same period¹⁵. The ensuing drive for increased productivity will place renewed pressure on our land and water resources. If Victorian producers are to service these markets, it is critical that neither long-term productivity, nor conservation of the environment, is compromised (CaLP Act).

¹¹ CSIRO and Australian Bureau of Meteorology (2012) **State of the Climate 2012**, CSIRO, Canberra.

¹² Commissioner for Environmental Sustainability (2008) **Climate change: We must act now**, State of the Environment Victoria 2008 Fact Sheet Series, CES, Melbourne.

¹³ Department of Sustainability and Environment (2012) **Report on climate change and greenhouse gas emissions in Victoria**, DSE, Melbourne.

¹⁴ Parliament of Victoria, Rural and Regional Committee (2012) **Final report: Inquiry into the capacity of the farming sector to attract and retain young farmers and respond to an ageing workforce**, Melbourne.

¹⁵ UN Department of Economic and Social Affairs, Population Division (2004) **World population to 2300**, United Nations, New York; Nellemann, C. (2009) **The environmental food crisis: The environment's role in averting future food crises: A UNEP rapid response assessment**. United Nations Environment Programme, GRID-Arendal.

Chapter 4 — A Way Forward



In previous chapters we have identified several constraints which have limited our capacity to report effectively. In this chapter we suggest how current arrangements could be improved.

¹⁶ Stankey, G. and Allan, C. (2009) Introduction, in Allan, C and Stankey, G.H. (eds) *Adaptive environmental management: A practitioner's guide*, Springer, 3 – 8.

¹⁷ See Part 2 for further discussion on the potential for knowledge derived from local settings, to be 'scaled-up' to the catchment scale, using a market-based approach.

Monitoring, evaluation and review

Council is committed to the principle of adaptive management as the basis for ICM in Victoria. However, we find that 'adaptive management' is a term often added to strategies and plans with insufficient understanding of what this demands in practice. Ongoing learning is an explicit part of adaptive management and for this to occur, it needs to be based upon a robust system of knowledge management. The role of monitoring and evaluation needs to be elevated beyond the functional, to a level at which it becomes the mechanism through which significant changes in policy and practice can be designed¹⁶.

This is some of the thinking behind 'EnSym', an Environmental Systems Modelling Platform, developed by DSE's ecoMarkets team. EnSym incorporates science, standards, metrics and information developed within DSE, as well as many leading international and national scientific models. It provides a common, statewide evidence-based framework to inform decision-making about where to invest for maximum environmental outcomes. As our understanding of the effects of management actions improve, so too are the models used by EnSym continuously reviewed and refined¹⁷.

As discussed previously, we find that monitoring efforts in Victoria continue to occur in a fragmented way, using different methods and standards. There is ongoing variability and inconsistency in the quality of data and information. We believe it likely that the limited long-term collection of statewide data on land and water resource condition has constrained the ability of policy makers to develop and enact evidence-based environmental policy at the statewide level. Council proposes a mandated strategic approach to catchment condition reporting and advocates a culture which recognises monitoring, evaluation and review as central to the effective and efficient delivery of ICM. We are mindful that, at the moment, there are few ramifications of ineffective monitoring, evaluation and review, other than those felt by the environment itself.

'Environmental accounting' is a new and evolving approach which has the potential to attend to the data gaps of previous approaches to condition reporting. In the same way that we use economic accounts to present a statistical picture of the structure of the economy, environmental accounts measure the quantity of physical natural resources and their economic value.

A State Integrated Catchment Management (ICM) plan

They allow us to measure how efficiently those resources are being used and to measure the impact that economic activity is having on their condition¹⁸.

The Wentworth Group of Concerned Scientists is running a trial of environmental accounts which is being rolled out nationally. The *Accounting for Nature* model is a regionally based, standardised model, to scientifically monitor and track the health and change in condition of Australia's major environmental assets^{18,19}. This includes regular environmental condition 'scorecards' for native vegetation, soil, water, greenhouse gas emissions, marine and coastal resources, air quality, waste management and water use. A common 'currency' that can be applied to any environmental asset and indicator of ecosystem health, at any location, at any scale (farm, catchment, region, state) is a compelling idea. It would enable future reporting on catchment condition and management at both the national and state level and rectify many of the current limitations around monitoring, evaluation and review in Victoria. It would allow CMAs to focus on monitoring for outcomes (e.g. condition change) rather than inputs (e.g. resources) and would help guide decisions

around both public and private investments in catchment management. North Central and Corangamite CMAs are both involved in trials of environmental accounting.

Considering the magnitude of the task, Council recommends that the design and management of an effective system of monitoring, evaluation and review be assigned to an independent, appropriately resourced entity. Its first key function would be to report annually, and publicly, on the progress Victoria is making towards the policy goals and targets of the State ICM plan; its second function would be to report on the overall condition of our catchments, at an interval of every six years, to align with the development of each new suite of Regional Catchment Strategies. It should offer advice on what is working well in land and water management, what needs fixing and how we are tracking. Importantly, this entity would be supported by legislation, and a policy culture which properly services adaptive management. This means that mandated monitoring, evaluation and review would not change with the politics of the day, nor be vulnerable to the historical issues of short-term funding, false starts, staff movements and poor information.

Council has been advocating a statewide strategy or plan, or explicit policy for the management of Victoria's catchments, for many years (Table 2).

There currently exist a range of documents and policies which deal with various aspects of land and water resource management at a range of scales. At the regional scale, the CALP Act requires each CMA to periodically review and update its Regional Catchment Strategy. These strategies provide a vision for the future landscapes of each region and identify goals, objectives and targets to managing the region's natural assets. The first suite of regional catchment strategies was developed in 1997 and the third is due to be completed by October 2012. These strategies are developed by the CMAs in consultation with their regional stakeholders and provide an important 'bottom-up' perspective to the statewide picture.

At the statewide scale there are several issue-based strategies which currently direct investment across themes, such as biosecurity, river health and coasts. But, the scope of these strategies (and their lack of consistent review) reflects a continuing tendency for our administrative structures to work against a coherent and integrated

¹⁸ Cosier, P. (2011) *Accounting for the condition of environmental assets*. Paper presented to the UN Committee of Experts on Environmental Accounting, London.

¹⁹ Wentworth Group of Concerned Scientists (2008) *Accounting for nature: A model for building the national environmental accounts of Australia*, WGCS, Sydney.



Figure 4
Key Victorian legislation and statewide strategies relevant to the *Catchment and Land Protection Act 1994*

Many of these strategies and frameworks were developed at least a decade ago. Some have lapsed or no longer reflect current arrangements; others have been incrementally updated or are in the process of being revised.

approach to catchment management (Figure 4). It is inevitable that this will give rise to inefficiencies in the pursuit of the CaLP Act objectives.

Council recommends the development of a State ICM plan to set priorities, goals, standards, processes and approaches for Victoria. Such a plan should establish a coherent, holistic framework under which the CMAs' Regional Catchment Strategies could set regional priorities in line with the State's objectives. It should interact not only with policies directed at land, water and biodiversity, but also planning and socioeconomic policies which can influence rural capability to adapt and respond to change. Such a plan is possible and should be established and supported through legislation²⁰.

²⁰ See for example, Government of South Australia (2012) *Our Place. Our Future: State Natural Resources Management Plan South Australia 2012 – 2017*, Adelaide; and *Natural Resources Commission Act 2003* (NSW).

Figure 5 gives a conceptual model of how a new statewide ICM plan for Victoria could relate to existing arrangements. At the top of the tree is an agreed and compelling vision which guides all of the activity below. It is aspirational and does not contain any specific targets. The State ICM plan sits below with clearly articulated goals and targets, aligned to which are a suite of theme-based strategies. Finally, underlying this framework is a commitment to continuous learning and adaptive management with annual and multiple-year reporting against selected condition and management targets and indicators.

The development of the plan will have given clarity to the statewide priorities for investment in ICM. It will have built upon a foundation developed over many years, by private landholders, catchment-based waterway management groups and Landcare groups²¹.

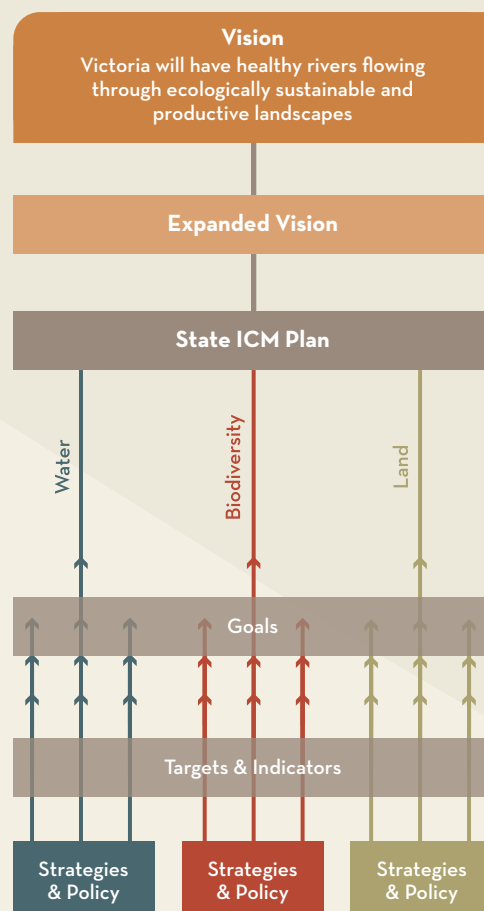


Figure 5
Suggested conceptual model for ICM in Victoria

Vision 2030

In the structure outlined previously, Council has proposed that the State ICM plan be led by a clear vision of what we wish for the future of Victoria's land and water resources and of the landscapes where they belong. Council has found it useful to work with a vision; it helps 'bring to life' the objectives of the CaLP Act and challenges us to contemplate whether existing systems support the vision or detract from it^{1,2}.

We suggest that the development of a State ICM plan should also provide for the development of a vision. This will involve community conversations about land use, the value we place on land and water resources and our collective hopes for the future of Victoria's landscapes. It will be a vision which allows for both sustainable production and conservation outcomes.

What follows is just an example of the sort of future to which we might aspire; perhaps it will help get the conversations started.

Vision 2030

In 2030, Victoria has a mosaic of healthy landscapes, each supporting a range of ecological, economic and social values and each matched to the capacity of the land and water resources which support it. The pattern of that mosaic is no accident. Over the last two decades, significant effort

²¹ DSE (2012) **Victorian Landcare Program Strategic Plan**, DSE, East Melbourne.

has been made, not only to envision these landscapes but also to ensure that we have in place the strategies and policies to support them. We have chosen the landscapes and special places we value and have resolved where responsibility for their protection will lie.

Some landscapes are shaped predominantly by natural values and are being actively managed for biodiversity conservation and to secure the future of threatened ecosystems. We have ensured that, in the face of a changing climate, the State's reserve system, together with complementary action on private land, has the capacity to ensure the viability of, and protect the integrity of, our diverse ecosystems and the plants and animals they support. Victoria's forests are highly valued for the diverse services they provide.

Other landscapes are defined by broadacre or irrigated agriculture and our need to produce food and fibre and to satisfy increasing national and global demands. These farm businesses and communities are managing for the long-term challenges of climate variability and have responded to community demands for 'clean and green' food and a greater emphasis on stewardship. New farm products and new patterns of land use have

created opportunities for investment and employment, from farm gate to consumer.

Continued pressures from water scarcity have wrought significant change in these landscapes. Successful farmers are trading actively in land and water and have the flexibility to respond to fluctuating commodity prices and climate whilst also caring for the resource base on which they depend. Agriculture has intensified in some places but with greater resource efficiency, and in others, there has been a shift towards the provision of ecosystem services, now a major land use across the State. Carbon trading has seen farms re-forested and arable paddocks managed specifically for carbon accumulation²².

In peri-urban areas, our rural landscape is preserved alongside the key natural resources which form that landscape. Fragmentation of agricultural land holdings has slowed. Environmental condition has substantially improved, particularly on private land and along local creeks. This has been supported by strong integrated regional and landscape-scale planning²³.

Guiding our effort in each landscape has been a unique set of targets relating to land, water and biodiversity, against which we have measured our progress over time. These targets are clear and measureable

and landscape management decisions are supported by a well-managed and improved knowledge base. There is now a mandate which supports the instigation and maintenance of long-term monitoring programs, together with fastidious data management. A body which reports independently on progress towards the landscapes we envisioned is now in place. It forms part of an institutional framework, set up by Government, which enables effective, accountable and truly integrated investments in catchment management.

Victorians now better appreciate the value of the State's land and water resources, understand their dependency upon them and are active in their stewardship. There are genuine opportunities for community engagement to build shared awareness, understanding and knowledge of our natural resources and contribute to their repair. As consumers, we understand the need to protect our environmental assets and are willing to pay for it. As custodians for our children, and theirs, we seek to fully account for natural capital in the State ledger and to break the link between environmental degradation and economic growth. We can imagine a future in which our continuing concerns for the environment are being addressed and we can see our role in achieving this²⁴.

²² Foran, B. and Poldy, F. (2002) *Future dilemmas: options to 2050 for Australia's population, technology, resources and environment*, CSIRO Sustainable Ecosystems, Canberra.

²³ See Buxton, M., Alvarez, A., Butt, A., Farrell, S., Densley, L., Pelikan, M. and O'Neill, D. (2011) *Scenario planning for Melbourne's peri-urban region*, RMIT, Melbourne.

²⁴ This sentiment is inspired by wording contained in the Central Victorian Greenhouse Alliance *Draft Strategic Plan* (2007).

Chapter 5 – Current Condition and Management

This chapter provides a brief summary of statewide condition and management for each of the six themes on which this report is based.

For each theme, detailed assessments relating to data quality, statewide condition and trends are given in Part 2. In each case, these assessments should be read in conjunction with specific information on the indicators and the way in which they have been used to contribute to an understanding of resource condition.

As discussed previously, there are many pieces of legislation that are relevant to the management of Victoria's land and water resources, as well as statutory plans and strategies that provide more specific direction (Figure 4). In this chapter, the particular Victorian legislation and statewide strategies relevant to each theme are identified.

Clearly, the management of Victoria's land and water resources is also in the hands of the community and the private sector, and the long-term efforts of many landholders and community-based groups to repair the condition of our catchments across the State are well established.

For the purpose of reporting here, however, it is the Government's response, through the work of a number of agencies and statutory authorities, that forms the basis of Council's reporting on management; this includes policies and strategies that relate to the management of private land, public land or both.

A close reading of this chapter will illustrate some of the difficulties flagged previously, associated with the currency and quality of data. Few cases are based on robust and current data. For most themes, Council has called on expert opinion to fill the data gaps and help tell the story of what is happening across Victoria's catchments. A qualitative assessment of catchment condition, at the statewide scale, has been given in Figure 1.

More rigorous condition assessments are possible at the sub-regional and local scale, such as those developed by the CMAs in their annual reports and accompanying catchment condition reports. At present, however, these cannot be aggregated up to the catchment and statewide scale, because of the lack of consistent monitoring and reporting over time.



Theme 1: Native vegetation

Indicators	Statewide condition	Statewide trend in condition	Data quality rating ²⁵
1.1 Native vegetation extent	Intact landscapes – assumed good to excellent	Intact landscapes – assumed stable	Good
1.2 Native vegetation quality	Fragmented landscapes – assumed poor to moderate	Fragmented landscapes – assumed declining	Poor

There has been significant decline in the extent of native vegetation across the State since European settlement, although this decline has slowed in recent years. Native vegetation is assumed to be in 'good' to 'excellent' condition in Victoria's largely intact landscapes but in 'poor' to 'moderate' condition, and continuing to decline, in fragmented landscapes^{26,27}.

Condition and trend

Expert advice from agency staff has informed the assessment of native vegetation in this report. Preliminary information is available on the statewide extent of native vegetation, based on mapping undertaken by DSE in 2011-12. However, given that the mapping is not finalised, it is not yet possible to quantify changes in native vegetation extent since 2005 (when native vegetation extent was first modelled). No current statewide dataset is available for native vegetation quality.

Since European settlement, there has been an extensive loss of native vegetation and decline in native vegetation quality. About half of Victoria's remaining native vegetation is found in largely-intact landscapes and

half in fragmented landscapes. Many of Victoria's largely-intact areas of native vegetation occur on public land and are protected within the parks and reserves system. Native vegetation in fragmented landscapes occurs on both public and private land.

The quality of vegetation on private land is particularly subject to a number of threatening processes, including the ongoing effects of past clearance, fragmentation, altered fire regimes and invasive plants and animals. Losses from clearance are thought to exceed gains from revegetation and natural regeneration on private land.

An updated assessment of native vegetation quality, for selected parts of the State, is due for completion in 2013 as part of DSE's response to the Victorian Bushfire Royal Commission. A good understanding of the extent and quality of our native vegetation is fundamental to long-term, integrated, landscape scale planning in Victoria.

²⁵ See inside front cover for an explanation of data quality ratings.

²⁶ See Parkes, D. 2008, *Native Vegetation Net Gain Accounting: First Approximation Report*, DSE, Melbourne.

²⁷ Largely-intact landscapes are contiguous areas of native vegetation greater than 20,000ha.

Legislation and strategies

The Victorian Government's directions for the management of native vegetation are set out across several pieces of legislation, including the *Flora and Fauna Guarantee Act 1988*, the *Planning and Environment Act 1987* and the *Sustainable Forest (Timber) Act 2004*, as well as statewide strategies such as *Victoria's Biodiversity Strategy*²⁸ and the *Native Vegetation Framework*²⁹.

There are no specific, clear, measurable targets for native vegetation at statewide level. However, management measures include:

- regional plans for native vegetation, developed by CMAs, based on the statewide *Native Vegetation Framework*;
- market-based approaches and voluntary programs to manage native vegetation on private land;
- management, by Parks Victoria, of many of Victoria's largely-intact areas of native vegetation in the parks and reserves system;
- planning controls implemented through the Victoria Planning Provisions and local government planning schemes; and
- controls on forestry operations³⁰.

State of the Forests and *State of the Parks* reports provide an assessment of the condition and management of forests, parks and reserves³¹.

The *Biosecurity Strategy for Victoria* and the *Invasive Plants and Animals Policy Framework* aim to protect Victoria's native vegetation from biosecurity threats and address emerging risks to native vegetation^{32,33}.

²⁸ DNRE (1997) *Victoria's Biodiversity – Our Living Wealth*, DNRE, East Melbourne; DNRE (1997) *Victoria's Biodiversity – Sustaining Our Living Wealth*, DNRE, East Melbourne; DNRE (1997) *Victoria's Biodiversity – Directions in Management*, DNRE, East Melbourne.

²⁹ DNRE (2002) *Victoria's Native Vegetation Management: A Framework for Action*, DSE, Melbourne.

³⁰ DNRE (2002) *Our Forests, Our Future*, DNRE, Melbourne.

³¹ DSE (2009) *Victoria's State of the Forests Report 2008*, DSE, Melbourne; Parks Victoria (2007) *Victoria's State of the Parks*, Parks Victoria, Melbourne.

³² DPI (2009) *Biosecurity Strategy for Victoria*, DPI, Melbourne.

³³ DPI (2010) *Invasive Plants and Animals Policy Framework*, DPI, Melbourne.

Theme 2: Threatened species and populations

Indicators	Statewide condition	Statewide trend in condition	Data quality rating
2.1 Conservation status of native plants and animals	Poor – large numbers of flora and fauna species listed as rare or threatened	Major decline since European settlement	Moderate
2.2 Threatened plant and animal populations		Assumed continuing decline since Council's previous catchment condition report (2007) ²	Moderate

Victoria's threatened native plants and animal species and populations are considered to be in 'poor' condition and declining.

Condition and trend

The conservation status of extinct, rare and threatened Victorian native flora and fauna species and communities is listed in DSE's Advisory Lists.

The Advisory Lists were updated in 2012 for vertebrate fauna and 2009 for invertebrate fauna³⁴. The Advisory List for flora has not been updated since 2005.

There has been an increase in the number of native vertebrate species considered critically endangered, endangered or vulnerable, since 2007. The conservation

status of invertebrates is less clear; this reflects a general lack of systematic surveys for invertebrates. The degree of habitat loss and modification in Victoria suggests that there are likely to be many more threatened invertebrates than indicated by the Advisory Lists.

Expert advice indicates that the overall trend for threatened species and populations is one of decline due to the degree of habitat loss through past habitat clearance and fragmentation, and ongoing degradation of remaining habitat. The exception is intact landscapes, where large, contiguous areas of animal and plant habitat occur.

Legislation and strategies

The Victorian Government's directions for the management of threatened species are set out across several pieces of legislation, including the *Flora and Fauna Guarantee Act 1988* and the *Planning and Environment Act 1987*, as well as *Victoria's Biodiversity Strategy* and the *Native Vegetation Framework*. There is not a strong management framework in place for threatened species and populations in Victoria, nor clear measureable targets.

Key management measures include:

- the preparation and maintenance of lists of threatened species and communities;
- the development of Action Statements and Management Plans;
- Victoria Planning Provisions and local government planning schemes to protect threatened species; and
- on-ground works to benefit threatened species in conservation reserves and other areas.

The preparation of listings of threatened species and communities forms the basis for the development of appropriate management plans and can be used to inform planning processes.

³⁴ DSE (2012) Advisory list of threatened vertebrate fauna in Victoria – 2012, DSE, East Melbourne; DSE (2009) Advisory list of threatened invertebrate fauna in Victoria – 2009, DSE, East Melbourne.

Theme 3: Soils

Indicators	Statewide condition	Statewide trend in condition	Data quality rating
3.1 Soil health	Unknown	Unknown	Poor

The condition status and trend in soil health in Victoria is unknown.

Condition and trend

There has been no assessment of soil health undertaken at a statewide level. Soil salinity, soil acidity, threat of erosion and soil carbon can be used to guide an assessment of soil health, but there is currently no 'reference' or 'natural' condition for these indicators. This makes it difficult to determine change in soil condition and so, to provide a soil health rating. In addition, existing datasets are often patchy or out of date.

Collection of soil salinity data across Victoria has been *ad hoc* and infrequent and there exists no current, comprehensive statewide map of soil salinity for Victoria. At the subcatchment scale, observations indicate that the spread of dryland salinity slowed during the drought, due to falling groundwater tables.

There are no new data on rates of soil acidification across Victoria since Council's last catchment condition report (2007). However, expert opinion suggests that soil pH has generally declined since the 1990s, due to the prolonged drier conditions.

Areas in Victoria under threat from wind and water erosion have been modelled using satellite imagery. For the period 2001-09, the modelled cumulative threat of wind erosion was found to be greatest in the State's north-west. Drought conditions reduced the threat of water erosion across much of the State; but the same conditions made it extremely difficult to protect soil from wind erosion.

Limited information on soil carbon levels exists in Victoria and often does not differentiate between organic and inorganic forms of soil carbon. Modelled soil carbon levels in Victoria have been found generally to be higher in high rainfall regions and higher under pasture than cropping.

The lack of data on soil health remains a critical gap in our understanding of catchment condition. Council recommends the development of a Soil Health Index, similar to the Soil Condition Index recently developed by the NSW Office of Environment and Heritage³⁵.

Legislation and strategies

The Victorian Government's broad directions for the management of soils are identified in the CALP Act 1994 and the recently-released *Soil Health Strategy* provides some goals for soil management³⁶. However, there are currently no clear, measurable targets for soil health in place.

Key management measures include farm extension services provided to farmers by DPI and CMAs.

³⁵ Chapman, G., Gray, J., Murphy, B., Atkinson, G., Leys, J., Muller R., Peasley, B., Wilson, B., Bowman, G., McInnes-Clarke, S., Tulau, M., Morand, D. and Yang, X. (2011) *Assessing the condition of soils in NSW*, Monitoring, evaluation and reporting program. Technical report series. OEH, Sydney.

³⁶ DSE (2012) *Soil Health Strategy: Protecting soil health for environmental values on public and private land*, DSE, Melbourne.

4

Theme 4: Rivers and streams

Indicators	Statewide condition	Statewide trend in condition	Data quality rating
4.1 Streamflow	Moderate (low streamflow compared to long-term average)	Increasing flows post-2010	Good
4.2 River and stream condition	Assumed moderate to good in the east, poor in the west	Assumed stable	Good

The extended dry period led to a significant decline in streamflow across many of Victoria's catchments. Expert opinion, and evidence from previous assessments, suggests that river and stream condition is 'moderate' to 'good' in the east and 'poor' in the west.

Condition and trend

Data from 1997 to 2010 show that Victoria's streamflow has been lower in recent years, compared to historical flows; this has been due largely to climate variability and the effects of water extraction for consumptive use. The extended dry period had a substantial impact on streamflow, particularly in central and western Victoria. Many Victorian catchments experienced some of the lowest streamflow on record. Many environmental water rights across Victoria were qualified during the drought, to augment consumptive supply.

Two statewide assessments of river and stream condition have been undertaken using the Index of Stream Condition (ISC) assessment method (1999, 2004)³⁷. Data collection and analysis have changed since 2004, the major change being in the use of remote sensing. The third ISC report will not be available until late 2012. Some preliminary data have been made available to Council for this report but are not sufficient to allow comparison with findings of Council's previous catchment condition reports. The ISC method is one of few tools, relating to land and water resources, which has the capacity to generate statewide data, using a rigorous methodology. It is disappointing that delivery of results from the 2010 ISC has been so delayed.

³⁷ DSE (2005) Index of Stream Condition: The Second Benchmark of Victorian River Condition, DSE, Melbourne.

Legislation and strategies

The *Water Act 1989* establishes the framework for the management of rivers and streams in Victoria and the *Victorian River Health Strategy 2002*³⁸ sets out the Victorian Government's statewide objectives for the management of rivers and streams, which have been implemented at the regional scale via Regional River Health Strategies. Sustainable Water Strategies establish strategic goals for water management at a regional scale. The proposed *Victorian Waterway Management Strategy*, currently being developed, will provide strong, updated statewide direction on the management of rivers and streams.

In addition, the *Heritage Rivers Act 1992* provides for special management arrangements for public land in certain parts of rivers and river catchment areas with significant conservation, recreation, scenic or cultural heritage attributes.

Key management measures have included:

- establishment of the Victorian Environmental Water Holder in July 2011, as a new independent statutory body deciding on the best use of Victoria's environmental water entitlements, and environmental watering plans for a range of high priority waterways;
- on-ground works undertaken by CMAs and Melbourne Water;
- provision of incentives to encourage better riparian zone management; and
- establishment of water quality targets in the State Environment Protection Policy (1986)³⁹ and water pollution restrictions by the Environment Protection Authority.

³⁸ DNRE (2002) *Healthy Rivers, Healthy Communities and Regional Growth: Victorian River Health Strategy*, DNRE, East Melbourne.

³⁹ EPA (1986) *State Environment Protection Policy (Waters of Victoria)*, EPA, East Melbourne.

5

Theme 5: Wetlands

Indicators	Statewide condition	Statewide trend in condition	Data quality rating
5.1 Wetland extent	Assumed moderate	Reduction in extent since European settlement and assumed continuing decline	Good
5.2 Wetland condition	Moderate	Assumed declining	Good

The extent and condition of wetlands is assumed to be declining. About half of the State's high value wetlands are currently in 'excellent' or 'good' condition; the remainder are largely in 'moderate' to 'poor' condition.

Condition and trend

Data on wetland extent were collected in 1994 and in 2009/10. However, the data are difficult to compare; it is unclear whether changes in extent are due to actual changes, or to recent wet climatic conditions or to more accurate modelling and better detection. For example, updated mapping by CMAs and DSE shows 'new' wetlands but many of these 'new' wetlands represent new recordings of wetlands rather than actual new occurrences. Expert opinion suggests that the combined extent of wetlands, across the State, is declining.

A welcome development since 2007 has been the launch of the Index of Wetland Condition (IWC) tool. The first assessment has been completed (2009/10) and the next condition assessment is planned for 2017/18⁴⁰.

The IWC assessment found that many of Victoria's high value wetlands retain their original area and form, their soils are relatively unmodified and there is no change to salinity levels. However, about one third of high value wetlands have a substantially altered water regime, largely due to river regulation. Two thirds contain vegetation in 'moderate' to 'very poor' condition, a likely result of changes in water regimes, grazing by livestock, cropping and weed invasion, exacerbated by the recent drought.

High value wetlands on public land are generally in better condition than those on private land (88% in good or excellent condition on public land, compared to 40% on private land).

⁴⁰ Papas, P. and Molomey P. (in prep) *Victoria's wetlands 2009-2011: statewide assessments and condition modelling*, Arthur Rylah Institute for Environmental Research Technical Report Series No. 229, DSE, Heidelberg.

Legislation and strategies

The *Water Act 1989* establishes the statutory framework for the management of wetlands in Victoria.

Victoria is a signatory to the Ramsar Convention and, in 2002, a *Strategic Directions Statement* was published; this established a set of objectives and statewide strategies for the management of Ramsar sites in Victoria⁴¹. Strategic goals for wetland management have been established on a regional basis in the CMAs' Regional Catchment Strategies and in Sustainable Water Strategies.

Regional management of wetlands is designed primarily to mitigate threats to wetland condition; there is no coordinated program or statewide framework. The *Victorian Waterway Management Strategy*, currently being developed, should provide a statewide direction on the management of wetlands.

Key management measures have included:

- the establishment of environmental watering arrangements and associated infrastructure; and
- regional wetland restoration projects by CMAs and volunteer programs.

⁴¹ DNRE (2002) *Management of Victoria's Ramsar Wetlands Strategic Directions Statement*, DNRE, East Melbourne.

6

Theme 6: Groundwater

Indicators	Statewide condition	Statewide trend in condition	Data quality rating
6.1 Groundwater level	Moderate	Unknown	Moderate
6.2 Groundwater quality	Assumed moderate	Unknown	Poor

The level and quality of groundwater across the State is considered as 'moderate'. Some statewide data on groundwater level and quality are available, but not sufficient to establish trends.

Condition and trend

Current, good quality data are available on groundwater levels from the State Observation Bore Network. However, the network of observation bores is unevenly distributed across the State and it is, therefore, difficult to establish a statewide picture of groundwater levels.

From the the late 1990s to 2010, groundwater levels in several (but not all) shallow aquifers declined, due to a combination of increased groundwater use and reduced recharge from surface water irrigation and rainfall.

Since 2007, long-term declines in deep aquifer groundwater levels have continued in Gippsland; this is associated with the dewatering of Latrobe Valley coal mines and off-shore oil and gas extraction. In other areas of the State, restrictions to

groundwater use and a return to wetter conditions in 2011, have contributed to the recovery of groundwater levels in deep aquifers.

Since 2011, groundwater levels across Victoria have been generally rising in response to rainfall, flooding and irrigation.

Groundwater salinity is a commonly used measure of groundwater quality and statewide data are patchy in spatial and temporal coverage. Modelling indicates that the most saline groundwater occurs in the State's north-west. There is no statewide information on temporal trends in groundwater salinity, since data are not collated or analysed to demonstrate trends at this level.

There remain critical gaps in our understanding of the condition and prospects for Victoria's groundwater resources. A recent investigation by the Victorian Auditor General's Office was unable to determine if groundwater use in Victoria is sustainable⁴².

⁴² VAGO (2010) Sustainable Management of Victoria's Groundwater Resources, VAGO, Melbourne.

Legislation and strategies

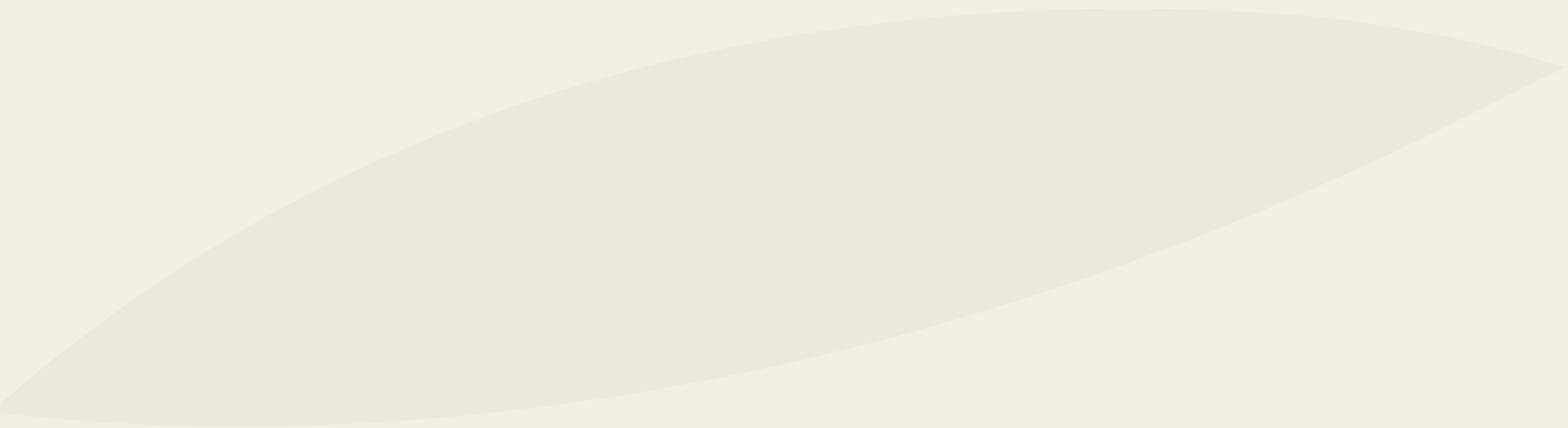
The *Water Act 1989* establishes the statutory framework for the management of groundwater in Victoria. There are some management arrangements for groundwater described in the *Victorian River Health Strategy*. Strategic goals for groundwater management have been established on a regional basis in Sustainable Water Strategies and Regional Catchment Strategies. A DSE policy paper, *Improving management of Victoria's groundwater resources* was published in 2011⁴³.

Key monitoring and management measures have included:

- ongoing monitoring of groundwater including water levels and salinity; and
- mapping of potential terrestrial groundwater-dependent ecosystems.

Regional management of groundwater is currently designed primarily to reduce threats to wetland condition. There is no coordinated or statewide framework to ensure that groundwater use, allocated via groundwater licences, is sustainable.

⁴³ DSE (2011) Policy paper: Improving management of Victoria's groundwater resources, DSE, East Melbourne.





Theme 1: Native vegetation 33

Theme 2: Threatened species
and populations 38

Theme 3: Soils 48

Theme 1: Native vegetation

Indicator 1.1 – Native vegetation extent

Native vegetation refers to the trees, understorey and groundcover plant species that occurred naturally in Victoria prior to European arrival. Native vegetation is intrinsically valuable in its own right. It plays a vital role in providing habitat for native species and protecting our water resources and soils.

Loss of native vegetation is closely associated with impacts on biodiversity. These include immediate and permanent impacts such as species loss, and longer term impacts such as population isolation. The degradation of remaining native vegetation is the major current threat to Victoria's biodiversity. Areas of native vegetation can face potential loss of habitat condition through pressures such as invasive species, altered fire regimes and climate change.

The section reports on the extent of native vegetation (Indicator 1.1) and the condition of native vegetation (Indicator 1.2) in Victoria.

Indicator definition

This indicator measures the extent of native vegetation in Victoria.

Why do we use this indicator?

Native vegetation extent provides an indication of the current coverage, as well as extent to which vegetation and landscapes have changed since European settlement, and the extent of remnant native flora and fauna habitat.

Data quality rating ◆

DSE first modelled the extent of native vegetation for the whole of Victoria in 2005. DSE revised this dataset in 2011/12 to produce updated modelling and mapping of native vegetation extent. The revised dataset combines information from satellite imagery, ancillary spatial datasets and ground-truthed site data to model native vegetation for the whole of Victoria, including discrimination between woody, grasslands and other non-woody classes.

Data available to assess change? ■

The revised dataset contains more detailed information on grasslands, smaller remnants and scattered trees than previously available due to improved analysis and modelling techniques. The 2005 and 2011/12 datasets are difficult to compare as it is often unclear from the data analysis whether changes in extent are due to actual new occurrences of native vegetation or to more accurate modelling of vegetation that was present in 2005.

Although native vegetation provides the foundation for many other natural resource values and processes, the basic datasets are not routinely updated and maintained. Updates are generally opportunistic; for example, the most recent update to the native vegetation dataset was possible because new vegetation cover data were required to improve the quality of fuel hazard mapping and fire management planning as part of the DSE response to the Victorian Bushfire Royal Commission.

Statewide condition and trend

Largely-intact landscapes

● (assume)

Fragmented landscapes

● to ● ▼ (assume)

The extent of native vegetation (modelled) in Victoria is shown in Figure 6. This map is based on a preliminary assessment of native vegetation extent by DSE – a final map will be produced by DSE in late 2012.

Figure 7 shows the extent of Victoria's native vegetation in 2005. Council is unable to quantify differences in native vegetation extent between 2005 and 2012 given the preliminary nature of Figure 6. What is evident when comparing Figures 6 and 7 however, is the improved mapping of grasslands (grassy and chenopod vegetation), particularly in the state's west. This is due to improved technology which allows non-tree areas in woody vegetation and smaller areas of grassland (to paddock scale) to be mapped in greater detail. Also evident are fire scars in the Big Desert Wilderness Park in the state's west. Although the Park was burnt in 2002, the scars are still evident as Mallee vegetation

⁴⁴ Largely-intact landscapes are contiguous areas of native vegetation greater than 20,000 hectares. Fragmented landscapes are those where there has been widespread removal and ongoing use of native vegetation for economic development.

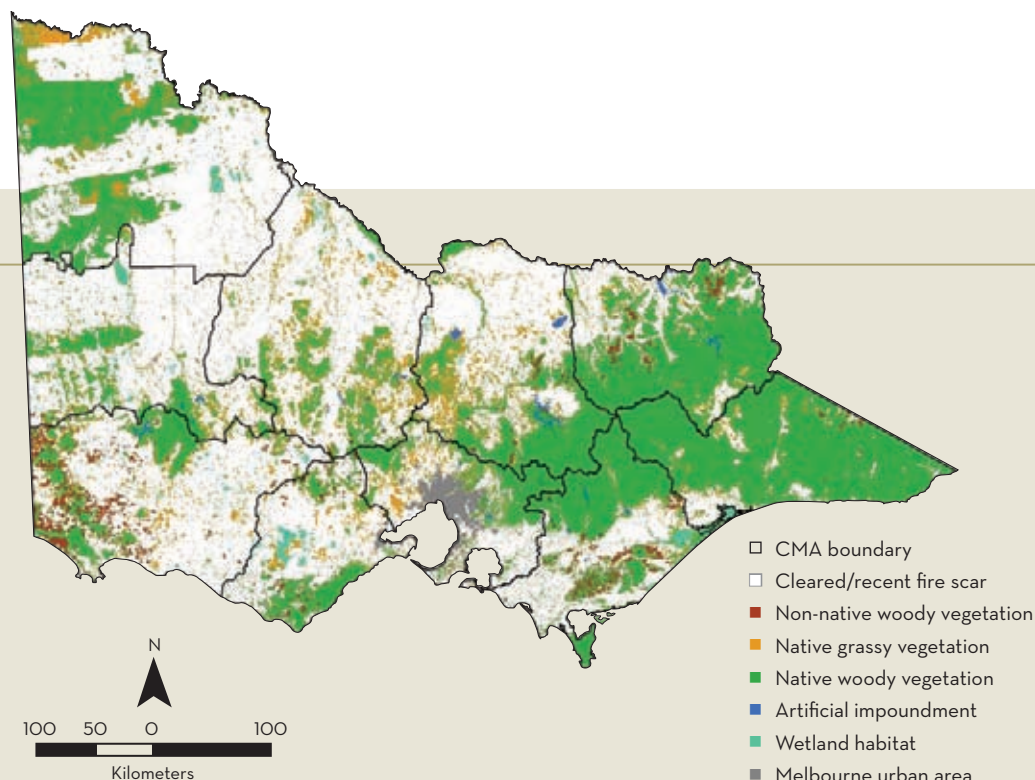


Figure 6. Native vegetation extent (modelled), showing largely-intact and fragmented landscapes⁴⁴, as of July 2012

Source: DSE, Biodiversity & Ecosystem Services, 2012

takes a long time to fully regenerate after fire, particularly during drought. Although not obvious at this scale, woody vegetation is also mapped in finer detail in Figure 6 than in Figure 7.

Expert opinion suggests that the extent of native vegetation is most likely to be declining on private land and in fragmented landscapes, and most likely to be stable in largely-intact landscapes. Much of the vegetation loss experienced is incremental (as opposed to broadscale clearance of

vegetation), and will have occurred through 'allowed actions' such as clearing associated with bushfire protection. Revegetation through investment programs partially mitigates the overall decline in vegetation extent. Overall, however, losses in native vegetation extent from clearance on private land are likely to have exceeded gains from revegetation and natural regeneration.

Victoria experienced the 'Black Saturday' bushfires, a series of landscape-scale bushfires, in February 2009. These bushfires

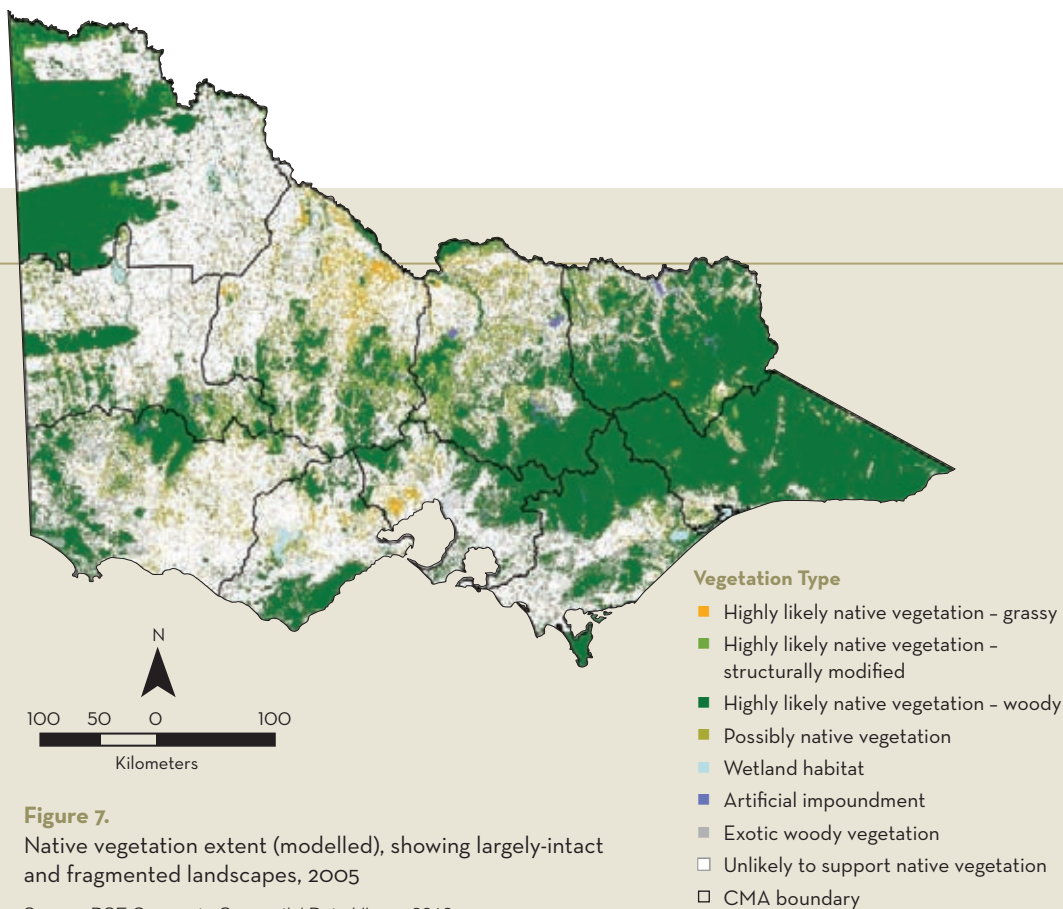


Figure 7.
Native vegetation extent (modelled), showing largely-intact and fragmented landscapes, 2005

Source: DSE Corporate Geospatial Data Library 2012

burnt over 270,000 hectares of vegetation, largely to the north-east of Melbourne. Any vegetation changes associated with bushfire are considered a ‘temporary’ disturbance to quality rather than a permanent loss of extent.

Many of Victoria’s largely-intact areas of native vegetation are protected within the parks and reserves system. Significant additions to the parks and reserves system since 2007 include the River Red Gum parks (with four new national parks: Barmah, Gunbower, Lower Goulburn River and Warby-Ovens) in northern

Victoria and Cobboboonee National Park in Victoria’s west (DSE 2010a; DSE 2009a). This led to the protection of a substantial amount of native vegetation in Victoria from 2007 (for example, more than 8,800 hectares of remnant native vegetation in Gunbower National Park).

Other large areas of native vegetation occur within Victoria’s forest system. Victoria’s native forest is found on both public and private land. In the CCR 2007, it was reported that native forest covered about

7,838,000 hectares or 34 per cent of the state’s total area (VCMC 2007). These figures were based on Statewide Forest Resource Inventory (SFRI) and Ecological Vegetation Class data. The SFRI project ran from 1994 to 2005 and involved the detailed mapping of mostly commercial eucalypt forest stands across State forest in eastern Victoria, using aerial photography and some field validation. Some National Parks and private native forest were also mapped. There was no ongoing investment in this project post-2006.

DSE has implemented the Forests and Parks Monitoring and Reporting Information System (FPMRIS) (see DSE (2010b) for more detail). This program will assess and monitor the extent, state and sustainable development of Victoria’s forests over time, via regular measurements of permanent ground plots and remote sensing. Plots are distributed statewide across both state forests and parks and reserves. The data and information collected and analysed will be used to generate the next five-yearly State of the Forest Report. This report is due to be released in early 2014.

Updated methods of data collection and analysis and extensions to the geographic sampling coverage mean the FPMRIS forest estimates are not directly comparable to previous estimates of forest extent.

Indicator 1.2 – Native vegetation quality

Indicator definition

This indicator measures the quality or condition of native vegetation in Victoria.

Why do we use this indicator?

Information on native vegetation condition can help us understand the ability of existing native vegetation to provide habitat for native plants and animals. This contributes to our understanding of the resilience of biodiversity.

Data quality rating

DSE carried out a statewide assessment of Victoria's vegetation condition in 2004/05. Data and mapping from this assessment were reported in the CCR 2007.

An updated assessment by DSE of native vegetation quality for selected parts of Victoria is due for completion in 2013 as part of the DSE response to the Victorian Bushfire Royal Commission. Vegetation quality has been assessed using DSE's habitat hectares approach. This is a site-based measure of quality and quantity of native vegetation that is assessed in the context of the relevant native vegetation type (see DSE (2004) for more information). The revised dataset will combine information from satellite imagery, ancillary spatial datasets and ground-truthed site data to model the quality of native vegetation across the landscape. It will include more accurate information on 'high quality' vegetation found on public land, parks and reserves and in fragmented areas.

Data available to assess change?

No further statewide mapping of vegetation quality has been completed since the CCR 2007.

Statewide condition and trend

Largely-intact landscapes

● (assume)

Fragmented landscapes

● to ● ▼ (assume)

Council cannot report on current native vegetation quality at the statewide level in this report due to a lack of current data. Readers are referred to the CCR 2007 (p67) for a statewide map showing native vegetation quality across Victoria. Vegetation quality was found to be generally good in largely-intact landscapes and in poorer condition in fragmented landscapes. The Victorian Environmental Assessment Council undertook an analysis of native vegetation quality in 2010 as part of their Remnant Native Vegetation Investigation (VEAC 2010). VEAC's findings were consistent with those of the CCR 2007.

In terms of changes in overall vegetation quality over time, the CCR 2007 reported that the underlying stock of native vegetation was found to be stable in largely-intact landscapes, but declining or at risk of decline in fragmented landscapes. DSE's 2008 *Net Gain Accounting* –

First Approximation Report analysed changes in vegetation quality from 1994 to 2004, showing a decline in quality during this period (DSE 2008).

Expert opinion suggests that current native vegetation quality is generally stable on public land and in largely-intact landscapes due to active conservation management, additions to the conservation reserve system and natural regeneration. However, it is most likely to be declining on private land and in fragmented landscapes. This is due to a number of threatening processes, including the ongoing effects of past clearance and fragmentation, inappropriate grazing regimes, altered fire regimes and invasive plants and animals. Improved management through investment programs partially reduces the overall decline in vegetation condition. However, these account for only a small proportion of native vegetation on private land – most native vegetation on private land is not managed for conservation purposes.

There are few data on the effect of Victoria's extended drought on vegetation quality. However, anecdotal evidence suggests that the effect of the drought was significant in some areas. For example, widespread mature tree death, which is quite rare within large stands, was observed in areas of foothills forests. Drought is part of Victoria's natural cycle, and vegetation condition is expected to recover over time with wetter conditions, although should the frequency and severity of droughts increase, this ability to recover will be increasingly tested. Similarly, while landscape-scale fires such as the 'Black Saturday' bushfires temporarily affect vegetation maturity and quality, any increase in the frequency and severity of fires will reduce the inherent resilience of ecosystems.

Theme 2: Threatened species and populations

2

Indicator 2.1 – Conservation status of native plants and animals

Native plant and animal species and communities are intrinsically valuable in their own right. They also provide ecosystem services such as air filtration, water purification and waste decomposition that support ecologically sustainable and productive catchments and landscapes. A high diversity of native species provides greater resilience of natural ecosystems to human and natural disturbances.

This section reports on the conservation status of native plants and animals (Indicator 2.1) and the status of threatened plant and animal populations (Indicator 2.2).

Indicator definition

This indicator refers to the number of native plant and animal taxa (species, sub-species or varieties) listed as extinct or threatened in Victoria.

The Victorian Government maintains two sets of lists of species of conservation significance – the DSE Advisory Lists and the Threatened List under the *Flora and Fauna Guarantee Act 1988*. DSE's Advisory Lists are used in preference to the Threatened List as changes to the Threatened List reflect the rate of public nominations rather than changes in either knowledge or actual status.

The Advisory Lists provide a record of all extinct and threatened plants and animal taxa in Victoria at a point in time. They are periodically reviewed by DSE. There are no legal requirements or consequences that flow from the inclusion of a species in an Advisory List. However, the Lists are commonly used in planning processes such as the development of management plans and strategies, local government planning schemes and in setting priorities for actions to conserve biodiversity.

The classification of 'extinct' refers to species that are known or presumed to have become extinct since European settlement. Threatened species are those considered 'regionally extinct', 'critically endangered', 'endangered' or 'vulnerable' in Victoria (see www.dse.vic.gov.au for category definitions). Rare species are those where there are relatively few known populations or the taxon is restricted to a relatively small area, but they are not considered otherwise threatened. National or international conservation status is not considered in assigning Victorian conservation status.

Why do we use this indicator?

Extinction of native species represents a loss in species diversity. The number of threatened species provides an indication of the risk of further loss of biodiversity.

Data quality rating ◆

The Advisory Lists are based on technical information and advice obtained from a range of experts. The categories and criteria of the International Union for Conservation of Nature Red List are adopted for assessments of the conservation status of individual taxa. Individual species can be added to or removed from the Lists over time if their conservation status changes. That said, the comprehensiveness of the Lists may be somewhat limited by the available knowledge base, including specialist expertise and survey effort. This is particularly the case for many invertebrate, lichen and fungi taxa for which our knowledge remains limited.

Data available to assess change? ■

No new information has become available on the conservation status of threatened and rare plants since the CCR 2007. An updated Advisory List for rare and threatened plants is due in 2013.

New information has become available on the conservation status of threatened vertebrate and invertebrate fauna since 2007, with Advisory Lists published by DSE in 2012 and 2009 respectively. An updated Advisory List for threatened invertebrates is due in 2013.

Care must be taken with interpretation of the information contained in the Advisory Lists, for the following reasons:

- conservation status is assessed at a whole of species or whole of jurisdiction level – it does not reflect regional variation in the status of populations;
- the number of threatened species may change either because more species are actually at risk or because of a better understanding of species that were already at risk; and

- changes in the rules used to assign categories or in the taxonomy of plant and animal groups may strongly influence the results (for example, the guidelines for application of the International Union for Conservation of Nature criteria have changed since 2007); and
- not all taxa are reviewed regularly (for example, the update of the 2007 Advisory List for threatened vertebrates was carried out on terrestrial and freshwater vertebrate fauna only).

This means that while information from the Advisory Lists can be analysed to assess change (for example, change in the number of threatened plants and animals over time), the results must be interpreted with caution. It is difficult to determine whether overall changes in the number of taxa listed reflect increased knowledge of a taxon or actual changes in status.

Statewide condition and trend



Plants

As of 2005, 51 native vascular plant and bryophyte species were listed as presumed extinct within Victoria. A further 1,616 vascular plant, bryophyte and fungi species were listed as rare or threatened (DSE 2005). Of the almost 3,200 native vascular plant species recorded in Victoria, about half are considered rare or threatened.

DSE is currently preparing an updated list of rare and threatened native plant species in Victoria. It is expected to be published in 2013. It is thus not possible to determine changes in the number of rare and threatened plant species between 2007 and 2012. Expert opinion indicates that the overall trend is one of decline due to the effects of past habitat clearance and fragmentation, and ongoing degradation of remaining habitat. The exception is intact landscapes where large, contiguous areas of remnant native vegetation occur. Some gains have been made through targeted recovery efforts and other management activities.

Examples of changes over time for selected plant populations are provided under Indicator 2.2.

Vertebrate animals

Nine native mammal species have become extinct in Victoria since European settlement (DSE 2012a). There have been no new extinctions since 2007.

The number of threatened native vertebrate species is shown by major group in Figure 8. Almost all vertebrate groups have a considerable proportion of their extant species listed as threatened (a broad category encompassing regionally extinct, critically endangered, endangered and vulnerable categories).

The number of such threatened species in each major group is shown as a percentage of all known extant species for that group (shown at top of each bar in Figure 8). For example, 22% of Victoria's extant terrestrial mammal species are listed as threatened.

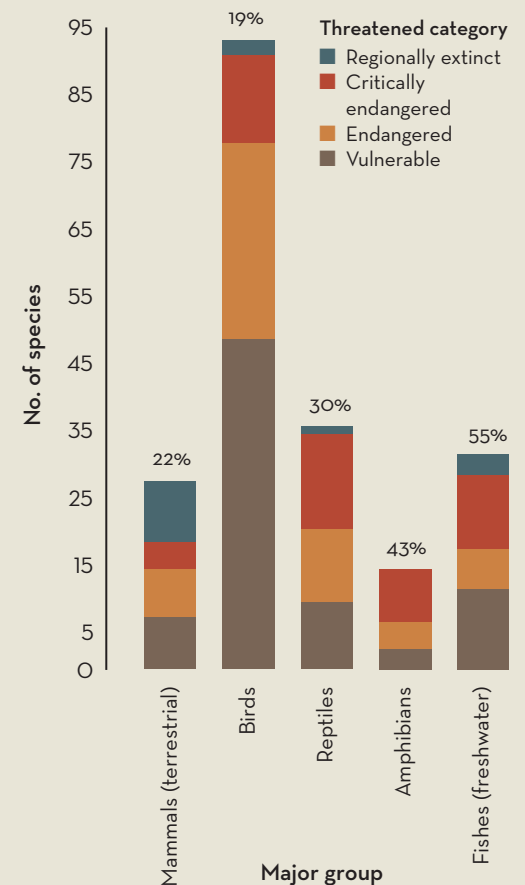


Figure 8.

Number of threatened native vertebrate species by major group, and percentage of all known extant species

Source: DSE (2012) Advisory List of Threatened Vertebrate Fauna in Victoria-2012

There has been an increase in the number of native vertebrate species considered critically endangered, endangered and vulnerable since 2007 (Figure 9). For example, 14 additional species have been listed as critically endangered since 2007. What Figure 9 does not reveal is that there were about 70 taxa whose status changed between 2007 and 2012: some taxa were new additions, some were deletions and some were recorded in the previous Advisory List but their conservation status has changed. Of these changes, more than half can be attributed to evidence of further species decline, with the remainder due to new information on the status of native species or changes to the assessment criteria and taxonomy. Examples of changes over time for select vertebrate animal populations are provided in Indicator 2.2.

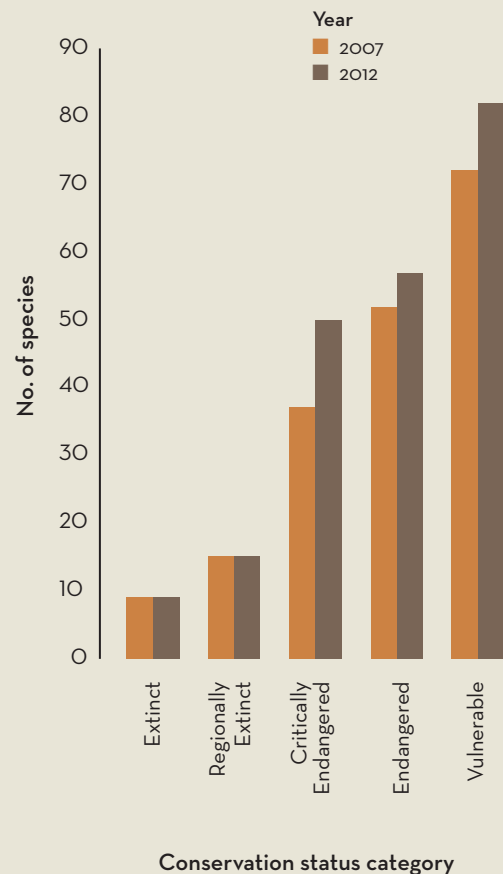


Figure 9.
Number of threatened native vertebrate species
in Victoria in 2007 and 2012

Source: DSE (2012) Advisory List of Threatened Vertebrate Fauna in Victoria-2012; DSE (2007) Advisory List of Threatened Vertebrate Fauna in Victoria-2007

Invertebrate animals

As of 2009, one invertebrate species was listed as extinct and 132 species were listed as threatened in Victoria. There is a widespread lack of information on virtually all invertebrates, a reflection of the general lack of systematic surveys for invertebrates. The total number of invertebrate species in Victoria is currently unknown. There are also problems in determining the conservation status of species for which there is limited information. Considering the degree of habitat loss and modification in Victoria, there are likely to be many more threatened invertebrates than indicated by the Advisory List (DSE 2009b).

The number of threatened invertebrate species is shown by major group in Figure 10. DSE is currently preparing an updated list of threatened invertebrate species in Victoria. It is expected to be published in 2013. As such, it is not possible to determine changes in the number of threatened invertebrate species between 2007 and 2012.

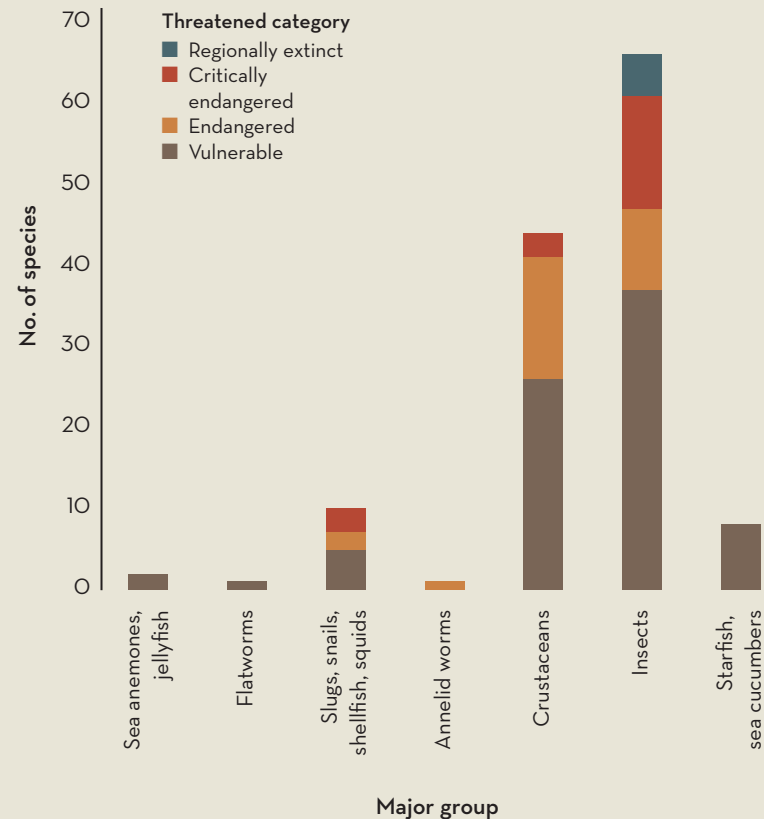


Figure 10.
Number of threatened native invertebrate species by major group

Source: DSE (2009a) Advisory List of Threatened Invertebrate Fauna in Victoria-2009

CASE STUDY

NaturePrint: a blueprint for nature conservation

The conservation of native flora and fauna is a challenge for natural resource managers, particularly given the current number of threatened species and the predicted impacts of climate change on native species. *NaturePrint* has been developed by DSE to assist natural resource managers to identify areas for conservation intervention in a strategic and targeted way. *NaturePrint* provides a consistent, transparent source of ecological information for decisions that impact on natural values.

NaturePrint incorporates scientific modelling and optimisation methods from some leading international scientific approaches. These techniques move beyond simple scoring systems based on arbitrary weightings and use quantified models that can be continuously improved as new information comes to hand.

NaturePrint combines our best statewide information on:

- distributions of species and their habitats;
- the condition of these habitats;
- how species are likely to use and move through landscapes;

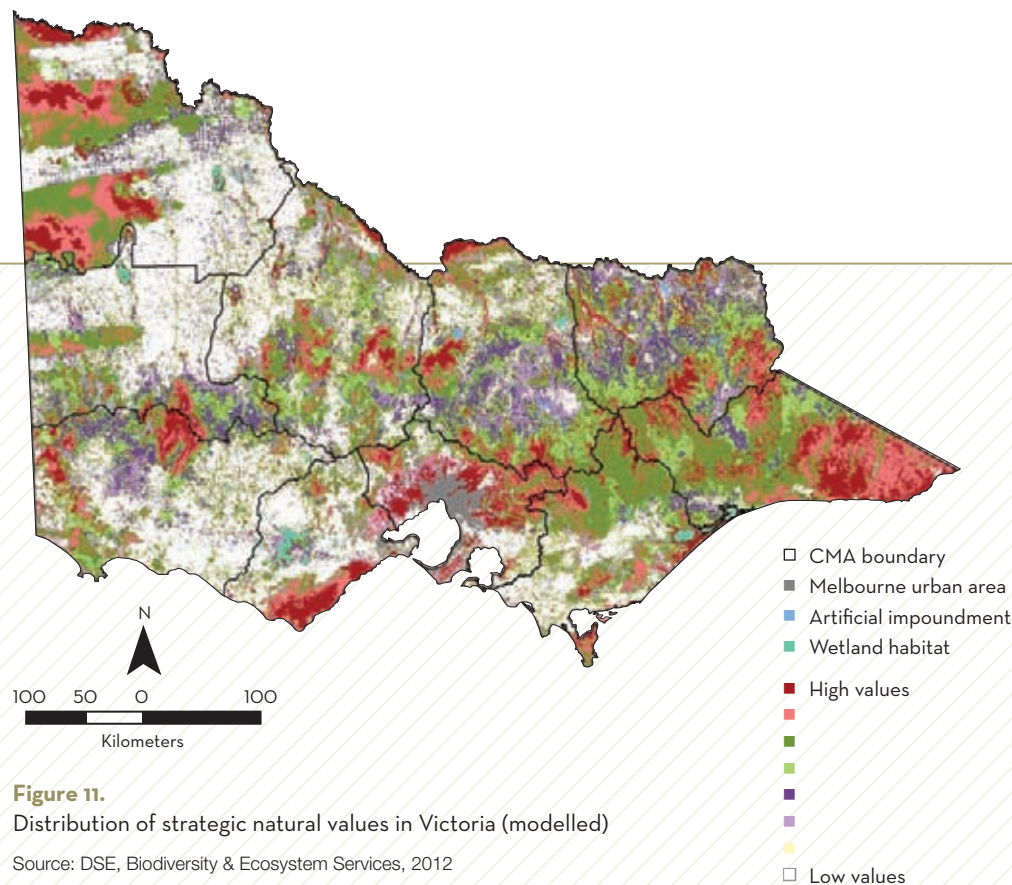


Figure 11.
Distribution of strategic natural values in Victoria (modelled)

Source: DSE, Biodiversity & Ecosystem Services, 2012

- how threats to species are likely to operate at landscape scales; and
- where re-establishment of habitat and/or relocation of populations is likely to be useful and feasible.

NaturePrint simultaneously takes into account the needs of a wide range of both plant and animal species, allowing natural resource managers to identify the most robust and efficient opportunities for biodiversity conservation.

Figure 11 provides an example of the information that can be generated from *NaturePrint*. Areas that appear as red, pink and dark green signify high value areas where effort to retain existing habitat can be most efficiently directed. Areas of light green, purple and mauve signify areas where effort to re-establish habitat for improved connectivity and adaptation can be most efficiently directed. The information can also be used to identify the importance of these areas for different species as a part of biodiversity planning and management.

Source: DSE (2011a)

Indicator 2.2 – Threatened plant and animal populations

Indicator definition

This indicator reports on estimates of current condition of, and level of threat to, a sample of threatened plant and animal populations and communities in Victoria.

Why do we use this indicator?

It is not possible to determine the status of all plant and animal populations in Victoria, given our limited knowledge of many species. This indicator provides an insight into particular threatened plant and animal populations, and may be considered a surrogate indicator for the general condition of plant and animal populations in Victoria.

Data quality rating

DSE's 'Actions for Biodiversity Conservation' system is designed to store information on the management of Victoria's threatened species, communities and threatening processes (DSE 2009c). DSE has developed Bayesian models as part of this system for a range of threatened plant and animal populations. Populations are selected from across Victoria and are generally those considered by DSE to be of high priority for management. Empirical data and expert opinion are used to estimate the current condition and overall level of threat to populations of a species or community in its habitat. This information is then combined and modelled to reflect the status of a population or community at a given point in time. The models are continuously refined as more information on particular populations becomes available (Moorrees & Lucas 2012 unpubl.).

One of the major benefits of the models is that they incorporate the uncertainty that inevitably exists in the natural environment. The models provide a set of probabilities that a population status is good, fair or poor rather than yielding an unequivocal result. The models can be used to predict which

management actions are likely to be more effective in mitigating threats and improving condition, making them a useful tool for prioritising management actions.

Ninety models are completed as of June 2012. This includes 49 terrestrial and freshwater animal populations (10 mammal, five bird, six amphibian, 14 reptile, eight fish and six invertebrate populations), 36 plant populations and five plant communities. There are more than 1,500 populations or occurrences of threatened species and communities included in the ABC system, so a sample of 90 equates to less than 6% of the total. Significantly more models are expected to be completed by late 2013. All models will be updated on a frequent and ongoing basis as new information on threatened populations becomes available.

Data available to assess change? **N/A**

This is the first time that DSE has developed this type of model for threatened plant and animal populations in Victoria. The models will provide a benchmark for detecting long-term changes in the status of threatened plant and animal populations. The analysis of trends in condition of populations will be somewhat limited until the number of models increases.

Statewide condition and trend



To date, DSE has modelled the current condition of, and level of threat to, 90 threatened plant and animal populations and communities in Victoria. Populations include the Spot-tailed Quoll, Eastern Barred Bandicoot, Southern Bent-wing Bat, Leadbeater's Possum, Regent Parrot, Red-tailed Black Cockatoo, Growling Grass Frog, Striped Legless Lizard, Eltham Copper Butterfly, Golden Sun Moth, Australian Grayling, Barred Galaxias and orchid and grassland communities.

Tables A1, A2 and A3 summarise the status of these threatened populations within their habitat and the level of threat to these populations, as of June 2012.

Table A1.

Condition of, and level of threat to, 90 plant and animal populations in Victoria, June 2012

Condition of populations within their habitat	Level of threat				Total
	Severe	Moderate	Negligible	Inconclusive	
Good	2	2	27	3	34
Fair	3	4	7	1	15
Poor	26	3	0	5	34
Inconclusive	2	0	4	1	7
Total	33	9	38	10	90

Table A2.

Condition of, and level of threat to, 49 animal populations in Victoria, June 2012

Condition of populations within their habitat	Level of threat				Total
	Severe	Moderate	Negligible	Inconclusive	
Good	1	1	15	2	19
Fair	2	2	2	0	6
Poor	16	3	0	2	21
Inconclusive	1	0	2	0	3
Total	20	6	19	4	49

Table A3.

Condition of, and level of threat to, 36 plant populations in Victoria, June 2012

Condition of populations within their habitat	Level of threat				Total
	Severe	Moderate	Negligible	Inconclusive	
Good	1	1	9	1	12
Fair	0	1	5	1	7
Poor	10	0	0	3	13
Inconclusive	1	0	2	1	4
Total	12	2	16	6	36

Source: DSE 2012

Tables A1, A2 and A3 shows that of the threatened species, populations and communities sampled, most are either in poor or good condition, and are generally considered to be under either severe or negligible threat. The most frequent combinations for both plant and animal populations are “good condition/negligible threat” and “poor condition/severe threat”. This reflects the obvious link between active threatening processes and declines in the viability of populations and occurrences.

Further analysis of the data for animal population (not shown here) indicates that amphibians are generally in greater peril than other animal groups – five of the six amphibian populations sampled are considered in poor condition. Many populations in remote areas are threatened by the disease associated with the Chytrid Fungus.

Native fish populations were generally in poor condition during the recent drought, including species such as the Murray Hardyhead, Australian Grayling and Macquarie Perch. The two subsequent wet years have led to improvements in the condition status of some populations of these species. Conversely, the wet

conditions in northern Victoria have led to deteriorating habitat conditions for the Hooded Scaly Foot, a small reptile that occurs on the northern plains in grassland habitat. Excessive native plant and weed growth is reducing the inter-tussock spaces required by this species for habitat.

Victoria’s 2009 bushfires were another significant event for some threatened species populations. A healthy population of Leadbeater’s Possum existed on the Lake Mountain plateau prior to the bushfires, but only two individual animals were known to have survived post-fire. While it is likely that this area will be recolonised by Leadbeater’s Possum over coming decades, this might be a slow process. Another impact of the bushfires is the risk of sudden “slugs” of sediment passing down rivers and streams following substantial rainfall on the exposed, post-fire soils. Populations of Barred Galaxias and Macquarie Perch were brought into captivity to avoid such an outcome following the 2009 bushfires. These fish have subsequently been returned to the wild and appear to be surviving.

CASE STUDY

2

From little things...big things grow

The Mountain Pygmy Possum (*Burramys parvus*) is a cold-climate specialist restricted to alpine and sub-alpine areas in south-eastern Australia. Three isolated, genetically distinct populations occur at Bogong High Plains, Mount Higginbotham and Mount Buller in Victoria and Mount Kosciuszko in New South Wales. The Mountain Pygmy Possum is nationally endangered.

The Mount Buller population of Mountain Pygmy Possum experienced a rapid decline in numbers from the mid-1990s. The decline was due to habitat destruction and fragmentation and increased predation by foxes and cats. From around 2004, DSE carried out programs to reconnect Mountain Pygmy Possum habitat and to control predators, but the population did not respond. The drop in population numbers was paralleled by a drastic decline in genetic diversity, one of the most rapid declines ever recorded for a mammal. By 2006, only 30 animals were estimated to remain at Mount Buller and, as these were almost all females, extinction was imminent.

'Species translocation' is the capture and release of wild animals from one location to another. In late 2010, DSE translocated six adult male Mountain Pygmy Possums from Mount Higginbotham to Mount Buller to allow cross-breeding in the wild. The program was successful and other males from Mount Higginbotham were introduced to Mount Buller in September 2011. In January 2012, half of the young Mountain Pygmy Possums captured at Mt Buller were fathered by a male from Mount Higginbotham. This was the first time that a 'genetic rescue' through translocation had been successfully carried out in Australia.

Climate change is likely to compound existing stresses on plant and animal populations and reduce the capacity of natural adaptive processes (Mackey *et al.* 2008). Isolated and genetically depleted populations, such as those of the Mountain Pygmy Possum, are particularly at risk. Translocation may provide a cost-effective technique to conserve genetic diversity and improve the genetic 'robustness' of wild populations in a changing climate.



Above:
Mountain Pygmy Possum (*Burramys parvus*)

Source: DSE (2011)

Indicator 3.1 – Soil health

Indicator definition

This indicator should report on soil health across Victoria. Data are limited, however, and only threats to soil health can be reported.

The term ‘condition’ is often used interchangeably with ‘health’. However, as explained in the Guidelines for the Australian Environmental Accounts Trials Stage 1 (Australian Natural Resource Management Groups 2012), the ‘condition’ of an environmental asset can be considered to be determined through direct measures, whereas an interpretation of an environmental asset’s ‘health’ can be determined by expert opinion through scientific assessment of combined measures of condition. That is why the term soil ‘health’ is used in this section.

Why do we use this indicator?

Soil underpins the sustainability and productivity of the land, and its health is paramount. Robust soil health is essential to provide a full range of ecosystem services and to maintain productivity.

Data quality rating

There are insufficient modelled or actual data to report on soil health at a statewide level, and existing data are often patchy or out of date. There are no benchmarks of soil health for different soil types in Victoria. Unless soil condition can be related to a benchmark value, soil health cannot be properly evaluated. While the development of a soil health index has been proposed, its components have not been identified.

Data available to assess change?

As indicated above, there are insufficient historical or current data to report on changes in soil health at a statewide level.

Statewide condition and trend ?

Soil health is defined as the condition of the soil relative to its inherent or potential capability to sustain biological productivity, maintain environmental quality and promote plant and animal health (MacEwan *et al.* 2011). It is not possible to give a universal set of chemical, physical and biological characteristics for healthy soil – it varies depending on the inherent qualities of the vast array of soils that exist. Soil health is therefore a relative condition – one definition is that soil is healthy if its functional capabilities are not impaired (MacEwan *et al.* 2011).

Soil health can be inferred by comparing its soil condition against a reference or 'natural' condition (using measurements from undisturbed sites and data from published literature and modelling). Soil condition can be assessed using indicators such as erosion, soil salinity and acidification, soil structure and soil organic carbon. The condition of these indicators is reported on, where possible, in the next section. However, there is currently no baseline 'reference' condition for each indicator. The lack of benchmarks makes it difficult to determine the change in soil condition from a natural state, and to provide a subsequent soil health rating.

The NSW Office of Environment and Heritage has recently developed a Soil Condition Index using soil condition data and theoretical benchmarks (see Chapman *et al.* 2011 for further detail). A similar process is recommended for Victoria.

DPI is progressively compiling data from past soil surveys and field experiments into the Victorian Soil Information System database (VSIS, an internal DPI database) (see www.vro.dpi.vic.gov.au for more information). In the longer-term, the VSIS is anticipated to provide support for the development of soil health indicators.

The following section reports on four chemical and physical parameters as surrogates for soil health: soil salinity and acidification, erosion and soil organic carbon. This includes recent work on dryland salinity, threat of erosion and soil organic carbon levels undertaken by DPI and DSE.

Dryland salinity

Dryland salinity occurs when soil and vegetation is degraded by the discharge and concentration of soluble salt through evaporation of saline groundwater. It commonly occurs when the saline

groundwater rises to within two metres of the ground surface. It is a key process that affects soil health – it can reduce the capacity of soils to support plant growth, a major hazard to agricultural productivity.

DPI estimates that around 252,700 hectares of soil in Victoria are affected by dryland salinity. Substantial areas of Victoria's north (particularly the Mallee) and west, and near Sale in the state's east, are affected.

Figure 12 represents a collation of data compiled by DPI from 1976 to 2011 for dryland salinity. Note that the map excludes small areas and also irrigation areas affected by salinity. Collection of the data that support this map has been *ad hoc* and infrequent, with some sites recorded only once and others regularly checked (Clark 2011). This approach has produced a fragmented collection of data that is unable to provide a complete picture of soil salinity (Clark 2011). This variability also means that older data in particular may not accurately indicate the current extent of salinity at various sites. Clark (2011) notes that there has been little funding available to benchmark the spatial extent and severity of soil salinity and monitor changes over time at a statewide level.

The spread of dryland salinity in Victoria slowed during the recent dry period due to lower groundwater tables, although many incidences of dryland salinity still occurred during the drought (Gill *et al.* 2012). This trend was observed at a sub-catchment scale. For example, DPI re-examined sites in north-central and western Victoria where soil salinity extent and severity had previously been mapped. DPI found that the extent and severity of soil salinity in all sub-catchments decreased between the late 1980s and 2008. Due to changes in the survey method, it was difficult to quantify changes in salinity over time. It is anticipated that the study will provide a benchmark for future assessments at a sub-catchment scale (Clark 2011).

The area affected by dryland salinity is likely to increase with the recent return to wetter conditions, due to more water being available to drive salinity processes. This has renewed the threat that salinity poses to agricultural productivity and land and water resources (Gill *et al.* 2012). It is important to monitor future trends to determine the effect of long term changes in our climate and land use/management on the extent and severity of soil salinity.

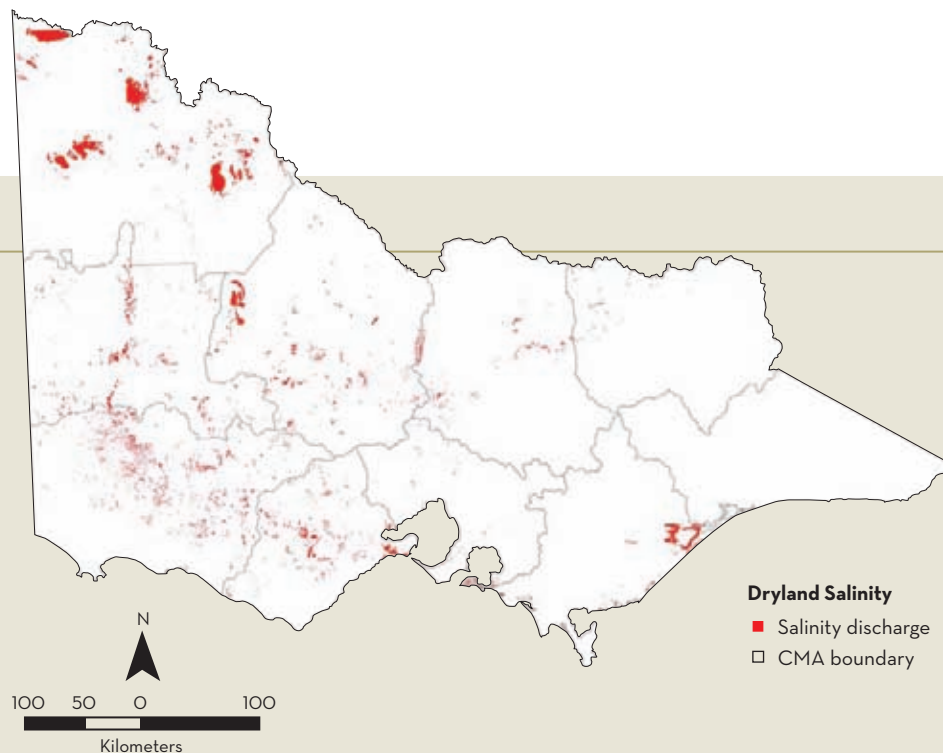


Figure 12.
Estimate of area affected by dryland salinity in Victoria (data from 1976-2011)

Source: DPI Corporate Geospatial Data Library 2012

Soil acidity and acidification

An acid soil is one with a pH significantly less than seven – strongly acidic soils are defined as those having a pH less than 4.5 (in water), with a pH of 7 being neutral. The ideal soil pH for most plants is slightly acidic with pH 5.5 to 6.5, although many will tolerate pH 5.5 to 8.5; pH tolerance varies between and within plant species.

The distribution of acid soils across Victoria's agricultural land was last mapped by DPI in 1996. This map was generated from soil test results from the State Chemistry Laboratory from 1973 to 1994, and provides an estimate of surface soil pH at a statewide scale (Crawford *et al.* 2011). As reported in the CCR 2007 (p134-135), the pH of Victoria's surface soils ranged from pH 4 (acidic) to pH 10 (alkaline). Surface soil pH was generally acidic in the

eastern and western uplands, the Strzelecki and Otway Ranges and north-eastern Victoria. Soil pH was high (i.e. alkaline) in north-western Victoria, in the Mallee and the Wimmera (VCMC 2007). Approximately 23%, or 3,000,000 hectares, of Victoria's agriculturally productive soil were affected by soil acidification (VCMC 2007; Crawford *et al.* 2011).

Many of the soils in Victoria are naturally acidic but pH has declined due to changes in land use from natural ecosystems to agriculture and the effects of some land management practices. More information is needed on induced acidification as distinct from natural variation in soil pH. It is unclear whether natural ecosystems are "stressed by" or in "natural equilibrium" with the current soil pH (Crawford *et al.* 2011). Species differences in the preferred ranges of soil pH shown by plants and soil biota can complicate this assessment.

Data on the spread of soil acidification in Victoria are very limited, particularly in areas containing irrigated agriculture, native vegetation and forest plantations (Crawford *et al.* 2011). There is no extra information on the rate or level of soil acidification (either surface soil pH or subsoil pH) at

a statewide level since the CCR 2007. Available estimates from the 1990s are likely to be dated given changes in agricultural practices. Our current understanding is hampered by a legacy of lack of data and long-term monitoring programs. This lack of data represents a critical deficiency in managing soil acidification (Crawford *et al.* 2011).

Expert opinion suggests that soil pH has generally decreased since the 1990s due to the prolonged drier conditions. This trend is variable – low soil pH in high rainfall areas has been largely ameliorated through management, but soil pH has increased in moderate rainfall areas with slight and moderate acidity due to access to agricultural lime.

Threat of wind and water erosion

Erosion is a natural process that is accelerated by factors such as increased water flows, and by land management practices that disturb the soil or leave it with a poor vegetative cover. Topsoil erosion limits the capacity of soils to support plant growth, affecting native ecosystems and agricultural productivity. Land management practices such as stubble retention can

reduce the threat of erosion. A high threat of erosion is regarded as undesirable.

Assessing the extent of soil erosion (for example, through direct measurement of soil loss) is technically impractical at the statewide scale due to the high variability in soil erosion events. DPI has used satellite imagery to model areas in Victoria under threat⁴⁵ from water and wind erosion, between 2001 and 2009. The erosion modelling incorporates information on both land use and the underlying susceptibility of soil to erosion. As shown in Figure 13, about half of the state is classified as being under very low to low threat of wind erosion, while about one-quarter is classified as being under a moderate threat. Less than 10% of the state is classified as being under high to very high threat of water erosion, with most of the state classified as being under very low to low threat.

⁴⁵ 'Threat' in this instance is defined as a "source of danger or harm to the condition of natural resource asset or the services it may provide" (MacEwan *et al.* 2011).

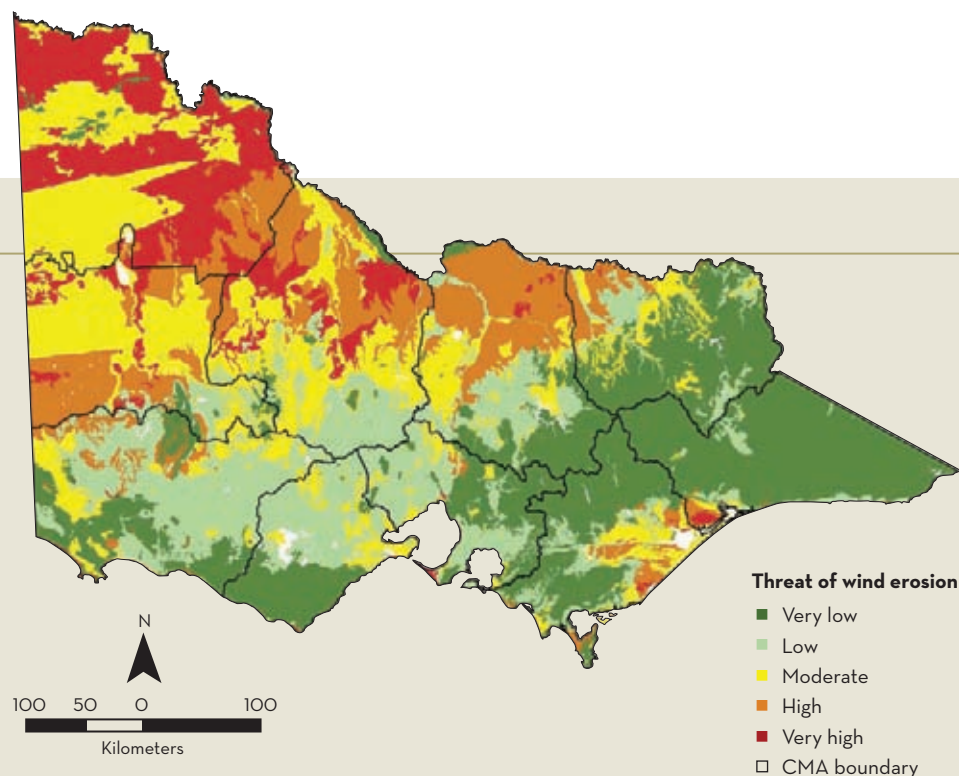


Figure 13.
Cumulative threat of wind erosion in Victoria
(modelled)

Source: MacEwan *et al.* (2011) Soil Assets and
NRM Investment Final Report

The lack of strategic, long-term monitoring makes it difficult to detect trends in soil erosion (or the threat of erosion) over time. Expert opinion indicates that the recent drought conditions experienced across much of Victoria reduced the threat of water erosion, primarily in cropping regions. However, the extended dry period made it extremely difficult to protect soil from wind erosion – bare ground is a common feature in drought-affected areas due to lack of

crop growth, very short stubble and so on, and any rainfall that occurs during the drought can cause erosion. Conversely, the return to wetter conditions improved the amount of ground cover, reducing the threat of wind erosion.

Level of soil organic carbon

Soil organic carbon is a measure of leaf litter, plant roots, branches, organisms and manure incorporated in soil (Walcott *et al.* 2009). It is a primary determinant of soil structure and its stability and is a key factor in soil water-holding capacity and water availability. Measurements of the amount of soil organic carbon can be made at various soil depths along with bulk density (mass per unit volume of soil) (Swift 2001, cited by Walcott *et al.* 2009).

Limited detailed information on soil carbon levels exists in Victoria, and it often does not differentiate the inorganic forms (e.g. limestone) from the organic forms. Soil carbon (both organic and inorganic) levels in topsoils (up to 30 cm in depth) in Victoria are relatively high compared with some other parts of Australia, although they remain low by world standards. Soil organic carbon levels are usually higher in high rainfall regions and higher under pasture than under cropping (Environment and Natural Resources Committee 2010). Figure 14 shows relative amounts of total soil carbon as modelled by DSE using the FullCAM model (see Webb (2002) for more information) across Victoria's publicly managed land.

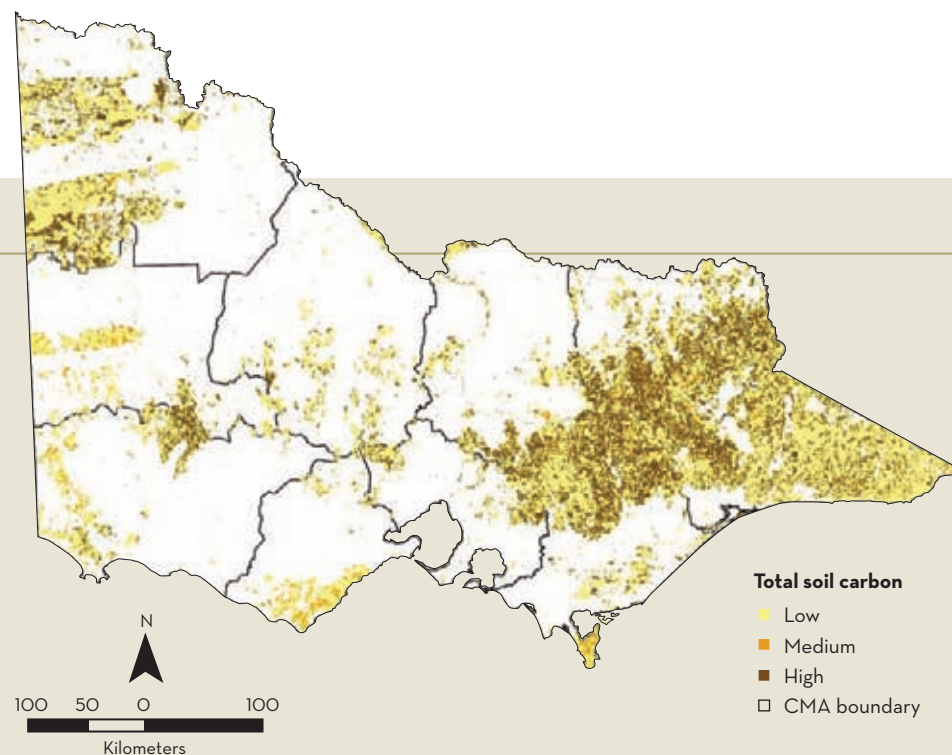
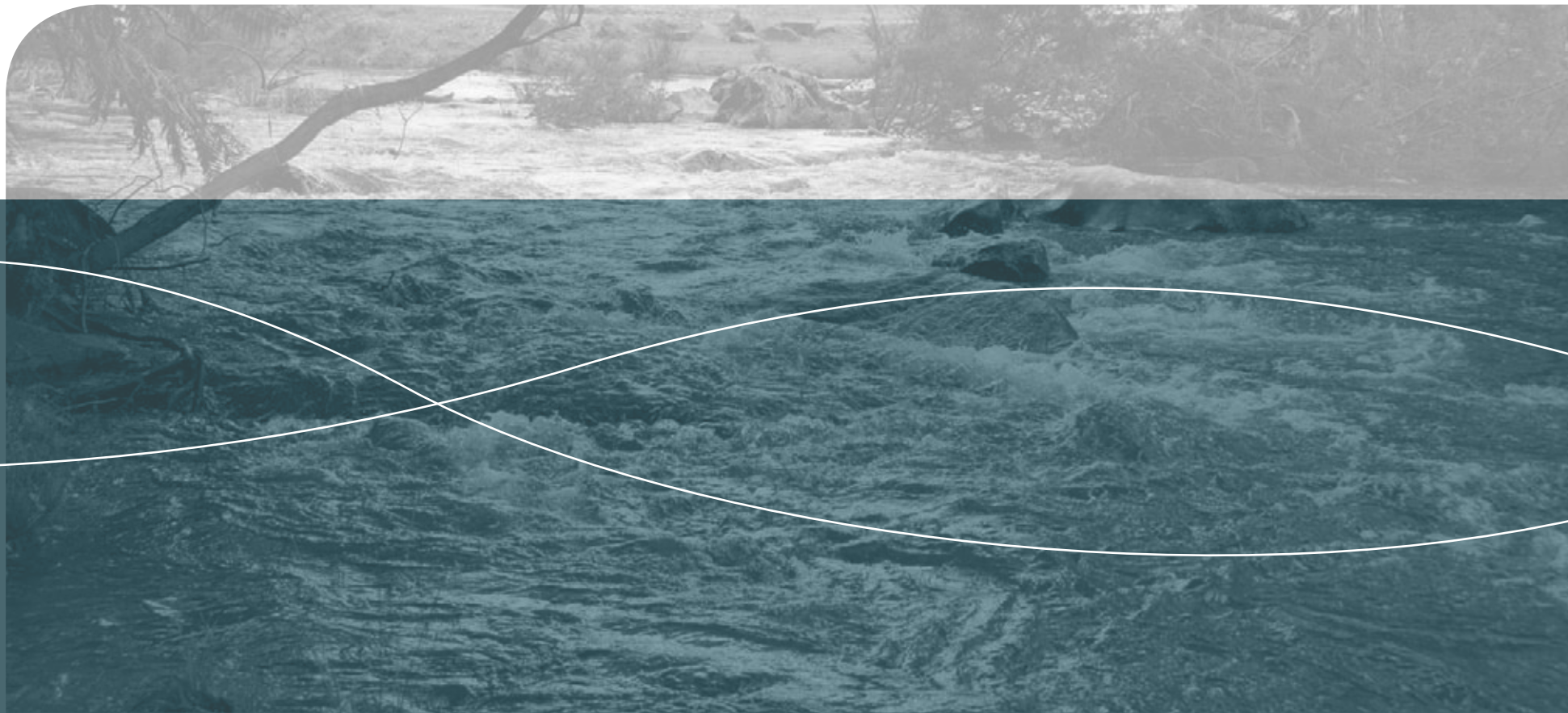


Figure 14.
Amount of total soil carbon in Victoria's public lands (modelled)

Source: DSE LandCarbon Project 2011

Higher amounts of soil carbon generally indicate more healthy soils. Increasing amounts of soil organic carbon will generally benefit soil health and agricultural productivity (Walcott *et al.* 2009). Soil organic carbon is the fuel for soil ecosystem activity and hence its level will be the primary determinant of potential activity of soil organisms. Depletion of soil organic carbon leads to soil lassitude and reduction in resilience. Specific levels of soil organic carbon are not easy to determine as the measurement of soil organic carbon is technically complex and variability (in space and time) is high. It is also difficult to separate the influence of land uses and management practices under different climates and soil types (Environment and Natural Resources Committee 2010).

The Commonwealth Department of Climate Change and Energy Efficiency is currently developing detailed national benchmarks of soil carbon levels for different soils and management activities. DPI is currently establishing soil organic carbon benchmarks on a range of soil types and management practices for agricultural lands in Victoria as part of the national Soil Carbon Research Program undertaken by CSIRO.



Theme 4: Rivers and streams	55
Theme 5: Wetlands	61
Theme 6: Groundwater	66

Theme 4: Rivers and streams

4

Indicator 4.1 – Stream flow

Victoria's rivers and streams provide riparian and aquatic habitat, supply ecosystem services and support our agricultural and industrial sectors. They supply drinking water and provide important opportunities for recreation and social interaction. If the condition of rivers and streams declines, so do these benefits.

This section reports on surface water flows (Indicator 4.1) and the condition and rivers and streams across Victoria (Indicator 4.2).

Indicator definition

This indicator reports on Victoria's average stream flows as a percentage of long-term average flows. Information in this section is summarised from the report *Victorian Water Accounts 2009-10* (DSE 2011b).

Why do we use this indicator?

Effective management of water resources to meet current and future urban, rural and environmental needs requires knowledge of how much water is where, who uses it and how this changes over time.

To manage water use sustainably it is important to ensure that there are sufficient flows to maintain river and floodplain environments. Data on stream flows are also used by industry and agriculture sectors and water corporations to ensure sustainable water use planning from a range of diverse water sources.

Data quality rating ◆

Continuous data are collected at surface water monitoring stations. Gauging stations were initially installed during the 1880s, further augmented across the state and regularly updated when technology improved from daily reading of results through chart recorders in the 1950s to fully automated sensors and downloadable data loggers. Data from these stations are incorporated into the Victorian Water Accounts and used by water corporations and CMAs, including for flood monitoring purposes.

Data available to assess change? ■

While methods of data collection have changed over the extended period of record, data are comparable across the period from the one site. The data are collected and collated as a public resource to be used in many reporting products from DSE, other data users and consultants.

Victoria's surface water monitoring program started with the *Irrigation Act 1886*, with the collection of stream flow data formally included in legislation in 1890. It is still part of the Minister for Water's obligations under today's legislation, the *Water Act 1989*,

which requires the Minister to ensure the delivery of a continuous water resource assessment program.

Four hundred and fifty four sites have continuous data records of water levels, volumes and/or water quality that are more than 15 years long, with a number of sites with continuous records of over 100 years.

Statewide condition and trend

● ▲ (post-2010)

Local factors such as sub-surface geology, soil permeability and moisture levels, vegetation cover and the pattern of individual rainfall events all influence how much rainfall ends up as stream flow (DSE 2011b). However, many years of low rainfall between 1997 and 2010, a lack of individual 'wet' years, increased temperatures and changes in seasonal rainfall patterns, led to a significant decline in stream flow across many catchments particularly in central and western Victoria. Extraction volumes also impact on stream flow volumes. Further information on water extraction for consumptive and environmental use is provided in the report *Victorian Water Accounts 2009-10* (DSE 2011b).

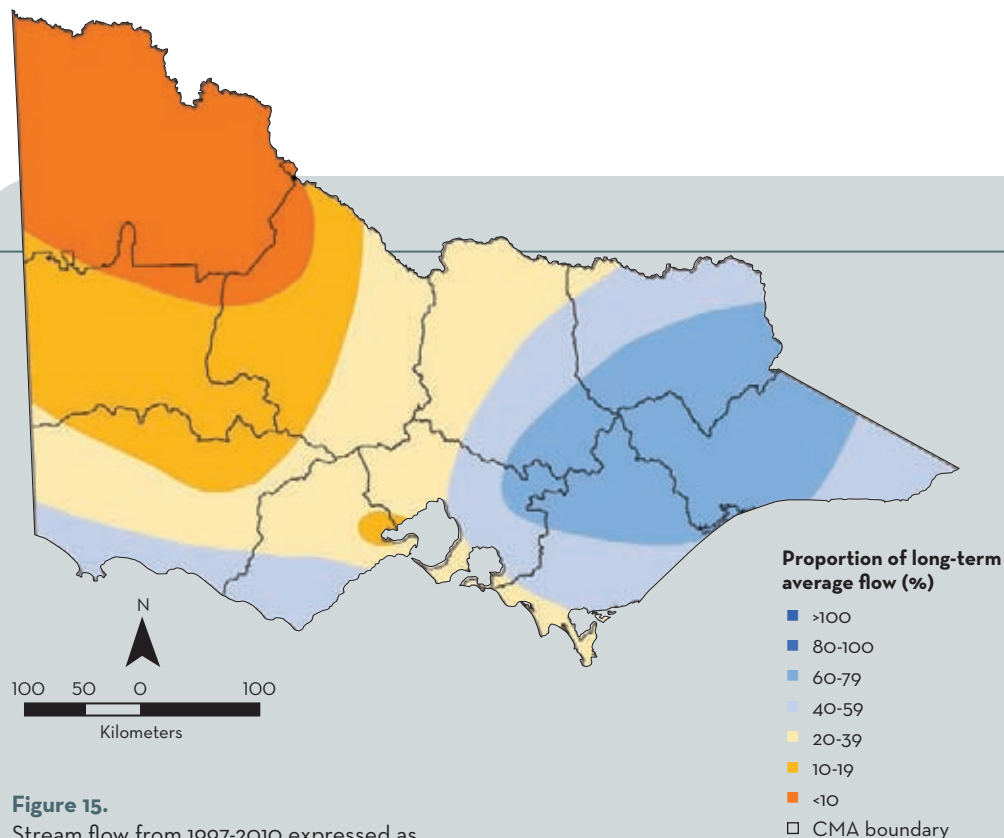


Figure 15.

Stream flow from 1997-2010 expressed as a percentage of long-term average flow. Discharges are in megalitres (ML)

Source: DSE (2011) Victorian Water Accounts 2009-10

Figure 15 shows stream flows from 1997 to 2010 across Victoria expressed as a percentage of long-term average flow. Even when rainfall was higher in 2010 than in the preceding drought, stream flows in many catchments across the state were slow to respond, given the dry condition of the catchments after many low rainfall years and above average temperatures (DSE 2011b).

Many Victorian catchments experienced some of the lowest stream flows on record (Kiem & Verdon-Kidd 2010): by 2009, stream flow volumes were 32% of the long-term average (DSE 2012b). Many environmental water rights across Victoria were qualified during the drought to augment consumptive supply, and all of these expired by mid-2011. Interestingly, the reductions in flows in Victoria since the mid-1990s exceeded climate change projections for 2030 (Sinclair Knight Merz 2009).

CASE STUDY

Environmental watering of Lake Carpul

The Victorian Environmental Water Holder (VEWH) is an independent statutory body responsible for holding and managing Victoria's environmental water entitlements to improve the environmental health of rivers, wetlands and floodplains. VEWB decides on the most effective use of the Water Holdings, including use, trade and carryover, and authorises waterway managers to implement watering decisions.

CMAs and Melbourne Water are VEWB's key partners, engaging with public land managers and storage operators as well as being the direct link with local communities, ensuring that environmental watering protects the environmental values of most importance to the community.

The first year of VEWB operations saw two seasonal watering plans and 46 seasonal watering statements released, authorising priority watering actions to be implemented across Victoria. This equated to 35 river reaches and 10 wetland and floodplain sites being watered with a total of 516,000 ML of environmental water, protecting and enhancing key environmental values, including a project at Lake Carpul.

Lake Carpul is located about 15km southeast of Robinvale, adjacent to the Murray River. The last time Lake Carpul was inundated was in 1993 as a result of Murray River flooding. The lake has been dry ever since. The lake is dominated by a black box community that generally requires watering one in every eight years. Lake Carpul was assessed in the 2009 Index of Wetland Condition survey as being in the best condition out of all sites assessed in the Mallee despite the long absence of water. This lack of water was causing deterioration of the vegetation condition. Without the pumping of environmental water into the lakes, the condition of the lake would continue to decline.

VEWB authorised the pumping of 2,060 ML into Lake Carpul, from mid-December 2011 to early June 2012, based on a proposal by the Mallee CMA. This water ensured the environmental values at Lake Carpul were maintained while the Mallee CMA investigated a works program to make future watering more efficient. The Mallee CMA worked with the surrounding landholders, local community, indigenous groups, water corporations and the VEWB to deliver this water.



As a result of the watering, the Mallee CMA noted an amazing response from waterbirds with over 20 species recorded, including the Blue-Billed Duck and Great Egret. The surrounding area also saw benefits with the river red gums and black box trees around the lakes flourishing and the surrounding environment becoming much healthier, as shown in the photographs.

Indicator 4.2 – River and stream condition

Indicator definition

Stream condition is measured through the Index of Stream Condition (ISC). The ISC is an integrated measure of the overall condition of a river/stream reach based on the assessment of five component sub-indices – hydrology, water quality, physical form, streamside vegetation and aquatic life. It is a measure of a stream's change from a natural or ideal condition.

Why do we use this indicator?

The Index of Stream Condition provides a generally consistent, integrated method for reporting on the condition of rivers and streams in Victoria. The use of condition benchmarks allows for comparisons over time.

Data quality rating ◆

The ISC is a statewide, integrated measure of river and stream condition in Victoria. The third ISC has seen improvements in on-ground data collection techniques and data analysis methods. New measures such as 'drought slices' (which effectively allow the impacts of the drought on hydrology to be separated from human impacts) have been added.

Data available to assess change? ■

Two statewide assessments of river and stream condition have been undertaken to date (1999 to 2004). The results from the third ISC will become available in late 2012.

The approach taken for the third ISC differs significantly from that undertaken for the second ISC in 2004. The major change is in the use of remote sensing – LiDAR (which records a three dimensional image of the earth's surface and vegetation structure – see www.csiro.au), and aerial photography – to assess the streamside zone and physical form components. As a result, instead of sampling at a limited number of random locations, coverage is continuous along an entire river reach and along both sides of the river. This will, for the first time,

produce an extremely comprehensive and accurate baseline for the streamside zone and physical form components of ISC across the state.

There are changes in the measurement and analyses of other components of the ISC. For example, water quality data will be considered over a five year period (2004 to 2009) rather than a single year. The aquatic life component is also more comprehensive. The hydrology data and models are updated, although they are no longer directly comparable with the results of the 2004 ISC hydrology component.

The revised approach makes it difficult to determine whether changes in condition over time are actual changes or changes due to the updated measurement and analysis techniques. While improvements to methodologies can increase the accuracy of condition data, benchmarks need to be held constant to be able to pick up actual trends.

Statewide condition and trend

East Victoria

● to ● (assume)

West Victoria

● (assume)

DSE's delivery of the results from the 2010 ISC has been affected by delays in the remote sensing work due to poor weather, and to the complexities of data analysis. Some preliminary results from the ISC assessment are available, and these are reported below.

The third ISC includes an assessment of the impacts of drought and human intervention on stream flows (known as 'drought slices') across Victoria. Table A2 shows that drought has had a greater overall impact on stream flow across Victoria than management activities. While this is perhaps not surprising, this is the first time that data are available to separate and quantify the impact of drought on stream flows.

Table A2 provides a summary of the impact of drought and human intervention on stream flow at a regional level. While informative, regional level data can mask the variation that occurs at the stream

Table A2.

Average reduction in Flow Stress Ranking (FSR)*
(% reduction in total FSR score) due to drought and management

CMA	Reduction in FSR score due to drought (average %)	Reduction in FSR score due to management activity (average %)
North East	31	2
Goulburn Broken	35	5
North Central	39	4
Wimmera	36	7
East Gippsland	33	0
West Gippsland	26	3
Port Phillip	34	7
Corangamite	37	3
Glenelg Hopkins	44	13

*Flow Stress Ranking (FSR) is based on five indicators – low flow, zero flow, high flow, seasonality and variability. The combination of these five indicators provides a measure of the hydrologic stress in a river. The FSR is based on at least 25 years of monthly flow data. The maximum FSR score is 10.

reach level. For example, while the Glenelg Hopkins CMA has the highest change in score due to drought, the reaches with the highest change in score due to drought are the Glenmaggie Creek (West Gippsland CMA), Painkalac Creek (Corangamite CMA)

as well as the Shaw and Eumeralla Rivers (Glenelg Hopkins CMA). Both climate and management activity can have an equally high impact as is the case with the lowest reach of the Goulburn River.

Estuary condition

Estuaries are where freshwater from rivers and streams mixes with seawater from the inshore marine environment. They provide habitat for a range of plants and animals, including migratory birds, and vital breeding grounds for many species. Estuaries support recreation and commercial activities such as fishing, aquaculture and tourism.

Catchments are a major source of sediments, nutrients and a wide range of chemicals which move into estuaries and potentially out into marine waters. Estuarine influences vary along Victoria's coast: for example, some estuaries are closed for much of the time and others are permanently open, while catchment land use and population density also vary (State of Victoria, Victorian Coastal Council 2011). A better understanding of the links between catchments, estuaries and broader coastal waters to maintain marine ecosystem health on Victoria's coasts is required (State of Victoria, Victorian Coastal Council 2011).

Data on ecological components of Victoria's estuaries are currently sparse and incomplete. For example, biological data are available for only a few estuaries, nearly always based on one-off sampling or a very short time series (Barton *et al.* 2008). DSE is addressing this lack of data through development of the Index of Estuarine Condition (IEC), and undertaking the first statewide assessment of the condition of Victoria's estuaries. The Index of Estuarine Condition (IEC) is an integrated measure of the condition of estuaries in Victoria. It is based on the assessment of six key components of estuaries that contribute to their ecological condition, namely physical form, hydrology, water quality, sediment, flora and fauna.

Theme 5: Wetlands

5

Indicator 5.1 – Wetland extent

Wetlands in Victoria encompass natural lakes, floodplain billabongs, alpine peatlands and shallow freshwater and saline wetlands.

Healthy wetlands provide important habitat and breeding areas for native species, contribute to ecosystem services, water storage, flood mitigation, groundwater recharge and discharge, water purification and the retention of nutrients and sediments (Ramsar Convention Secretariat 2004).

This section reports on the extent of wetlands (Indicator 5.1) and condition of wetlands (Indicator 5.2) across Victoria.

Indicator definition

This indicator reports on the extent of wetlands in Victoria.

Why do we use this indicator?

Information on wetland extent can help determine the degree to which wetland ecosystems and their diversity are being maintained. Reduction in wetland extent occurs when wetland habitat is permanently lost (for example, through activities such as drainage or infilling). The loss of wetland habitat impacts adversely on wetland biodiversity.

Data quality rating

The first statewide geospatial inventory of wetland extent was developed through wetland mapping and surveys undertaken from the early 1970s through to 1994, with a statewide wetland map produced in 1994. Catchment Management Authorities and DSE undertook wetland mapping post-1994, but until recently this information was not incorporated into the statewide wetland dataset.

DSE has now incorporated those updated regional data into the statewide wetland dataset, and has also undertaken new mapping in south-west Victoria to produce an updated, more accurate 2012 inventory. Wetlands present in 1994 were presumed to still be extant in 2012. The updated inventory includes wetlands that were omitted from the 1994 inventory because they were too small (less than one hectare) or not detected with the available methods, and also corrects positional errors in the 1994 data. As a result, the boundaries of many existing wetlands are mapped more accurately than in 1994 (see Alluvium (2011) for more detail).

Data available to assess change? **N/A**

Data on the 1994 extent of wetlands were collected between the late 1970s and 1994. It is difficult to compare this with the 2012 dataset as it is often unclear from the data analysis whether changes in extent between 1994 and 2012 are due to actual changes (e.g. loss of wetlands or creation of artificial wetlands or the recent wet climatic conditions) or more accurate modelling which allows for better detection of wetlands than in 1994. Detecting changes in wetland extent is also challenging as it involves distinguishing between wetlands that are temporarily dry and those where habitat has been permanently lost.

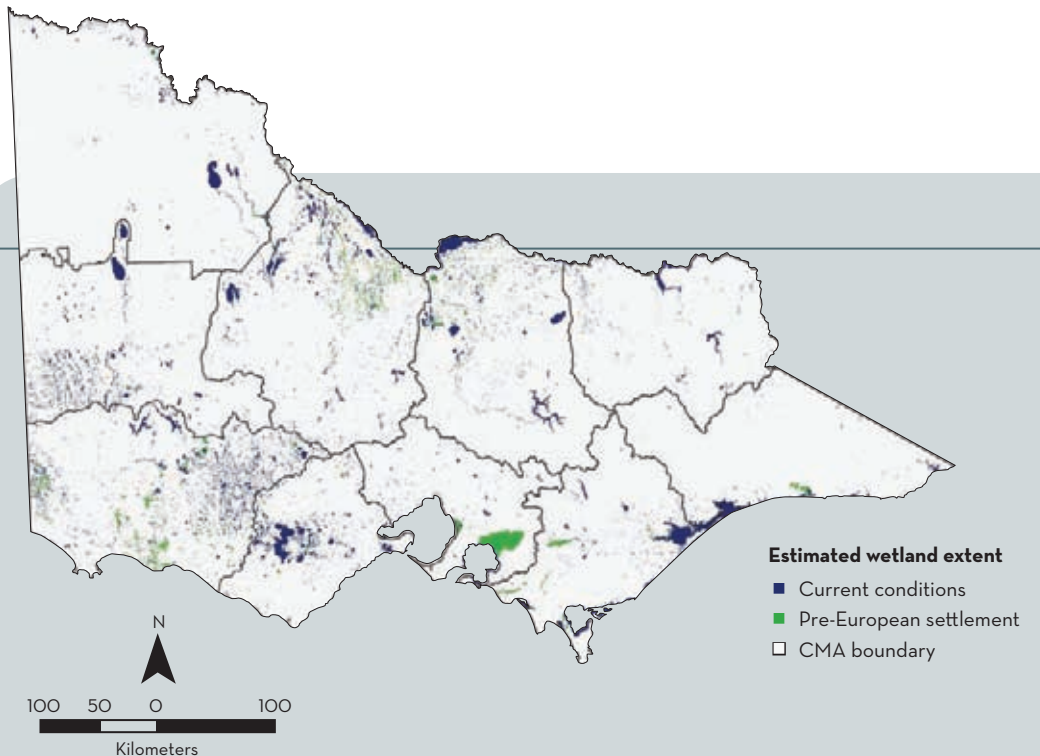


Figure 16.

Wetland extent in 2012

Source: DSE Wetland Inventory Update Project 2012

Statewide condition and trend

● ▼ (assume)

The current extent of wetlands in Victoria is shown in Figure 16. Many newly mapped wetlands are modified to some extent (dams and/or levees or cropped) (Alluvium 2011). The 'new' areas shown on the map in Figure 16 may represent new recordings of wetlands rather than actual new occurrences.

Indicator 5.2 – Wetland condition

Indicator definition

This indicator reports on wetland condition using the Index of Wetland Condition (IWC). The IWC provides a systematic, integrated assessment of the condition of non-marine influenced wetlands in Victoria. The IWC is based on the assessment of six sub-indices that are critical to the function of wetlands. These are:

- wetland catchment (intensity of land use and extent and fragmentation of native vegetation adjacent to wetlands);
- physical form;
- hydrology (wetland water regime);
- water properties (changes in salinity and activities that contribute to an input of nutrients into wetlands);
- soils (amount and severity of wetland soil disturbance); and
- biota (diversity, health and weediness of the native wetland vegetation).

The IWC uses a rapid assessment technique to score the condition of a wetland by comparing each of the measures that make up the index to a 'reference condition'. The reference condition is the estimated condition of wetlands at the time of European settlement, based on scientific knowledge and expert opinion.

Why do we use this indicator?

Changes in wetland condition (for example, through altered hydrology, water pollution, nutrient enrichment or pest plant and animal invasion) can lead to biodiversity loss and impair wetland functioning. Changes in wetland condition may be localised or may be indicative of broader changes in surface and groundwater flow regimes and catchment condition.

Data quality rating

Two statewide assessments of wetland condition using the IWC have been undertaken in Victoria, in high-value and representative wetlands. In total, 829 wetlands have been assessed (approximately 6% of the naturally-occurring, non-alpine wetlands in the state).

The first assessment occurred in 2009/10 following a period of extended drought. This assessment focused on 587 high value wetlands listed under the Ramsar convention, Directory of Important Wetlands Australia (DIWA) and high value wetlands in the Wimmera region (i.e. the Edenhope wetlands). The second assessment was undertaken in 2010/11 and followed a period of widespread and severe flooding. This assessment focused on 240 wetlands selected as representative of the range of Victorian wetland types. All assessments involved an on-site visit to score wetland condition using the standardised IWC method (see Papas *et al.* (2008) for more detail on method).

Data available to assess change? **N/A**

The Index of Wetland Condition is the first statewide assessment of wetland condition in Victoria. This assessment will provide a benchmark for detecting long-term trends in wetland condition, with the next condition assessment planned for 2017/18.

⁴⁶ High value wetlands are those recognised for their important environmental, social and economic values to the community and with the highest priority for management.

Statewide condition and trend



The following results from the IWC assessment of high value wetlands⁴⁶ and wetlands considered representative of broad Victorian wetland types are summarised from Papas and Moloney (2012).

Overall wetland condition

About half of the high value and representative wetlands assessed are in excellent or good condition (Figure 17). The remainder are largely in moderate to poor condition, with a very small number in very poor condition. The percentage of wetlands in excellent or good condition following the extended dry period reflects the degree of wetland resilience and effectiveness of management at these wetlands. A higher proportion of wetlands were in good or excellent condition on public than on private land.

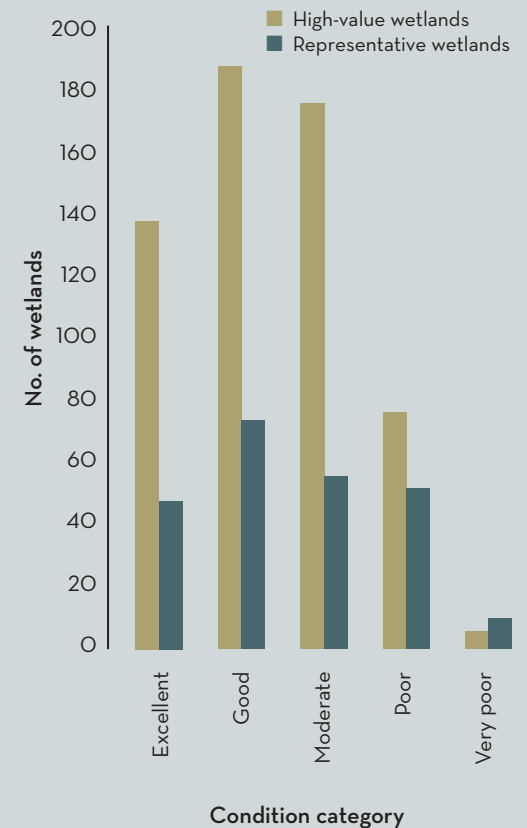


Figure 17.
Overall condition of wetlands in Victoria

Source: Papas and Moloney (2012 in prep) Victoria's wetlands 2009-2011: statewide assessments and condition modelling

Wetland condition by category

An analysis of the main components of wetland function reveals that most wetlands assessed had largely unaltered physical form, relatively unmodified soils and no change to the original salinity of the wetland (Figure 18). However, about one third of high value wetlands have a substantially altered water regime, largely due to river regulation. Nearly half of representative wetlands had a wetland catchment in very poor condition. Many wetlands contain vegetation in moderate to very poor condition, a likely result of changes in water regime, grazing by livestock, cropping and weed invasion, and exacerbated by the recent drought.

There were many more representative wetlands in excellent condition on public land than private land at the sub-index level for biota (vegetation), soils, wetland catchment, physical form and water properties. Wetland condition and the condition of all sub-indices except biota (vegetation) is significantly higher for high value wetlands than representative wetlands in Victoria.

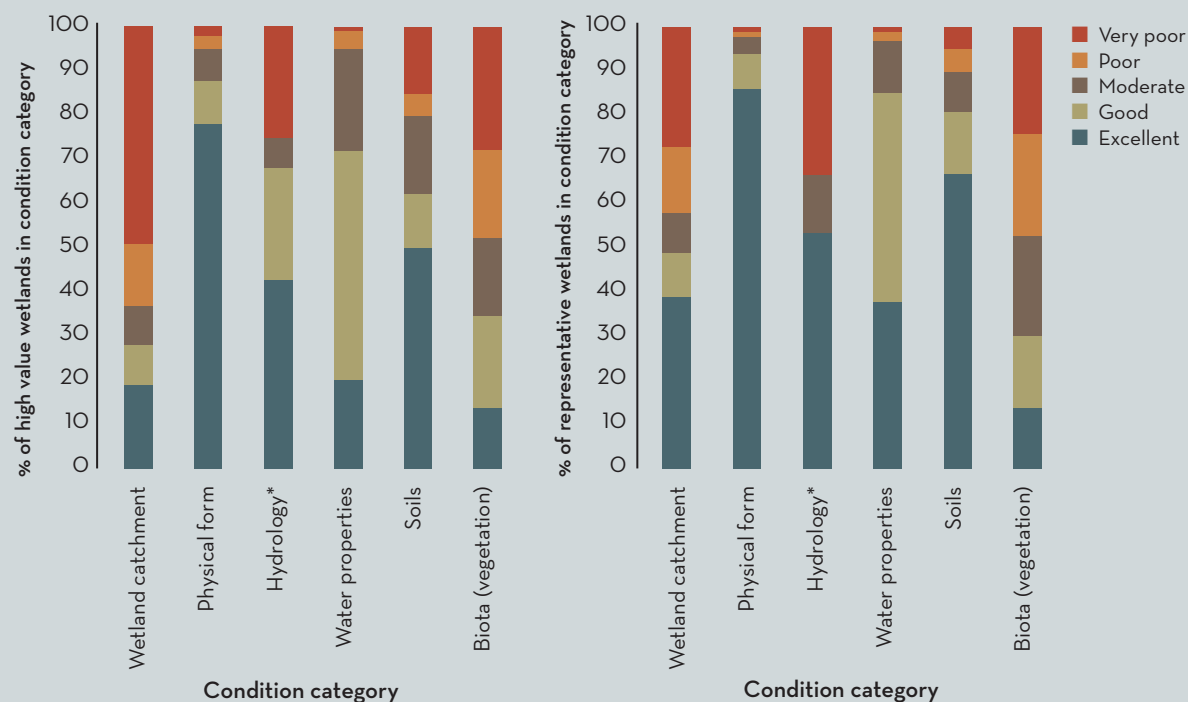


Figure 18. Condition of high value wetlands (left) and representative wetlands (right) for each sub-index of the IWC (% of wetlands in each category)

*Hydrology measure has three possible condition categories only

Source: Papas and Moloney (2012 in prep) Victoria's wetlands 2009-2011: statewide assessments and condition modelling.

The most prevalent threats to representative wetlands were non-point source runoff, livestock grazing, pugging by livestock and feral animals, excavation of the wetland bed, a change to the flow regime of the wetland's water source and landforming (e.g. levelling). Almost all threats were more prevalent at wetlands on private land than on public land.

Theme 6: Groundwater

6

Indicator 6.1 – Groundwater level

Groundwater is water that exists in the spaces and fractures in rock and sediment beneath the surface. It originates as rainfall or snow, and then seeps from the surface into the groundwater system, where it eventually makes its way back to surface rivers and streams, lakes and wetlands and the ocean.

Groundwater is an integral part of the water cycle. It is a significant and valuable component of Victoria's water resources. It provides base flow to rivers and streams and supports wetlands, other groundwater dependent ecosystems, agriculture and domestic and urban use. It is widely used in more than 80 cities and towns in Victoria (Victorian Auditor-General's Office 2010).

This section reports on groundwater levels (Indicator 6.1) and quality (Indicator 6.2) across Victoria.

Indicator definition

The indicator reports on groundwater levels in shallow and deep aquifers in Water Supply Protection Areas (WSPAs) and Groundwater Management Areas (GMAs) in Victoria. Deep aquifers are confined aquifers or aquifers where the water table is generally deeper than 40 metres.

Why do we use this indicator?

Groundwater level data, coupled with knowledge of the aquifer, the climate and groundwater use can be used as an indicator of sustainable use of the resource. Groundwater supports groundwater dependent ecosystems, human consumption and agricultural, commercial and industrial uses and contributes to environmental flows.

Trends in groundwater levels reflect change in aquifer storage resulting from differences between what flows into (recharge) and what flows out of (discharge) an aquifer. Groundwater level trends in shallow aquifers are more likely to reflect changes in recharge, from either rainfall or irrigation, whereas deeper aquifer trends may show a greater influence from pumping. Deeper aquifers are less likely to contribute water to groundwater dependent ecosystems.

Data quality rating ◆

Data on groundwater levels are collected from the State Observation Bore Network (SOBN). Groundwater levels in WSPAs and GMAs are monitored quarterly via DSE's State Observation Bore Network using a consistent, documented process for taking samples and recording data. However, the network of data points is unevenly distributed across the state, and not necessarily in the areas of greatest significance from an environmental perspective.

Data available to assess change? ■

Data on groundwater levels have been progressively collected across Victoria since the 1960s. Since 2007, DSE has commenced or re-commenced monitoring at 300 bores in WSPAs and GMAs across the state. In addition, monitoring of groundwater use has commenced at a further 600 bores. Monitoring has ceased at 400 bores that are located outside of WSPAs and GMAs or that no longer provide reliable data. DSE has also improved the reliability of groundwater level data in areas where groundwater use is the highest.

Statewide condition and trend



Drought and dry conditions prevailed in the period 1998 to 2010. Rainfall during the summer in 2010/11 was well above average in some areas of the state, particularly in the north. The volume of groundwater extracted since June 2010 was much less than in previous years: about 30% of the long-term average north of the divide and about 50% south of the divide.

Shallow aquifers

Groundwater levels in the Riverine Plains (i.e. Goulburn, Campaspe and Loddon valleys) declined from the late 1990s to 2010 due to a combination of increased groundwater use and reduced recharge both from surface water irrigation and rainfall. Groundwater declines were also observed in the Upper Loddon GMA, Upper Ovens, Deutgam WSPA, Nepean GMA and Glenelg GMA. However, since 2011 groundwater levels across Victoria have risen in response to rainfall, flooding and irrigation. Elsewhere, groundwater level trends are generally stable (Figure 19).

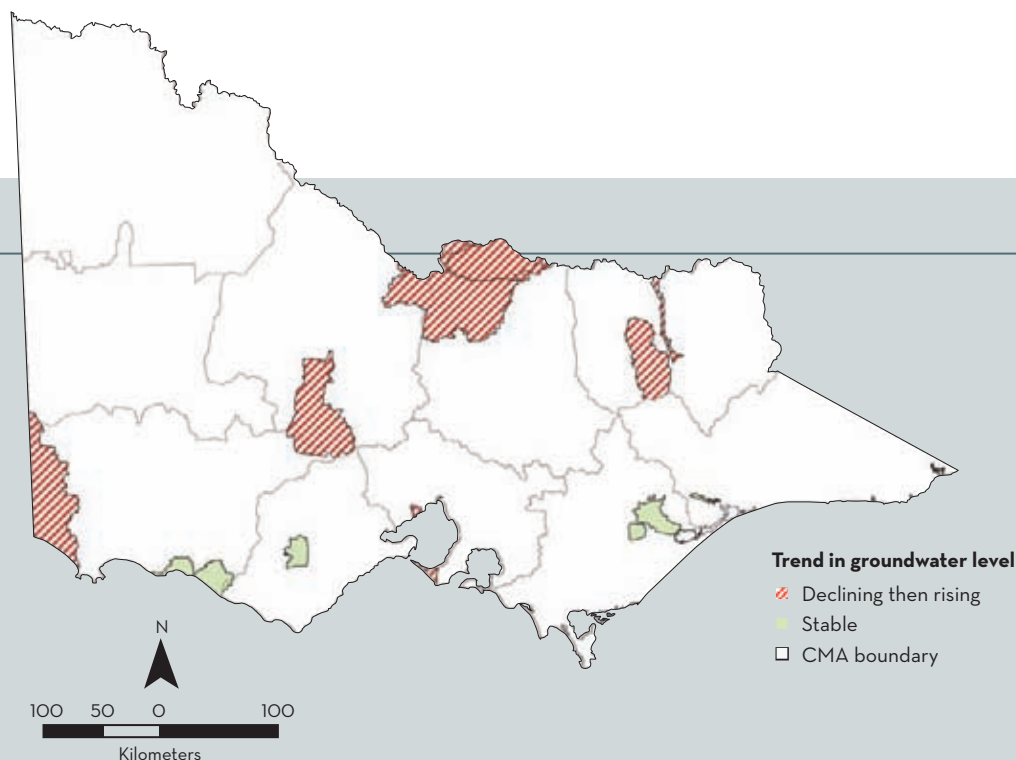


Figure 19.
Groundwater level trends in shallow aquifers,
2007-2012

Source: DSE Corporate Geospatial Data Library 2012

Deep aquifers

Long-term declines in groundwater levels are associated with the Latrobe Valley coal mines (dewatering) and off-shore oil and gas extraction (Bass Strait). These declines have continued since 2007. Groundwater levels in the remainder of the state are either stable or stable to rising (Figure 20).

Groundwater levels in the Riverine Plains (Campaspe and Katunga WSPAs) declined in the late 1990s. Restrictions to groundwater use since the mid-2000s reduced the rate of decline. Groundwater levels recovered fairly rapidly following the return to wetter conditions in 2011 due to reduced groundwater use and increased leakage from the overlying shallow aquifers.

Victoria's surface runoff is projected to decline and become less reliable with climate change. As such, groundwater is likely to become an increasingly important water resource. Expanding urbanisation, increasing food production for population growth and increasing legislative requirements for environmental flows may also put future pressure on groundwater (DSE 2011c). Data on groundwater availability will play a vital role in determining whether future groundwater use is sustainable, and how it should be managed.

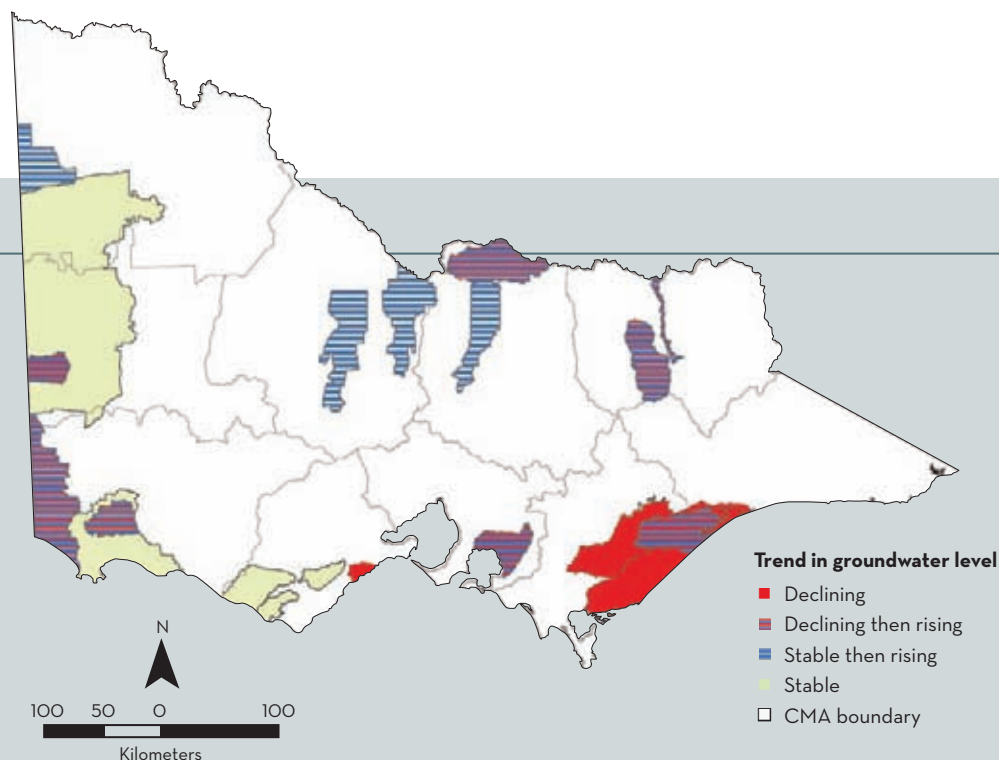


Figure 20.
Groundwater level trends in deep aquifers,
2007-2012

Source: DSE Corporate Geospatial Data Library 2012

Indicator 6.2 – Groundwater quality

Indicator definition

This indicator reports on groundwater salinity, a commonly used measure of groundwater quality. Data limitations mean that groundwater contamination, another indicator of groundwater quality, cannot be reported here.

Why do we use this indicator?

Excessive groundwater salinity may limit groundwater use by domestic, agricultural, commercial and industrial users and the productivity of lands reliant on borewater irrigation. Groundwater dependent ecosystems (see case study) and stygofauna (animals that live within groundwater systems) rely on the maintenance of appropriate salinity levels to remain healthy, while varying salinity levels can adversely affect vegetation growing in areas of shallow water tables.

Groundwater contaminants such as nitrates, phosphates and toxicants also affect groundwater quality. Fortunately, Victoria has relatively little contaminated groundwater, with groundwater contamination only occurring in isolated instances. Groundwater contamination potentially reduces available water supplies and threatens ecosystems that are dependent on it.

Data quality rating

Regular salinity samples are obtained and analysed by Rural Water Corporations where there is an identified issue such as the potential for saltwater intrusion in coastal areas or rising groundwater levels that contribute to secondary salinity.

More broadly, salinity measurements are taken on an *ad hoc* basis to determine current conditions. DSE has remapped groundwater salinity in 2012 to incorporate new data and new modelling techniques (Figure 21). The updated map is based on more detailed geological and bore data than was previously available.

Data on groundwater contaminants are collected through individual reports associated with contaminated land investigation. However, there is little coordination of statewide data collection and data are not compiled into a centralised database. The data are therefore not readily accessible.

Data available to assess change?

Changes in groundwater quality over time can be assessed in particular GMAs and WSPAs where salinity data are collected regularly. However, data are not collated or analysed to demonstrate trends at a statewide level.

Similarly, while data on groundwater contamination are collected regularly (generally as part of environmental audits), these data are not collated and cannot be easily reported over time at a statewide level.

Statewide condition and trend

● ? (assume)

Figure 21 shows the general distribution of different levels of groundwater salinity across Victoria. As shown, the most saline groundwater occurs in the north-western part of the state. Groundwater in this part of the state has typically been in the aquifer for an extended period, providing more opportunity for salts to become concentrated through evapotranspiration and minor dissolution of soil and rock material. Less surface water is available for groundwater recharge in this semi-arid area, meaning that salts remain concentrated. The discharge of water to salt pans also increases groundwater salinity at a local level.

The Great Dividing Range of central and eastern Victoria is host to comparatively fresher groundwater. Rainfall is generally higher in these areas, and groundwater flow is within cracks within the rock. This leads to the water generally being in the aquifer for shorter periods of time, particularly near the surface, resulting in less opportunity for concentration of salts through evapotranspiration and dissolution of rock material.

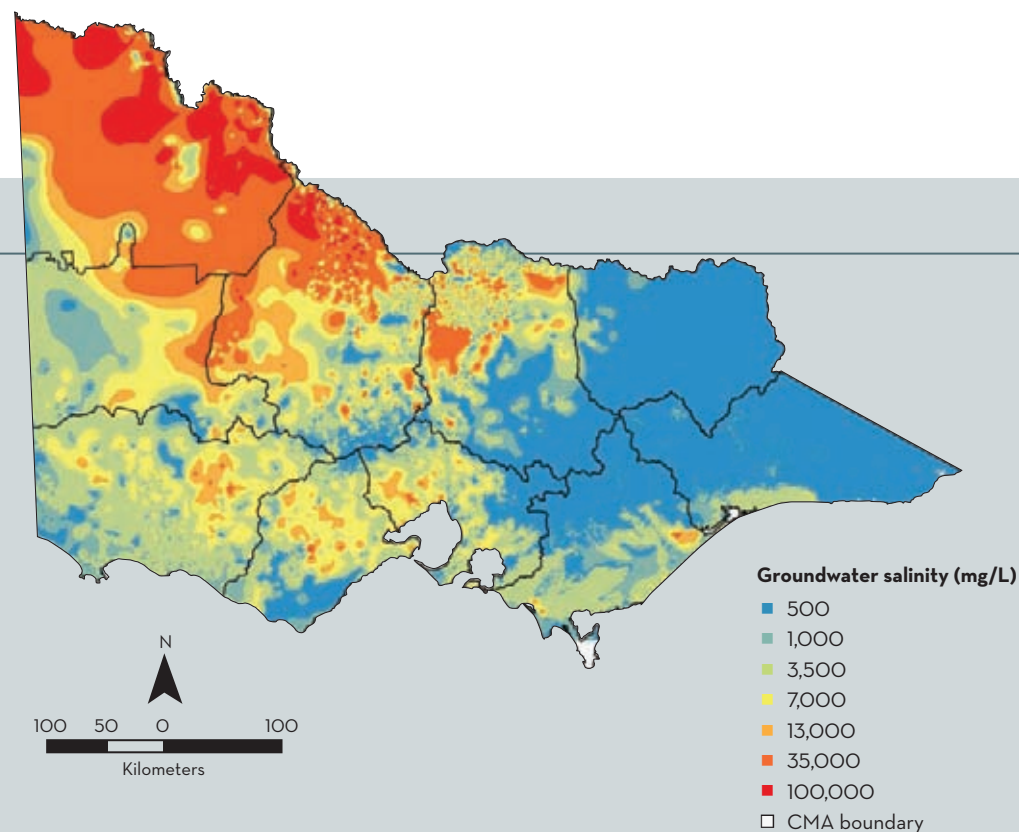


Figure 21.
Groundwater salinity in Victoria

Source: DSE Corporate Geospatial Data Library 2012

CASE STUDY

6

Groundwater dependent ecosystems

Groundwater dependent ecosystems (GDEs) are ecosystems that are partially or completely dependent on groundwater for their existence or health. They include wetlands, river base flows, cave ecosystems, springs, mangroves and billabongs (Dresel *et al.* 2010). GDEs provide important habitat for plants and animals and support recreation activities such as fishing and bird watching.

Threats to GDEs include altered surface water regimes, climate change, salinity, nutrients and groundwater extraction. It is well understood how land use practices and extraction of groundwater resources can affect groundwater levels, flows, and quality. The threat these changes in groundwater regime pose to the condition of GDEs, while significant, is less well understood (Sinclair Knight Merz 2001).

DPI and DSE have recently mapped potential GDEs across Victoria to help improve our knowledge of these ecosystems. This is believed to be the first time that such mapping has been attempted at a large scale in Australia, and represents one of very few attempts internationally (Dresel *et al.* 2010). Figure 22 provides an example of potential GDEs in the western district region.

Work is also underway to determine the sensitivity of potential GDEs to changes in groundwater quality and quantity. Improved GDE mapping, combined with a better understanding of the interaction of these ecosystems with ground and surface water, will allow DSE to determine the threats from groundwater extraction to different types of GDEs, and allow improved management of these ecosystems.

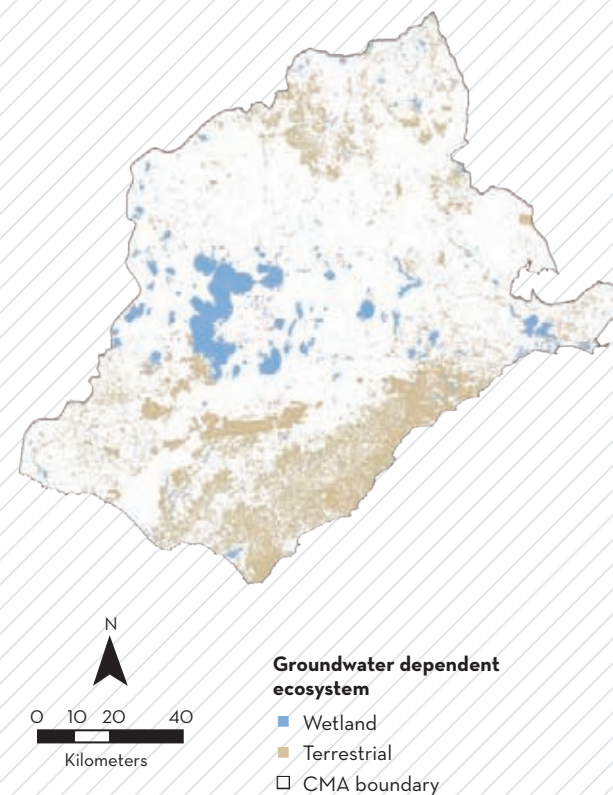


Figure 22.
Potential wetland and terrestrial GDEs -
western districts

Source: DSE Corporate Geospatial Data Library 2012

Climatic variability	73
Land use change	78
Agricultural productivity	81
Social and economic change in the agricultural sector	83
Community participation in catchment management	85
Indigenous involvement in catchment management	86
Expenditure in catchment management	88



Climatic variability

Any discussion of land and water resources needs to include reference to the factors that influence their condition and management. This section examines some key influences on natural resource condition and management in Victoria, namely climatic variability, land use change, agricultural productivity, social and economic change in the agricultural sector, community participation in ICM and expenditure in integrated catchment management. While discussed separately, each issue is inter-related. For example, climatic variability influences land use, which in turn can drive social and economic change.

Victoria's long-term average maximum temperature has increased over the past century. Figure 23 shows trends in Victoria's maximum and minimum temperatures from 1910 to 2010. Warming during the last decade has been somewhat tempered by the prolonged drought, as reduced cloud cover and soil moisture produced cooler overnight temperatures (DSE 2012b). However, the mean annual temperature has remained above average for the past decade or so. The frequency and severity of very hot temperatures has increased, and the frequency and severity of very cold temperatures has decreased since the beginning of last century (DSE 2012b).

In addition to the generally warmer conditions, Victoria experienced an extended heatwave in the summer of 2008/09, with much of central, southern and western Victoria experiencing the hottest conditions in more than 70 years. On 7 February 2009, the date the Black Saturday bushfires commenced, Victoria recorded its hottest ever temperature of 48.8°C at Hopetoun in the state's north-west, 1.6°C above the previous record for Victoria (DSE 2012b).

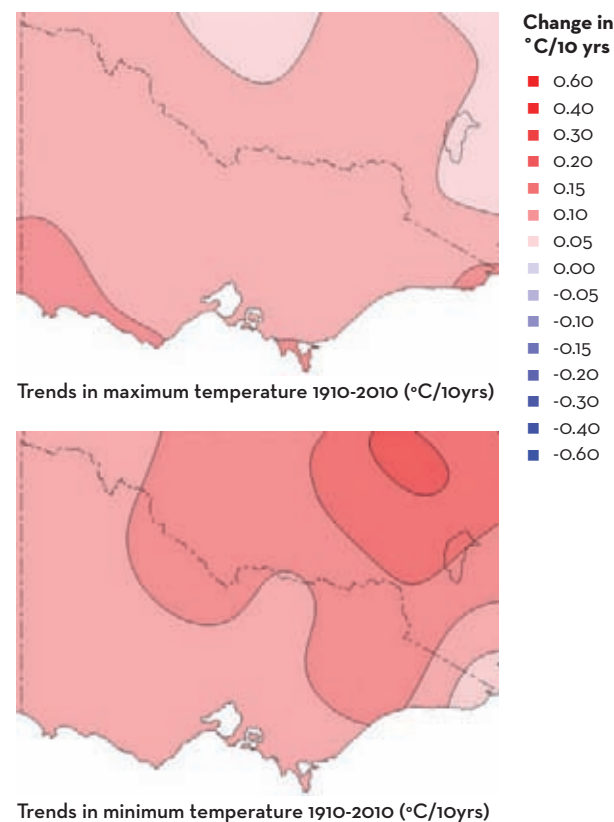


Figure 23. Trends in maximum temperature (top) and minimum temperatures (bottom) from 1910-2011 in Victoria as a change in °C per decade. Red indicates warming trend over the century

Source: Commonwealth of Australia (2012)
Bureau of Meteorology

Assessing the impact of Victoria's warmer conditions on land and water resources requires long-term, rigorous and consistent data. A good example of long-term monitoring is the International Tundra Experiment (ITEX) involving scientists from many different countries working for over 20 years to date. Its main aim is to examine the response of plant species and tundra ecosystems to environmental change, specifically to increases in summer temperatures. Victorian ITEX followed the same international methodology augmenting the study with new techniques, including altitudinal gradient sites and genetics (DSE and Parks Victoria 2012). The ITEX plots in the Victorian Alps are being monitored, with passive warming chambers used to measure the ways that alpine plants, invertebrates and soil processes are likely to respond to warming. Changes in some plant species over five or more years are being demonstrated, including earlier first flowering times in ITEX plots compared with the controls. These changes are the first evidence of what we can expect in the future as conditions become warmer, and some of the changes will have implications for management.

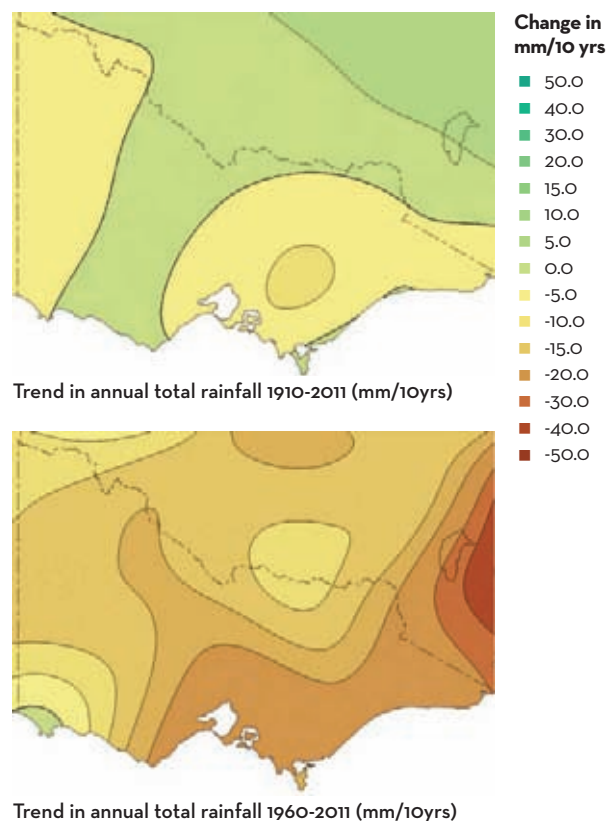


Figure 24. Trend in annual total rainfall in 1910-2011 (top) and 1960-2011 (bottom) in Victoria as a change in millimetres per decade. Red indicates drying and green indicates wetting trends in annual rainfall

Source: Commonwealth of Australia (2012)
Bureau of Meteorology

Victoria's rainfall is naturally variable. The first half of the 20th century was broadly drier and included two prolonged drought periods. The second half of the 20th century was characterised by large decadal-scale fluctuations in rainfall (DSE 2012b). Figure 24 shows rainfall trends in Victoria from 1910 to 2011 and 1960 to 2011.

The 13 year drought from 1997 to 2009 was Victoria's longest period of sustained rainfall deficit in the instrumental record (DSE 2012b). The overall drier conditions of the "Millennium Drought" were exacerbated by a lack of wet months and wet years during this period. Victoria's seasonal rainfall patterns also appear to be changing, with a reduced autumn and winter rainfall offset by more unpredictable spring and summer weather, even in the record rainfall of 2011. The impacts of the drier conditions are described in a number of sections throughout Part 2 of this report.

Cumulative and monthly rainfall variations are shown in Figure 25 for alpine areas above 1,000 metres in south-east Australia. These areas contain the headwaters for Victoria's major rivers and are a major source of Victoria's rainfall

and subsequent runoff. As shown, despite recent wetter conditions, the cumulative rainfall deficit of the “Millennium Drought” is larger than the preceding two wet periods in the mid-1970s and early 1990s.

The extended dry period was most likely a combination of natural variability and warming of global temperature, although the relative contribution of each factor is unclear. There have been decades of below average rainfall in the past, and there are climate drivers that vary on longer time scales. However, the recent dry period is consistent with climate change projections (such as reductions in rainfall across mid-latitudes), although these changes are bigger and earlier than initially projected.

After many years of below average rainfall, Victoria recorded its fifth wettest year on record in 2010, with western, central and north-eastern Victoria particularly affected (DSE 2012b). The higher rainfall levels benefited the natural environment in a number of ways. For example, preliminary condition assessments showed an improvement in vegetation condition in the Barmah Forest following the wet conditions of 2010/11 (GBCMA 2011). The high rainfall levels in the Wimmera region benefited some threatened flora species,

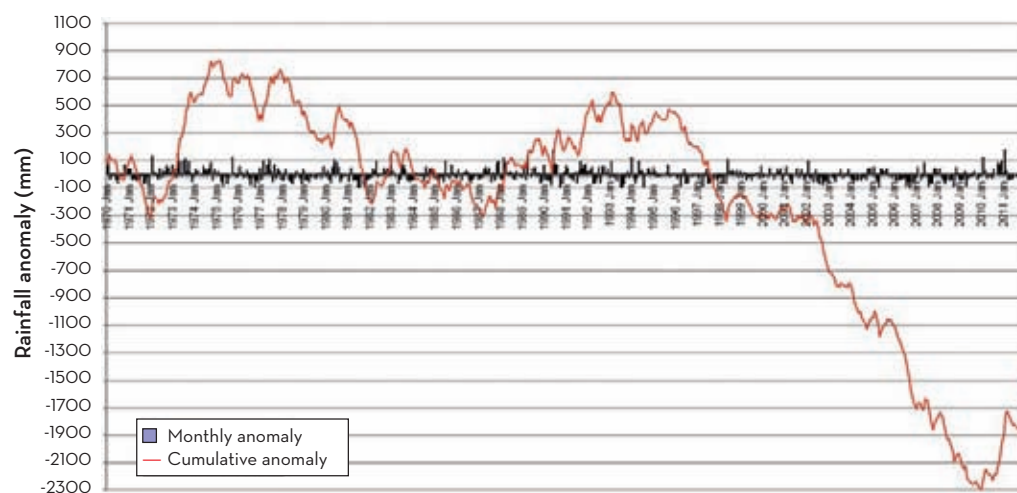


Figure 25. Cumulative and monthly rainfall variations (in mm) from the long-term average for the Alpine regions (+1000m), south-eastern Australia, 1970-2012. Individual monthly variations are shown in the columns

Source: Karl Braganza, Australian Bureau of Meteorology

with several discoveries of previously unknown populations, while floods led to reduced salinity levels and increased levels of dissolved oxygen in some waterways (WCMA 2011). Despite record annual rainfall in 2010 and 2011, autumn and winter rains were still below average.

A return to the dry conditions experienced from 1997 to 2009 is likely at some stage in the future (Climate Commission 2012). Recent climate models indicate that extended dry periods, implying a higher risk for drought, are expected to increase by the end of this century in south-eastern Australia (Climate Commission 2012). It thus remains important to plan for such a scenario as part of the long-term catchment resource planning process.

CASE STUDY

How communities deal with environmental change – Lake Boga

In 2009, the Department of Planning and Community Development examined how communities cope with, and respond to, environmental change consistent with what is envisaged under climate change. The study focused on the township of Lake Boga near Swan Hill and the complete drying of the town's lake in 2008.

The lake is central to the town's recreation and tourism industry and provides an important meeting place for the community. The drying of the lake had a range of social and economic impacts. Local residents expressed anger, frustration and shock following the lake drying. Less obvious impacts included a feeling of social isolation caused by the loss of a key community meeting place. Economic impacts included a decline in tourism income and a drop in property values, particularly around the lake frontage.

The lake's drying did not lead to increased migration away from the area: some residents were trapped by the loss in value of their properties, while others regarded the local area as home, with or without

the lake. This suggests that population change may be a slow process even in the face of relatively rapid environmental change or climate variability.

Lake Boga residents showed resilience in recovering from an unexpected environmental event, and some were able to diversify their business or farming activities. However, in many ways, residents did not really adapt to the new environment. Rather, they adapted to an interim phase while they waited for the lake to fill again.



Above:

Lake viewed from Lake Boga jetty, southern end of lake, October 2009

Source: DPCD 2009

In March 2010, water was returned to Lake Boga through an allocation made by Goulburn Murray Water. In early 2011, major flooding in the region saw Lake Boga return to full capacity and threaten to overflow. A follow-up study by DPCD in 2011 examined the community response to water returning to the lake.



Above:

Lake viewed from Lake Boga jetty, southern end of lake, February 2011

Source: DPCD 2011

The return of water to the lake had an extremely positive impact on the town and its residents. It provided renewed opportunities for family and social activities and there was a sense of optimism about the upcoming tourist season. It reinvigorated the local population and encouraged them to spend more time and money in the community.

The town of Lake Boga was spared the inundation that devastated other towns across north-west Victoria. However, it did experience secondary impacts from the floods such as compromised road access and visitors staying away for an extended period. It also became a refuge for people from nearby flooded areas. The floods were seen by many to be a very different situation to the extended dry period, with opportunities for the community to respond and work together through activities such as sandbagging. The direct action required

during the floods provided a sense of unity and purpose and brought the community together in a different way to the dry lake experience.

The Lake Boga community faced the environmental extremes of drought and flood over a relatively short time period. There was a strong belief that the current trends and patterns, such as record flood following record drought, would occur in the future, although it was also expected that there would be periods of more “average” weather conditions in-between. Local residents recognised that more frequent extreme events would make life more difficult, but mostly indicated that they would stay in the area and adapt to whatever changes eventuated.

Source: Waters *et al.* (2010) *The Drying Lake: Lake Boga's experience of change and uncertainty*; Waters and McKenzie (2012) *Dealing with Extremes: The Lake Boga Follow-up Study – Report on Findings*.

Land use change

Victoria's land use (the purpose to which land is committed) is shown in Figure 26. Major land uses include 'primary production', mainly private land with uses such as agriculture, forestry, aquaculture and animal production, and 'conservation reserves', mainly public land reserved for nature conservation purposes and values. Environmental factors such as rainfall and groundwater availability, soil type, climate and geography play a significant role in determining appropriate land use. Land use and land capability should be matched so as to prevent lasting damage to catchment resources.

There is little information available on recent land use change at a statewide scale. An example of regional land use change and its impacts is given below.

Substantial and rapid land use change has occurred in south-western Victoria in the past 20 years, with grain and oil seed cropping replacing traditional agricultural land uses such as sheep grazing (Figure 27) (Clifton *et al.* 2006).

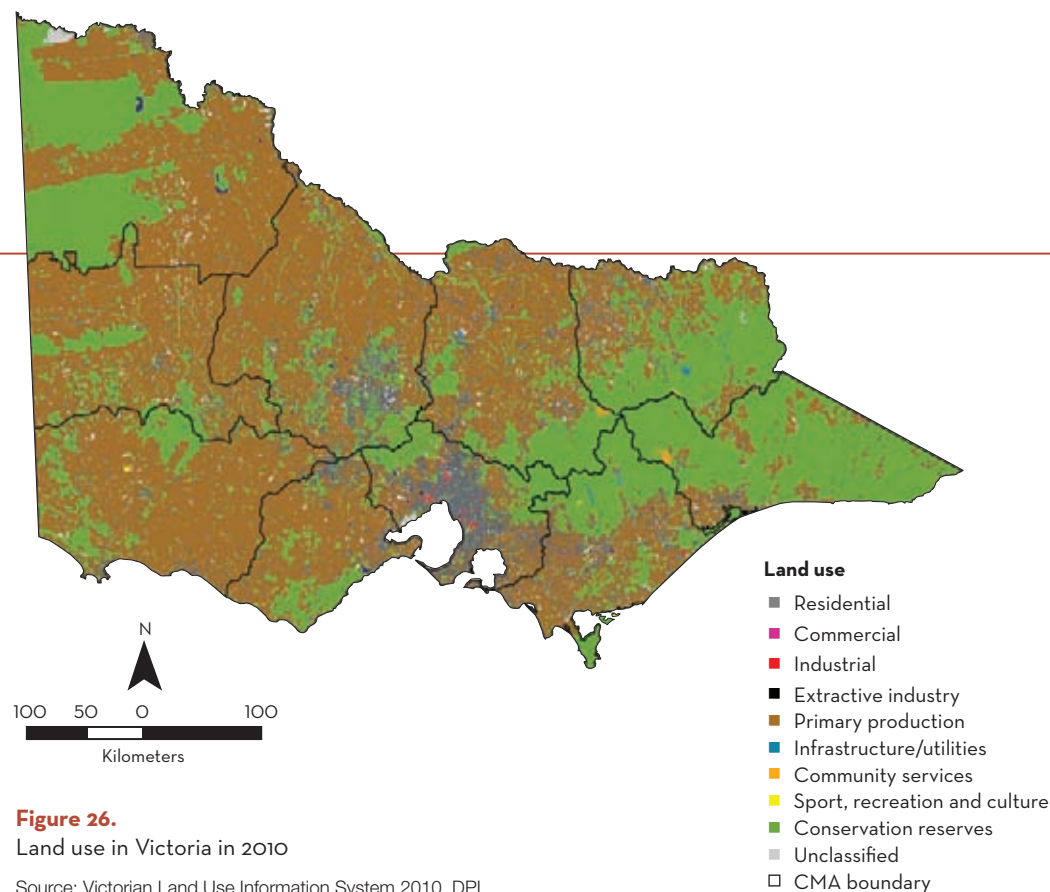


Figure 26.
Land use in Victoria in 2010

Source: Victorian Land Use Information System 2010, DPI Spatial Information Sciences

These changes were partly driven by a significant drop in the profitability of wool production in the early 1990s, which led farmers to seek alternative land uses. At the same time, there was an increase in cropping profitability, improved cropping technology and drier conditions which reduced the potential cost of crop production (DPI 2009a). Other land use changes include the expansion of dairy farming and of blue gum plantations, at

least until the collapse of many plantation companies in 2008 (Clifton *et al.* 2006; DPI 2009a). The growth in dairying is most likely a combination of farms becoming larger, increased profitability in the industry (encouraging farmers to convert existing grazing land) and migration from other parts of Victoria such as Goulburn Valley or overseas (DPI 2009a).

The scale and nature of land use changes that have taken place are so large that they may transform the amount and quality of the region's water resources (Clifton *et al.* 2006). Increasing development and predicted drier climate conditions mean that competition for water resources in the region is intense (Hekmeijer *et al.* 2011). With this in mind, DPI recently established surface water and groundwater monitoring sites in areas with grazing, cropping and plantations. Information from these sites will be used to measure and compare water and salt balances for different agricultural land uses. These data will allow DPI to accurately quantify and compare the catchment scale impacts of different agricultural land uses on surface water, groundwater and salinity (Hekmeijer *et al.* 2011).

Land and its uses are particularly important for rural communities, where many people are directly dependent on land for their livelihood, and the way land is used has a central role in defining the identity of an area and its community (Schirmer *et al.* 2009). The changes in land use described previously affected the local population, land prices and employment.

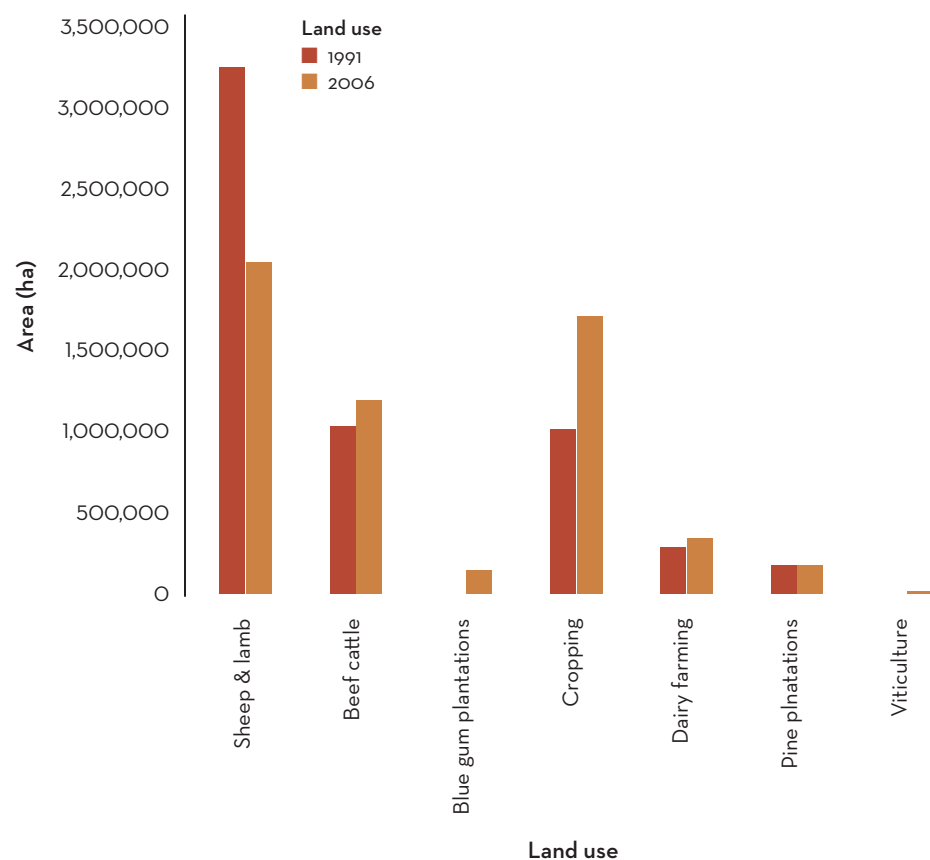


Figure 27.
Land use change in south-west Victoria
between 1991-2006

Source: DPI (2009) South West Farm Monitor Project

CASE STUDY

Environmental accounts trial – Corangamite Region

Environmental accounts provide an effective and efficient method to quantify and monitor the interactions between the economic drivers of land use change and the condition of the natural environment to better inform decision-making.

Corangamite Catchment Management Authority (CCMA) is one of 10 regions across Australia participating in the Regional Environmental Accounting (REA) trial as agreed by NRM Regional Chairs in Darwin in 2010.

Corangamite is uniquely positioned in that it is the only region to have also participated in a case study with the purpose of trialling the System of Environmental-Economic Accounts (SEEA) (EC, FAO, et al 2012). As part of the SEEA study, a selection of environmental accounts were produced to demonstrate the practicalities of applying internationally accepted accounting concepts within a local setting (Stoneham *et al*).

To date, good progress has been made on the aims set out for the REA pilot. For example, environmental accounting has allowed an understanding of what has been lost through land-clearing (91% from 1750), but also what has been gained through investments in revegetation and restoration (10.9% in 2008-09). These are useful statements for decision-makers.

The trial leaves open the possibility of adding refinements that better reflect the complexities of local perspectives and ecosystems. Such refinements could improve the accounting system over time to achieve consistent, regular and credible accounts that decision-makers require before setting environmental policy.

At the end of the trial, CCMA hopes to accomplish a set of environmental accounts which are aligned with international, national and state environmental accounting processes and are able to inform decision makers about the inextricable linkages between the environment and the economy. This aim separates the current trial from all previous environmental monitoring work (Cosier 2012).

Expansion of rural residential properties and blue gum plantations was associated with high population turnover, since existing residents often moved away when properties were sold for plantations. Land use change during this period also contributed to substantial increases in land values between 1996/7 and 2007/8, with an increase of between two and three times their original values (DPI 2009a). Rural land prices also increased, particularly in areas with an expanding sea/treechanger population such as near the coast and other scenic areas. Changes in farm-based employment included a decrease in the number of people employed in the sheep industry and an increase in cropping employment. While many of those once employed by sheep enterprises are now employed by either cropping and/or beef enterprises, some workers or farmers left the farming work force altogether. This is also a reflection of an ageing rural population (DPI 2009a). These changes are likely to lead to ongoing social change in rural communities in Victoria's south-west.

Agricultural productivity

Australian agricultural productivity has more than doubled since the 1960s. The value of Victoria's agricultural production has increased over the past decade, and in 2010/11 Victoria accounted for 28% of Australia's food and fibre exports, valued at \$8.1 billion, from only about 3% of the arable land area of Australia (DPI 2012). While continuing to grow in absolute terms, the size and importance of agriculture has declined relative to the rest of the economy: as real incomes and standards of living have increased, the relative share of agriculture as a percent of GDP has decreased. There has been an overall decline in farmers' terms of trade despite the fact that prices received for many commodities have increased in recent years (McKenzie & Frieden 2010).

In the face of declining terms of trade, Australian agriculture has depended on productivity gains to maintain profitability (Mullin 2007). The growth in agricultural productivity and efficiency has been driven by technological innovation and competition, the introduction of pest- and disease-resistant animals and plants and by farmers adapting promptly to research findings and new markets (Future

Farming: Rural Planning Group 2009). New technology has allowed unproductive and underutilised land to be used for alternative or additional income sources, such as the generation of renewable energy (Future Farming: Rural Planning Group 2009), and in some cases has reduced impacts on land and water resources. Other technological developments like Precision Agriculture allow greater control over production systems by recognising variation and managing these different areas of land according to a range of economic and environmental goals. These methods can help farmers identify land capabilities, and manage their land to match land use to land capability to optimise profitability. These systems have the potential to ensure the efficient use of water and fertilisers, maintain soil fertility and allow for targeted management of nitrogen pollution, while conserving biodiversity and natural resource base in less productive parts (CSIRO 2009).

Increased productivity has also been achieved through increasing economies of scale (i.e. fewer but larger farms), as has occurred in areas such as western Victoria, a major grain-growing region (Barr 2011, unpubl.). This increase in the size of farms

has been a significant agricultural trend observed over the past three decades (Parliament of Victoria Rural and Regional Committee 2012). Generally, larger farms have a good track record at improving productivity. Smaller farms have a poorer track record, often because they cannot generate sufficient funds to invest in farm development (Barr 2009). There are many small farms with low incomes which are not able to invest in their future.

Key risks to agricultural productivity include climate variability, land use change and natural resource decline. These risks are described in a number of sections of this report. However, one risk to productivity which needs further discussion is invasive plants and animals and biosecurity⁴⁷.

Invasive plants, animals and pathogens remain a significant threat to farm, fishery and forestry productivity, as well as the condition of Victoria's land and water resources. Impacts include decreased quality and quantity of agricultural products, loss of livestock and reduced land values. The biosecurity environment in Victoria is becoming more complex, as trade volumes and patterns, migration, land use, agricultural practices and climate

⁴⁷ Biosecurity refers to the protection of the economy, environment, social amenity or human health from negative impacts associated with the entry, establishment or spread of animal or plant pests and disease (DPI 2009b)



change evolve and interact. The strategic, statewide approach of the *Invasive Plants and Animals Policy Framework* (IPAPF) (DPI 2010) focuses on minimising the impact of pest species (such as foxes and rabbits) that threaten the productivity of the Victoria's primary industries and the natural environment. In line with the *Biosecurity Strategy for Victoria* (DPI 2009b), increasing resources will need to be directed to prevent the establishment of new species and provide capacity to deal with new incursions as soon as they occur.

The increased food production required at global, national and state scales will provide challenges and opportunities within a broader context of declining quantity and quality of arable land, climate change, water scarcity, increasing cost of energy, biodiversity decline, declining reserves of fertilisers and reaching crop yield plateaus (McKenzie 2012). There is potential for increasing agricultural productivity and efficiency to occur at the detriment of ecosystem services that support underlying natural systems. Council recognises that

many of the issues around ever-increasing food and fibre production are interconnected, difficult and long-term, and cannot be resolved in the short term or in isolation from one another.

Left:

Foxes killed as part of the successful Fox Bounty program in 2011, western Victoria

Social and economic change in the agricultural sector

There is a wealth of demographic information for Victoria at a number of different scales. It is outside of the scope of this report to examine all aspects of Victoria's demographic profile. Rather, this section presents a selection of information from this complex area, with a focus on demographic characteristics that may influence natural resource condition and community capacity to manage these resources.

Data from the 2006 population census are used in this report as data from the most recent population census (2011) were not available at the time of writing. Nevertheless, annual estimates of population are produced by the ABS. These provide an indication of population size and growth rates but, unlike the census, do not provide detailed information on population characteristics.

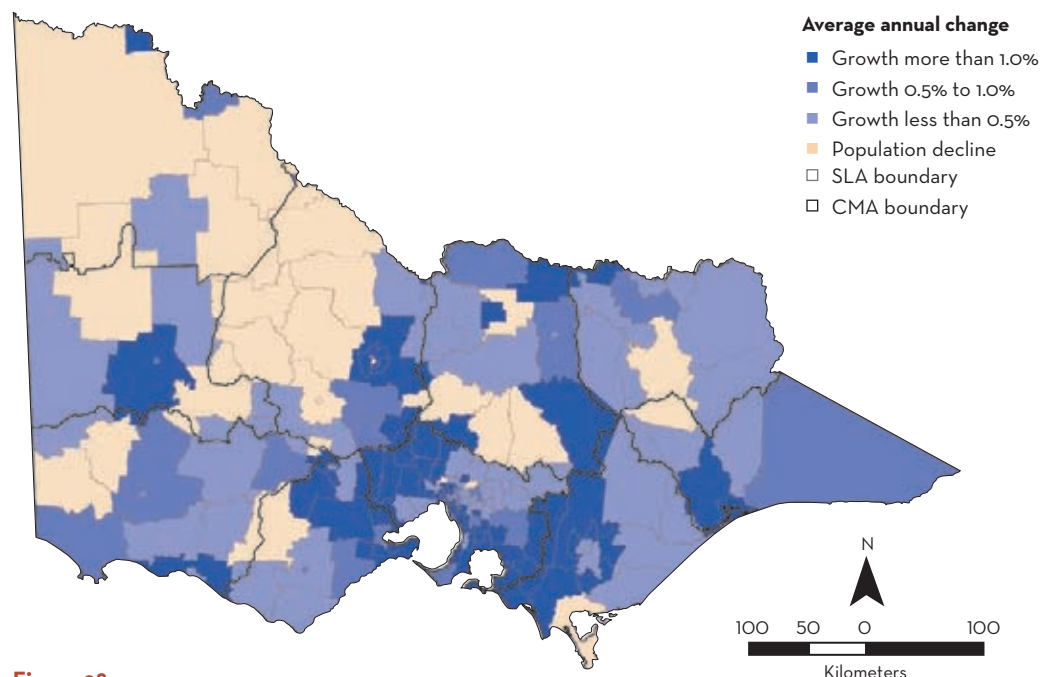


Figure 28.
Average annual population change, Victorian
Statistical Local Areas 2001-2010

Source: ABS Estimated Resident Population, cat. no. 3218.0

Demographic information can help us understand the social and economic context in which ICM activities occur. Growing populations can place additional pressures on natural resources through human activities such as urban and rural development. On the other hand,

declining populations may lack the means to effectively manage these resources (for example, through volunteering).

Victoria's rural population in 2009/10 was estimated at 1.47 million people (DPCD 2011). Overall, Victoria's regional population has grown over the past 10 years, although

there has been a population decline in some rural areas, particularly in Victoria's north-west (Figure 28)⁴⁸. The capital intensification of agriculture requiring fewer workers, rationalisation of services into fewer, larger centres and increased personal mobility allowing people to access goods and services further away have contributed to this decline. There is also the increasing economic and social attractiveness of urban life, with a strong flow of younger people to Melbourne seeking education and job opportunities. In areas such as Gippsland, this decrease in population has been offset by retirees from Melbourne and other parts of Victoria. However, there is less retirement immigration in the Mallee and Wimmera regions, resulting in a population decline in these areas (McKenzie and Frieden 2010). Population decline does not necessarily correlate with economic decline. Improvements in agricultural technology and farm consolidations may require a smaller workforce, but can result in enhanced agricultural productivity and economic prosperity, for example in Victoria's dryland farming areas.

⁴⁸ 'Rural areas' refers to Victoria's non-urban areas: that is, those areas located outside of Melbourne and outside of regional cities such as Geelong, Ballarat and Bendigo. 'Regional areas' refers to Victoria's non-metropolitan areas: areas located outside of Melbourne but including regional cities.

Rural areas in Victoria are characterised by large gaps in the young adult age groups, with net outmigration being a critical factor creating this pattern (McKenzie and Frieden 2010). The outmigration of young people in rural areas is a particular issue for Victoria's agricultural industry: the number of people aged between 20 and 30 years entering farming fell by about two-thirds between 1976 and 2006 (Barr 2011, unpubl.; Parliament of Victoria Rural and Regional Committee 2012).

The size of the farming sector workforce in Victoria has been steadily declining for decades. The long-term trend for employment in the agricultural sector is estimated to be flat to negative (Parliament of Victoria Rural and Regional Committee 2012). This decline is the result of, amongst other factors, the long-term drought which reduced confidence and employment opportunities, falling commodity prices and the reduction in trade protection. Improvements in productivity have also reduced the need for farm labour.

Community participation in catchment management

Community participation in ICM results in improvements to natural resource condition and contributes to the social fabric of rural communities. The membership of Landcare and community-based ICM groups⁴⁹ in Victoria between 2006/07 and 2010/11 is shown in Figure 29 (RMCG 2012, unpubl.). There has been a pattern of steady growth in membership over the past five years, indicating renewed support for community participation in ICM. The demonstrated increase is also partly due to the way that membership data were counted and recorded: data from 2006 to 2008 represent Landcare group membership only, while data from 2008 onwards include both Landcare and community-based ICM group membership.

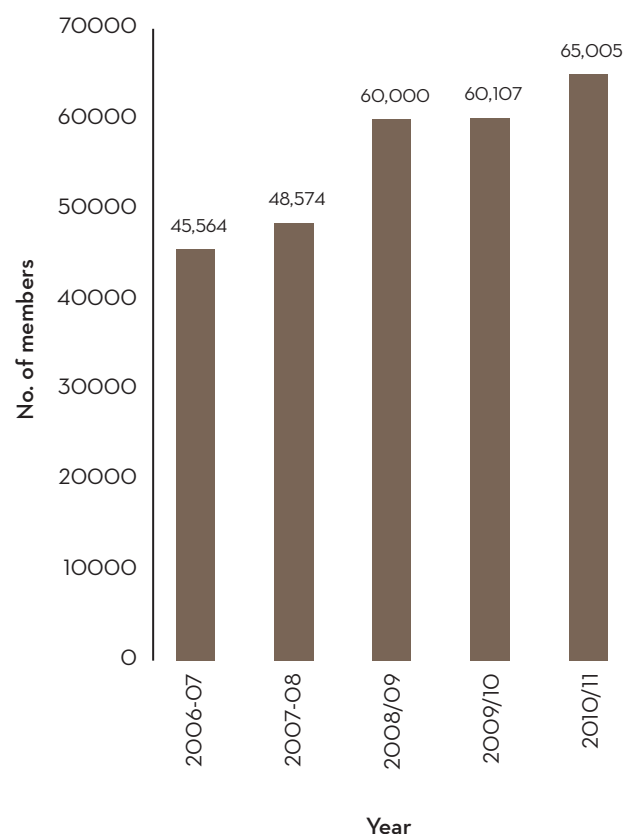


Figure 29.
Five year trends in Landcare and other community-based ICM group membership

Source: RMCG (2012, unpubl.) Victorian Landcare Membership 2010-2011: Draft Report

⁴⁹ A Landcare group is a volunteer, community-based organisation with a focus on integrated catchment management. Landcare groups are self-nominated and associate themselves with the Landcare brand. Community-based ICM groups are volunteer based community organisations with a focus on natural resource management. These groups are many and varied and do not associate themselves with the Landcare brand (for example, Coastcare, 'Friends of' groups (RMCG 2012, unpubl.).

Indigenous involvement in catchment management

For Victorian Traditional Owners and the broader Aboriginal community, access to, and use and management of natural resources is embedded in cultural practice and responsibilities: that is, cultural heritage and integrated catchment management are merged into a single concept. The health of Victoria's land and water resources is therefore central to the cultural identity of Traditional Owners, and they continue to hold strong aspirations for greater involvement in all aspects of managing their traditional Country.

Since the release of the CCR 2007, a range of Commonwealth and State ICM programs, the introduction of negotiated agreements and an innovative approach to the resolution of native title have provided an opportunity for Traditional Owners to become more involved in ICM. Examples include:

- the establishment of Aboriginal Corporations and Registered Aboriginal Parties across much of Victoria. These entities hold and represent the rights and interests of Traditional Owners, particularly concerning land and natural resources;
- the Victorian approach to negotiating native title claims through the *Native Title Settlement Act 2010*, which attempts to link Native Title outcomes with employment and economic development opportunities, particularly on Country through increased participation in integrated catchment management;
- the hand-back to Traditional Owners and joint management of a progressively larger proportion of the public land estate as a key policy option to resolve issues of native title and land justice; and
- the range of government programs and initiatives such as Indigenous Protected Areas, Working on Country, Indigenous Land Management Facilitator network and the Indigenous Carbon Farming Fund that are enabling Traditional Owners to pursue community development goals as well as delivering a wide range of public good outcomes.

However, while Indigenous participation in ICM is on the rise in Victoria, progress is patchy and much work remains to be done to maintain the current momentum. Council hosted two statewide workshops on Indigenous engagement in ICM in 2009 and 2010. These workshops found that the on-ground impact of increased Traditional Owner and Aboriginal participation in ICM is not yet known; it is also not clear whether there is a stronger connection to Country as a result of this participation, or whether Traditional Owners feel more empowered in ICM decision-making.

CASE STUDY

Yarrilinks

Yarrilinks is an award-winning revegetation project that began in 1999 in Yarriambiack Shire, north-west of Melbourne. Yarrilinks is supported by the Yarrilinks Landcare Network and Wimmera Catchment Management Authority.

Yarriambiack Shire's landscape is highly fragmented and contains many threatened species and communities. The Yarrilinks project aims to protect, enhance and restore native vegetation in the Shire, with a key focus along Yarriambiack Creek. Since inception, the project has worked with almost 250 landholders to protect and restore more than 2,000 hectares of native vegetation, most of it Buloke woodlands.

A key component of the Yarrilinks project is an annual community planting day and social weekend. The planting weekend is unique in Australia as it invites city-based migrants, local farmers and community members to work together to improve the environment. Partner organisations such as Adult Multicultural Education Services (AMES) and the Sudanese Australian Integrated Learning program (SAIL) transport Melbourne-based refugee families to small towns in the Yarriambiack Shire

region to stay with host families from the local area over the weekend. Many of the volunteers are recent migrants to Australia, with volunteers from 24 different cultures taking part since 1999.

As well as its environmental benefits, the planting weekend provides opportunities for cultural exchange. For example, "Lentil as Anything", a Melbourne-based restaurant chain, prepares a vegetarian dinner for the volunteers using local produce. This is an important way of sharing culture as most of the chefs are from different parts of the world. The dinner also exposes local volunteers to international and vegetarian dishes that they may not eat regularly.

Yarrilinks also fosters a greater cultural understanding between city and country people: volunteers can learn about rural community life in Victoria, while host families can meet people from countries they may never have otherwise encountered. An additional benefit is that some migrants choose to settle in the Wimmera – for example, Nhill in the northern Wimmera now has about 100 Karen people living in its township.



Top:

Volunteers from Melbourne plant indigenous seedlings including Buloke on the Schier property in Murtoa in Yarriambiack Shire

Photograph: David Fletcher

Above:

Yarrilinks volunteers. Over 150 volunteers took part in the annual Yarrilinks planting weekend in Murtoa last year

Photograph: David Fletcher

Expenditure in catchment management

Measuring expenditure in ICM can provide a wealth of information, and is associated with the importance placed on the condition of the environment. There may be many issues that interplay with the allocation and prioritisation of State and Federal budgets, but the level of expenditure available for environmental works demonstrates the priority placed on the environment by the community, State and Federal governments, and determines the amount of effort that can be put into the management of environmental resources.

Expenditure in ICM should not be used as a direct measure of management effectiveness – the amount of dollars spent on managing the environment does not necessarily relate to any change in natural resource condition, particularly over a short time period. The effectiveness of investment in ICM can also be obscured by other factors, including drought, fire and floods. Implementing a robust and well planned system of monitoring, evaluation and review can improve the capacity of ICM agencies to account for expenditure, programs and policy operating at different scales, while gathering data and information to inform future decision making that focuses on continuous improvement. An appropriate

and supported system for monitoring evaluation and review will also improve accountability of all ICM agencies, including Government, for the use of public funds to manage our land and water resources.

The significant investment by local landholders in ICM activities within their catchments is not included here. On average, local communities invest approximately \$1.50 for every \$1 of Commonwealth and State investment through CMA programs. For some specific on-ground works, the contribution from the community may be more than \$4 for every \$1 of Government investment.

Investment in ICM is primarily through various State and Australian Government funding sources with decisions about what to invest in based on their priorities, as well as those articulated in Regional Catchment Strategies. The Victorian Investment Framework provided an investment vehicle through which funding was allocated to Catchment Management Authorities. Figure 30 shows the significant support from the Victorian State Government to the CMAs over an extended period, and that the proportion of this support has increased over time.

Since 2008, the Australian Government directed funding through the five-year Caring For Our Country program. Annual Business Plans set out the targets for investment for each year of the five year program to achieve the Caring for our Country outcomes. These Business Plans provided guidance on the types of proposals that may receive funding and that address these targets. Projects were funded according to the six national priorities: the National Reserve System, Biodiversity and Natural Icons, Coastal Environments and Critical Aquatic Habitats, Sustainable Farm Practices, Community Skills, Knowledge and Engagement, and Regional Base Level Funding.

Catchment Management Authorities deliver on-ground operational works and also partner with other organisations such as Greening Australia Victoria, Landcare and Trust for Nature and several others to deliver on-ground projects. When analysed with other corporate information, data show that Catchment Management Authorities deliver operational activities efficiently with approximately 80% of their combined average income spent on on-ground operational works (Figure 31). They have also been shown to be efficient

organisations from the perspective of dollars spent on on-ground operational works per full time equivalent employee.

Data show that Catchment Management Authorities are adaptable and flexible organisations, with expenditure closely following annual income year by year, and the capacity to cope with sudden funding shifts.

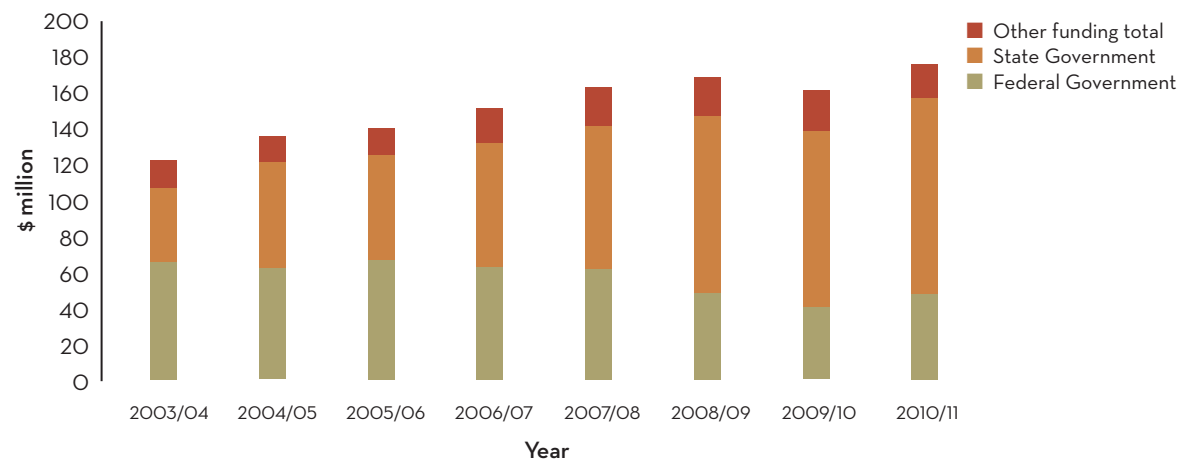


Figure 30.
Total funding of CMAs by source

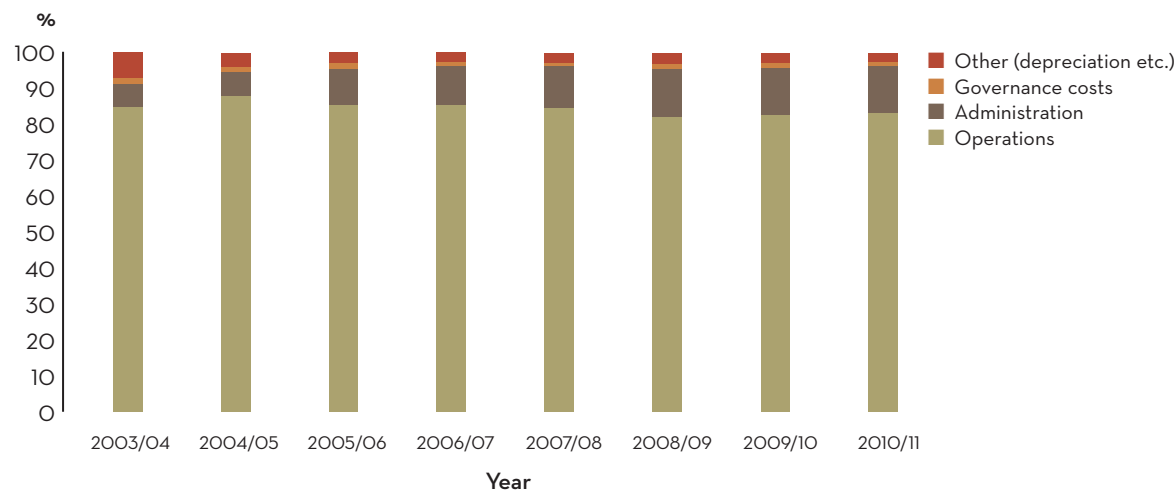


Figure 31.
Average CMA expenditure by type

CASE STUDY

ecoMarkets

Overview

EcoMarkets is a term used to describe a range of market based approaches that the Victorian Government uses to address landscape decline and improve the health of the environment. These approaches include conservation auctions such as BushTender and EcoTender and the native vegetation offset program Bushbroker.

The Victorian Government uses the ecoMarkets program to deliver regional programs through Catchment Management Authorities and Landcare Networks. The value in collaboration allows DSE to draw together information from across the state to further refine processes and improve the cost effectiveness of environmental investment and market based approaches.

To ensure that these processes and environmental investment are based on the best available data and modelling, EnSym (Environmental Systems Modelling Platform) was developed by the ecoMarkets team in DSE. This platform incorporates science, standards, metrics and information developed within DSE, as well as many leading international and national scientific

models. EnSym provides an evidence-based framework to inform decision making about how and where to invest for maximum environmental outcomes. The scientific models utilised in EnSym improve our understanding of the impact that actions such as revegetation, weed control and riparian management have on the broader landscape.

A large part of the science driving ecoMarkets is based on mapping Victoria into 20-metre grids. New landscape modelling techniques make it possible to identify the contribution that each 20-metre grid can make to improving environmental outcomes. This detailed knowledge of the unique aspects of any particular location in the landscape allows prediction of the catchment scale impacts of any land management action or group of actions to be made.

EcoTender

EcoTender is unique as it focuses on both delivering multiple environmental outcomes and measuring the environmental trade-offs that have to be considered as part of decision making. The methods used in EcoTender introduce a comprehensive evaluation of decisions to ensure investment

focuses on obtaining overall improvements to the environment in the most cost effective manner.

Successful landholder tenders are those that offer the best environmental value for the investment. Successful landholders sign contracts and receive periodic payments for delivering management activities that result in environmental improvements. The benefit to landholders is in the assistance they receive with their property planning and decision-making.

Through EcoTender, landholders are rewarded for providing environmental improvements in biodiversity, water quality and catchment health that benefit the wider community.

West Gippsland EcoTender

The largest conservation auction in Victoria to date has been the West Gippsland EcoTender (with contracts awarded to landholders in 2011). It covered the whole of the West Gippsland Catchment Management Authority (WGCMA) region. It was coordinated by DSE with regional implementation and field support from regional bodies including the WGCMA and Landcare. The tender allocated \$2.5m to landholder payments.

During the West Gippsland EcoTender, more than 450 landholders registered their interest. As a result 70% of landholders were visited by experienced regional staff. A landholder commented:

"It was a really lovely experience when we did the site assessment; we got to see the property through someone else's eyes. I learned so much along the way – I got interesting advice and insight into how the bush works, we even saw a lyrebird on the property which we hadn't seen before."

The field officers produced around 600 site management plans which detailed the actions that each landholder could undertake to improve the environment on their property. One of the challenges for landholders was to think about the actions they were willing to undertake, how much it would cost and what they needed to be paid to complete those actions when they offered a bid.

Landholders tendered a price to deliver multiple environmental benefits through improved management of natural areas such as wetlands, rivers and native vegetation and revegetation of gullies and paddock areas. Landholders successful in the bid process were offered five year

contracts with the option of permanently protecting their sites through covenants.

Environmental Outcomes for Victoria

The successful projects will manage more than 1,100 hectares of native vegetation and revegetation projects. This includes the protection of 46 kilometres of river frontage and 16 hectares of natural wetlands. It also includes over 200 hectares that will be newly covenanted for the ongoing protection of sites. Landholders have also committed to planting 230,000 indigenous plants, controlling weeds and pest animals and fencing out areas from stock. The activity that the EcoTender has generated will support local economies through the supply of materials, nursery stock and labour.

The environmental outcomes expected from the projects have been modelled using the EnSym modelling platform. The West Gippsland EcoTender is expected to result in catchment and biodiversity improvements including a large reduction in runoff and erosion.

Moving forward

The ecoMarkets program is supporting regional bodies in the delivery of wetland, river, woodland, grassland and other conservation tenders all across Victoria. In partnership with CMAs and Landcare over 3,000 landholder sites have been assessed and over \$15M has been paid to landholders for environmental improvements that will benefit the wider community.

References	93
Acknowledgements	96



References

- Alluvium (2011) *Statewide wetland geospatial inventory update project outcomes*. Report P111012R02 by Alluvium for Department of Sustainability and Environment, East Melbourne
- Australian Bureau of Statistics (ABS) *Regional Population Growth 2009-10*, cat. no. 3218.0
- Australian Natural Resource Management Groups (2012) *Australian Environmental Accounts Trials Stage 1 Guidelines 2012*
- Barton, J.L., Pope, A.J., Quinn, G.P. and Sherwood, J.E. (2008) *Identifying threats to the ecological condition of Victorian estuaries*. Department of Sustainability and Environment Technical Report
- Barr, N (2011, unpubl.) *Structural ageing in the farming sector – why and how*
- Barr, N (2009) *The house on the hill: the transformation of Australia's farming communities*. Land and Water Australia, Canberra
- Chapman G, Gray J, Murphy B, Atkinson G, Leys J, Muller R, Peasley B, Wilson B, Bowman G, McInnes-Clarke S, Tulau M, Morand D & Yang X (2011) *Assessing the condition of soils in NSW, Monitoring, evaluation and reporting program*. Technical report series, Office of Environment and Heritage, Sydney
- Clark, R (2011) *Remapping soil salinity in Victoria in 2008 and 2009 to identify changes in its extent and severity since the late 1980s*. Department of Primary Industries, Epsom, Victoria
- Clifton, C, Daamen, C, Horne, A, Sherwood, J (2006) Water, land use change and 'new forests': what are the challenges for south-western Victoria? *Australian Forestry*, Vol. 69: 2, pp 95-100
- Climate Commission (2012) *The science behind southeast Australia's wet, cool summer*
- Cosier P & Sbrocchi C (2012) Regional Trials of Environmental Asset Condition Accounting in Australian SEEA, *SEEA Expert Meeting on Ecosystem Accounts*, Melbourne, May 2012
- Crawford, D, Heemskerk, G and Dresel, E (2011) *Acid soils and soil acidification in Victoria – a review*. Department of Primary Industries, Epsom, Victoria
- CSIRO (2009) Use of Precision Agriculture by the Australian Grains Industry, in: *Crop and Pasture Science*, 2009, 60, 795-798
- Department of Planning and Community Development (2012) *Victoria in Future 2012. Population and Household Projections 2011-2031 for Victoria and its Regions*
- Department of Planning and Community Development (2011) *Victorian Population Bulletin 2011*
- Department of Primary Industries (2012) *Agriculture in Victoria*. Available at: <http://www.dpi.vic.gov.au/agriculture>
- Department of Primary Industries (2010) *Invasive Plants and Animals Policy Framework*
- Department of Primary Industries (2009a) *South West Farm Monitor Project: Summary of Results 2007/2008*
- Department of Primary Industries (2009b) *Biosecurity Strategy for Victoria*
- Department of Sustainability and Environment (2012a) *Advisory List of Threatened Vertebrate Fauna in Victoria – 2012*
- Department of Sustainability and Environment (2012b) *Report on Climate Change and Greenhouse Gas Emissions in Victoria*
- Department of Sustainability and Environment (2011a) *Introduction to NaturePrint: A blueprint for nature conservation*
- Department of Sustainability and Environment (2011b) *Victorian Water Accounts 2009-2010: A statement of Victorian Water Resources*
- Department of Sustainability and Environment (2011c) *Policy Paper: Improving management of Victoria's groundwater resources*
- Department of Sustainability and Environment (2010a) *National Parks Act Annual Report*

Department of Sustainability and Environment (2010b) *FPMRIS Planning Document No. 1: Strategic Plan for Implementing a Forests & Parks Monitoring & Reporting Information System in Victoria 2009-2014*

Department of Sustainability and Environment (2009a) *National Parks Act Annual Report*

Department of Sustainability and Environment (2009b) *Advisory List of Threatened Invertebrate Fauna in Victoria – 2009*

Department of Sustainability and Environment (2009c) *Actions for Biodiversity Conservation Factsheet*

Department of Sustainability and Environment (2008) *Native vegetation Net gain accounting first approximation report*

Department of Sustainability and Environment (2007) *Advisory List of Threatened Vertebrate Fauna in Victoria – 2007*

Department of Sustainability and Environment (2005) *Advisory List of Rare or Threatened Plants in Victoria – 2005*

Department of Sustainability and Environment (2004) *Vegetation Quality Assessment Manual – Guidelines for applying the habitat hectares scoring method, Version 1.3*

Department of Sustainability and Environment and Parks Victoria (2012) *Potential impacts of climate change on alpine vegetation. The*

Victorian International Tundra Experiment (ITEX) and associated projects – 2004-2012. Management and policy implications of the science – 2012

Dresel, P. E., Clark, R. Cheng, X., Reid, M., Fawcett, J., and Cochraine, D. (2010) *Mapping Terrestrial Groundwater Dependent Ecosystems: Method Development and Example Output*. Victoria Department of Primary Industries, Melbourne

Environment and Natural Resources Committee (2010) *Inquiry into Soil Carbon Sequestration in Victoria*

European Commission, Food and Agriculture Organisation, International Monetary Fund, Organisation for Economic Co-operation and Development, United Nations, World Bank (2012) *System of Environmental-Economic Accounting Central Framework*

Future Farming: Rural Planning Group (2009) *Improving Rural Land Use – Independent Report to the Minister for Planning*

Gill, B, Zydor, Z and Hekmeijer, P (2012) *Victoria's Salinity Status 2012: Technical Report*

Goulburn Broken Catchment Management Authority (2011) *Annual Report 2010-11*

Hekmeijer, P, Zydor, H and Reid, M (2011) *Catchment scale impacts of land use change in south-west Victoria (CMI 102920): Report on 2009-10 drilling and weir construction programs*

Kiem, A. S. and Verdon-Kidd, D.C. (2010) *Towards understanding hydroclimatic change in Victoria, Australia – preliminary insights into the “Big Dry”*

MacEwan, R, Clark, R, Hopley, J, Reynard, K and Morse-McNabb, E (2011) *Soil Assets and NRM Investment Final Report*. Department of Primary Industries, Epsom, Victoria

McKenzie, N (2012) *The role of soil information in the issues of our time*. Australian Soil Information Symposium: Connecting people with the soil information future, April 2012

McKenzie, F and Frieden, J (2010) *Regional Victoria: Trends and Prospects*. Department of Planning and Community Development

Moorrees, A and Lucas, A (2012 unpubl.) *Bayesian Modelling in the ABC System: Users Guide*. Internal document

Mullen, J.D (2007) “Productivity growth and the returns from public investment in R&D in Australian broadacre agriculture”. *Australian Journal of Agricultural and Resource Economics* 51: 359-384

Papas, P and Moloney, P (2012 in prep) *Victoria's wetlands 2009-2011: statewide assessments and condition modelling*. Arthur Rylah Institute for Environmental Research Technical Report Series No. 229. Department of Sustainability and Environment, Heidelberg

Papas, P, Lyon, S, Jin, C and Holmes, J (2008) *Development of a Wetland Catchment Disturbance Index*. Arthur Rylah Institute for Environmental Research. Department of Sustainability and Environment, Heidelberg

Parliament of Victoria Rural and Regional Committee (2012) *Inquiry into the Capacity of the Farming Sector To Attract and Retain Young Farmers and Respond to an Ageing Workforce*

Ramsar Convention Secretariat (2004) *The Ramsar Convention Manual: a Guide to the Convention on Wetlands (Ramsar, Iran, 1971)*, 3rd ed. Ramsar Convention Secretariat, Gland, Switzerland.

Reid, M, Cheng, X, Adelana, M, Hekmeijer, P, Zydor, H and Gill, B (2011) *Mapping of Salinity Provinces for risk assessment of environmental asset regions in Victoria – 2011*. Department of Primary Industries, Epsom, Victoria

RMCG (2012) *Victorian Landcare Membership 2010/2011: Draft Report*. Report prepared for the Department of Sustainability and Environment

Schirmer, J, Williams K and Dunn, C (2009) *Socio-economic impacts of land use change in the Green Triangle and Central Victoria: Final summary of findings of the Land Use Change project*. Prepared for Forest & Wood Products Australia

Sinclair Knight Merz (2009) *Combined impact of the 2003 and 2006/07 bushfires on streamflow*. Report prepared for the Department of Sustainability and Environment

Sinclair Knight Merz (2001) *Environmental Water Requirements of Groundwater Dependent Ecosystems: Environmental Flows Initiative Technical Report Number 2*. Commonwealth of Australia, Canberra

State of Victoria, Victorian Coastal Council (2011) *Emerging scientific issues on Victoria's coasts: 2011 update*

Victorian Auditor-General's Office (2010) *Sustainable Management of Victoria's Groundwater Resources*

Victorian Catchment Management Council (2007) *Catchment Condition Report*

Victorian Environmental Assessment Council (2010) *Remnant Native Vegetation Investigation Discussion Paper*

Walcott, J, Bruce, S and Sims, J (2009) *Soil carbon for carbon sequestration and trading: a review of issues for agriculture and forestry*. Bureau of Rural Sciences, Department of Agriculture, Fisheries & Forestry, Canberra.

Waters, E and McKenzie (2012) *Dealing with Extremes: The Lake Boga Follow-up Study -Report on Findings*. Department of Planning and Community Development

Waters, E, McKenzie, F, McCarthy, C and Pendergast, S (2010) *The Drying Lake: Lake Boga's experience of change and uncertainty*. Department of Planning and Community Development

Webb, A (2002) *Pre-clearing soil carbon levels in Australia. National Carbon Accounting system Technical Report Volume 12*

Wimmera Catchment Management Authority (2011) *Annual Report 2010-11*

Acknowledgements

Council would like to thank the following people for their contribution to this report:

Adam Fennessy
Adam Hood
Adrian Moorrees
Alex McMillan
Allison Long
Andrea Burns
Anne Buchan
Anthony Mellor
Bruce Gill
Cathy Ronalds
Cheryl Nagel
Chris McAuley
Chris Norman
Christine Forster
Dale Watson
David Adams
David Cummings
David Lucas
David Parkes
Doug Crawford
Elizabeth Morse-McNabb
Fiona McKenzie
Gary Stoneham
Ian Mansergh
Jaymie Norris

Jane Doolan
Janet Holmes
Jennifer Cane
Jill McNamara
John Riddiford
Jonathan Hopley
Kate Shanahan
Ken Donohoue
Kristen Thrum
Leon Metzeling
Linda Grootendorst
Louise Sullivan
Mark Eigenraam
Martin Bluml
Mel Mitchell
Michael Jensz
Neil Barr
Nevil Amos
Nikki Gemmill
Patrick O'Halloran
Paul Bennett
Paul Wilson
Rae Moran
Rae Talbot
Randal Nott
Richard MacEwan
Rob Clark
Sarah Ewing

Scott Lawrence
Sean Grimes
Sarina Loo
Stephen Salathiel
Stuart Horner
Tony Varcoe

Council:

Mick Murphy OAM (Chair)
Adam Fennessy
Cheryl Batagol
Chris Arnott
Cullen Gunn
Jan Mahoney
Joanne Anderson
John Young
Rod Gowans
Sandra Brizga
Anthony Boxshall (EPA Observer)
Gavan Dwyer (DPI Observer)

Secretariat:

Patricia Geraghty (EO)
Neil Meyers
Tracey Koper
Fiona Donohoue
Marian Pernet

