

9

What does the changing environment mean?

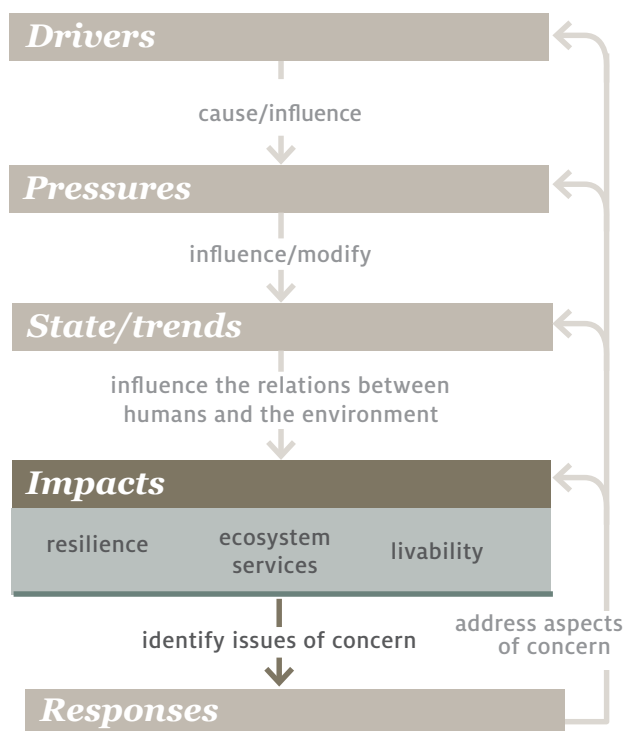


Fog rising on the Murrumbidgee
Photo: © Rod Burgess

9.1 Introduction

Links and influences

The *Driver–Pressure–State–Impact–Response* model as used in the ACT State of the Environment Report



The Driver–Pressure–State–Impact–Response (DPSIR) model used in this report is used almost universally in state of the environment reporting around Australia and in other countries, although in different ways.

The most advanced applications of DPSIR explain how the components of the framework can be considered together to answer questions such as ‘What do changes to biodiversity or air quality mean to our way of life?’ Used in this way, DPSIR can be used to explain the interactions between humans and the environment.

This is important given that the underpinning assumption of most environmental policy, in the Australian Capital Territory (ACT) and Australia, is that we want the relationships between people, the economy and the environment to lead to sustainable use of resources in ways that meet our ethical and moral obligations to other species and maintain a high quality of life for humans. This is borne out in the outcomes of a series of community and expert workshops designed to inform the structure of the 2015 State of the Environment Report.¹ These workshops concluded that ACT state of the environment reporting should consider:

- not only what impacts humans have on ecological systems, but also what benefits humans derive from these systems (the concepts of livability and ecosystem services)
- how susceptible coupled socioecological systems might be to shocks, which might mean they could no longer function in ‘desirable’ ways.

This chapter aims to address these considerations by providing indicative and preliminary assessments on:

- livability – a way to assess how attractive the ACT is compared with other places in terms of the perceived quality of life here
- ecosystem services – a way to identify the ways in which the environment provides goods and benefits to people in the ACT, which both support and fulfil our lives
- resilience – a way to consider how well the coupled socioecological systems in the ACT might be able to cope with expected and unexpected pressures and shocks without losing the essential characteristics of those systems.

9.2 Livability

9.2.1 What is livability?

The term ‘livability’ is used to describe the combination of factors that contribute to people’s quality of life and wellbeing. A city, town or region is more likely to be livable if there are high levels of health and welfare, safety, economic opportunities, access to transport, opportunities for recreation and attractiveness, and low levels of pollution.²⁻⁵

Human wellbeing is central to the concept of livability. A livable town, city or region is one in which people are supported to enjoy good physical and mental health, fulfil social relationships, and have a high level of life satisfaction and happiness.⁶

There are also significant flow-on effects from achieving a high level of livability. For example, highly livable cities are more likely to attract visitors — for both business and leisure — which can further increase prosperity for local industries.^{3,7}

The *State of Australian Cities 2013* report describes livability:⁸

The liveability of a city is judged by the health, wellbeing and the quality of life of people living within it. Although difficult to define precisely, urban liveability can be measured both subjectively for example, by asking people how they feel about their quality of life in their cities and objectively for example, by examining social and economic measures for urban populations such as income, wealth, education, health, economic and community infrastructure assets, opportunities and services.

For this State of the Environment Report, livability is defined to include those aspects of the quality of life determined mainly by the physical environment, including the natural and built environments. However, those aspects of livability that depend on economic and social conditions should not be excluded from consideration in the State of the Environment Report.^a

ACT state of the environment reporting requires specific attention on key aspects of the environment that are managed by the ACT Government: open space, the built environment (including housing), amenity and connectivity, waste management and health.

This section thus considers:

- overall indices of livability
- access to green infrastructure and open space
- the built environment, including housing
- connectivity, transport and congestion
- human health, as affected by the natural and built physical environment
- government management of livability (response).

a The Commissioner for Sustainability and the Environment and the *Environment Act 1993* requires that a State of the Environment Report must include,⁹ as the Commissioner considers necessary:

... the social, aesthetic, cultural and economic conditions that affect, or are affected by the things mentioned in subparagraphs (i) to (v) [namely earth, atmosphere, water, organisms, ecosystems, characteristics and qualities that contribute to biodiversity and ecological integrity and the interactions and interdependencies].

*The environment is
where we all meet;
where all have a mutual
interest; it is the one
thing all of us share.*

-Lady Bird Johnson

9.2.2 Indices of livability

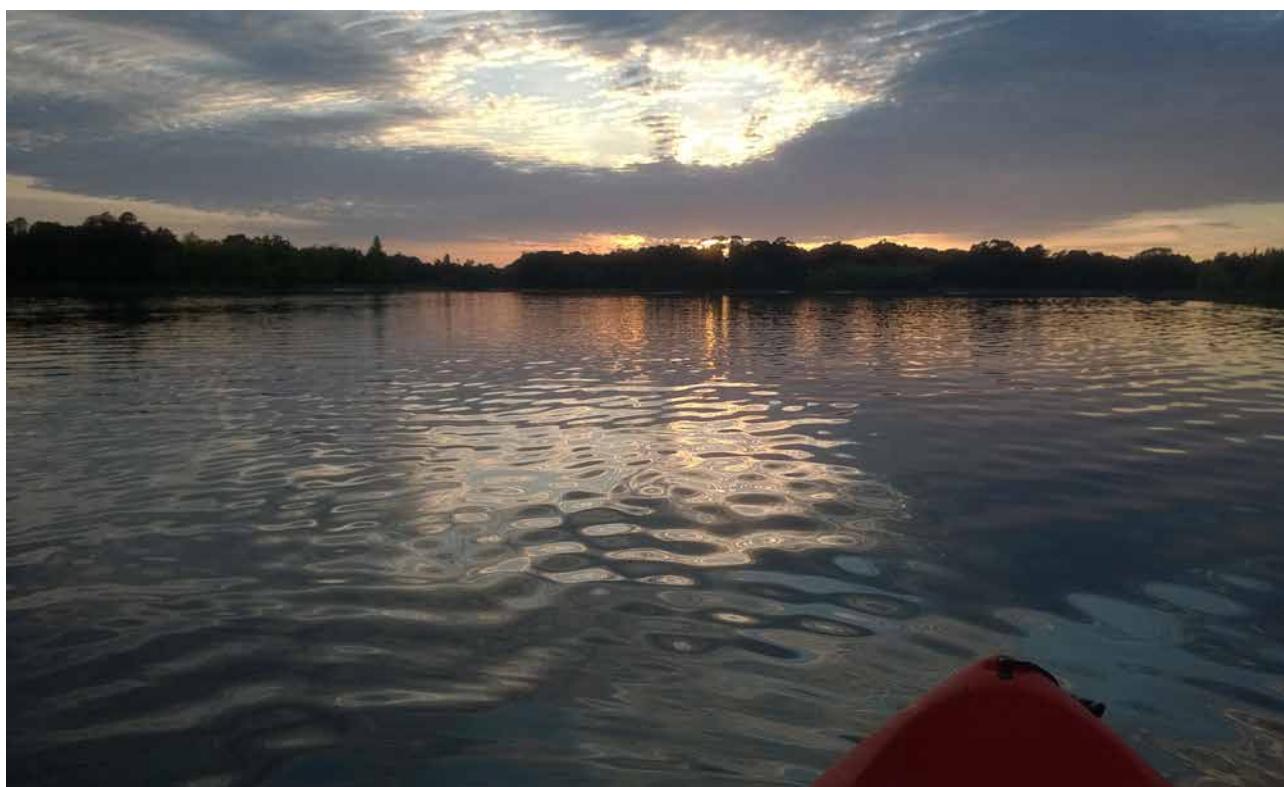
Canberra and some other Australian cities are generally regarded as among the world's most livable. The 2011 ACT State of the Environment Report notes that:¹⁰

The city's environment, liveability and amenity depend in considerable measure on accessible open space and green infrastructure that provides passive ecosystem benefits. (vol 1:xxvi)

and

We are a highly urbanised population residing in a city, ranked as one of the top 30 cities worldwide for its liveability, water quality and availability, waste removal, air pollution and congestion ... where we enjoy extensive green space within and around the city. Further, we experience very little industrial pollution as we import most of our consumer goods and services from interstate and overseas. (vol 1:6)

Overall measures of livability are available from a number of sources.



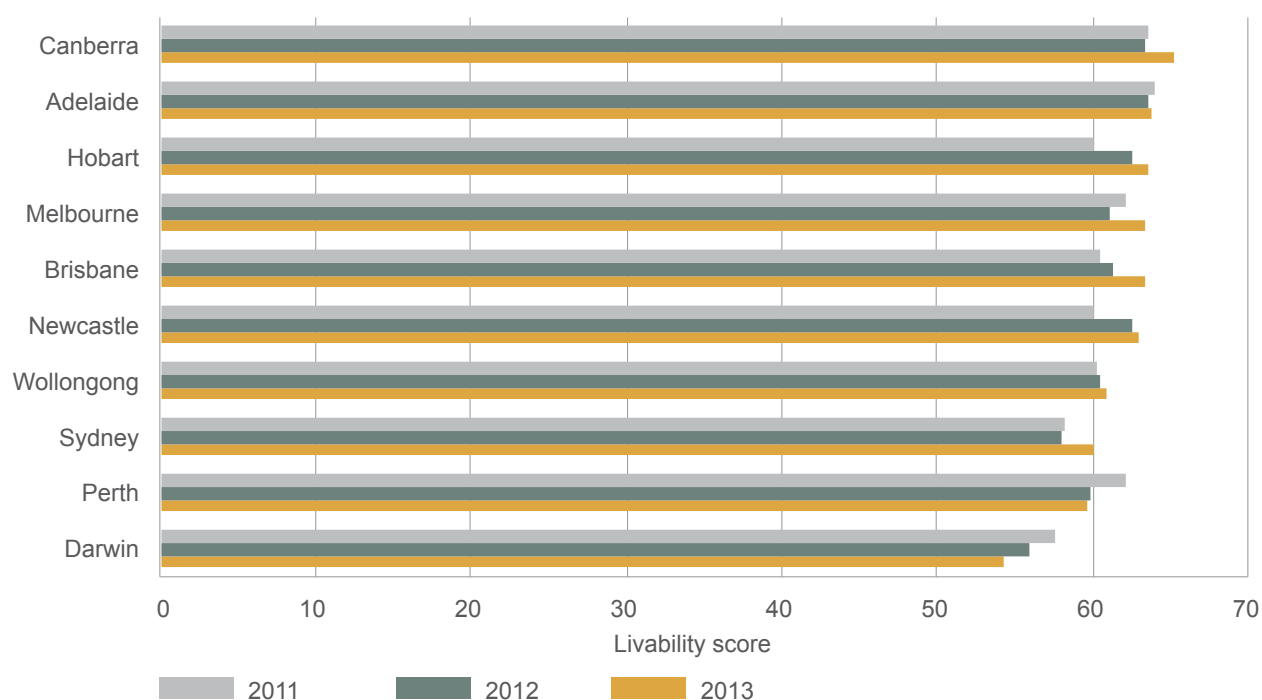
Lake Burley Griffin from a kayak
Photo: ACT Government

Australian Cities Livability index

The Property Council of Australia's Australian Cities Livability Index measures the livability of Australia's capital cities from the point of view of people who live in them, using an annual survey conducted by Auspoll. This surveys residents in relation to 17 attributes:

- look and design of the city
- clean, well maintained and unpolluted
- wide range of recreational outdoor environments
- vibrant cultural entertainment scene
- good public transport service
- good road network and minimal traffic congestion
- safe place for people and their property
- attractive natural environment
- good approaches to environmental sustainability and climate change
- good health-care services
- good schools and other educational facilities
- good range of quality affordable housing
- good balance of different housing types
- good employment and economic opportunities
- affordable place to have a good standard of living
- good climate
- a diverse range of people who get along well.

The index was most recently calculated for 2013. The results showed that Canberra is the most liveable city in Australia of those in the survey, although the variation among livability scores was small. Canberra has ranked first or second in the livability score for the three most recent surveys (Figure 9.1).

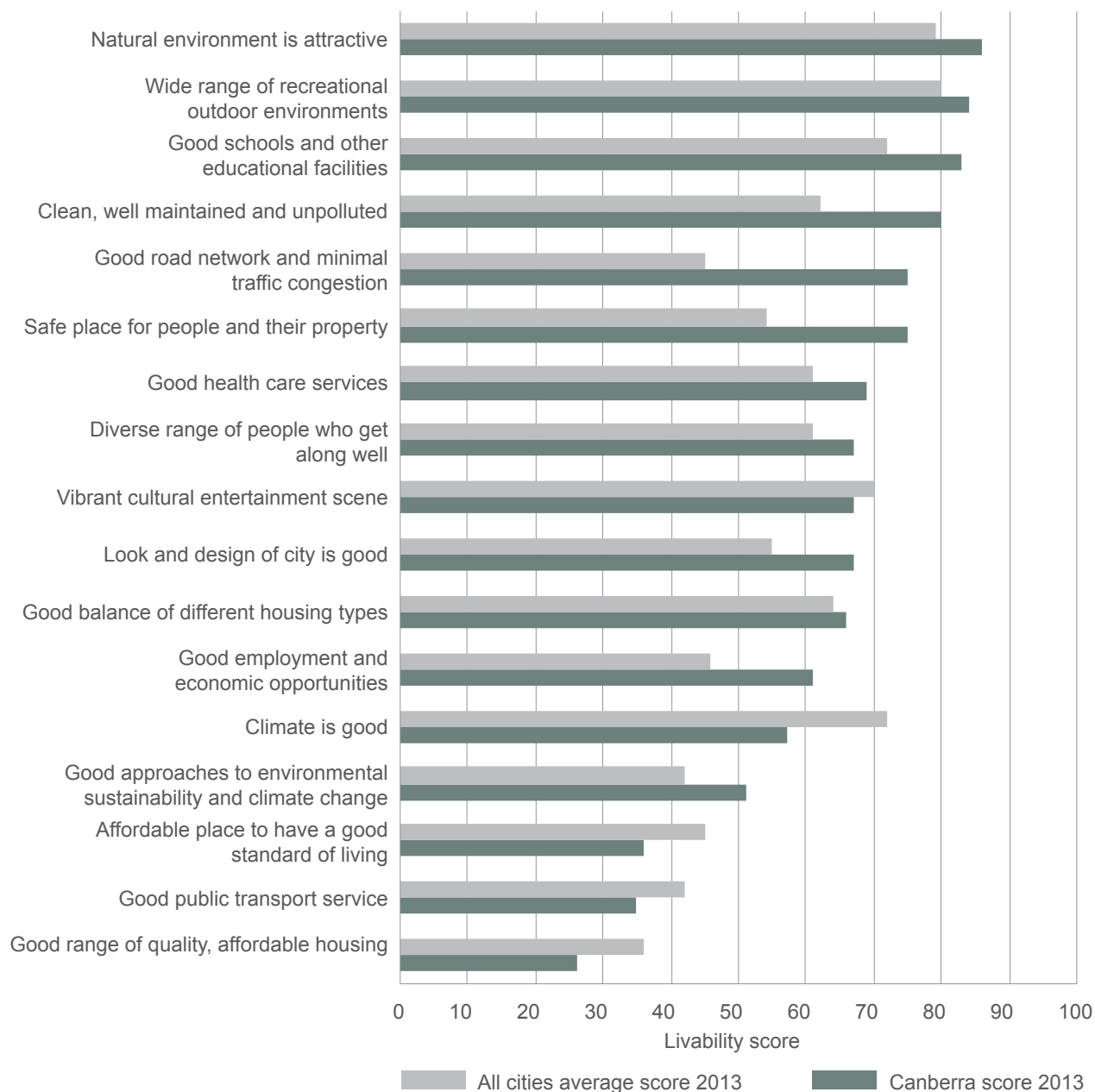


Source: Property Council of Australia"

Figure 9.1 Australian city livability scores, 2011–2013

Canberra rated very highly on cleanliness and maintenance, outdoor leisure opportunities, safety, environmental approaches, quality of education, and a diversity of people who get along well (all ranked 1;

Figure 9.2). Canberra rated poorly for its public transport and affordable housing (both ranked 9) and climate (ranked 10).



Source: Property Council of Australia¹¹

Figure 9.2 Canberra and all Australian cities livability attributes, 2013

Organisation for Economic Co-operation and Development international comparison of livability

The Organisation for Economic Co-operation and Development (OECD) has produced a range of studies that compare standards of living, quality of life, wellbeing and livability across OECD economies, cities and regions. One of the most recent and frequently updated of these is the OECD Regional Well-being Index.¹² Nine wellbeing dimensions have been

identified (Table 9.1) and a set of indicators developed for the 362 OECD regions.

The use of a common set of indicators across all regions has some disadvantages. In particular, it means that richness and complexity of each dimension is not captured. For example, the quality of the environment for each region is assessed by a single measure – estimated average level of particulate matter in the air experienced by the population – as this can be obtained for all regions using remote-sensing data collected by satellites.

Table 9.1 Organisation for Economic Co-operation and Development wellbeing dimensions

Wellbeing dimension	Definition
Education	Percentage of labour force with at least secondary education
Jobs	Employment percentage of working age population; unemployment percentage of total labour force
Income	Household disposable income at constant prices in US\$ adjusted for purchasing power parity
Safety	Number of homicides per 100 000 people
Health	Life expectancy at birth in years
Environment	Estimated average level of PM _{2.5} in µg/m ³ experienced by the population
Civic engagement	Voter turnout at election as percentage of total voters
Accessibility to services	Percentage of households with access to broadband internet
Housing	Number of rooms per person

µg/m³ = micrograms per cubic metre; PM_{2.5} = particulate matter less than 2.5 microns

In the OECD comparison, the ACT scored highest among the Australian states and territories, and had

a higher livability score than any OECD economy (Table 9.2).

Table 9.2 Organisation for Economic Co-operation and Development Regional Well-being Index, 2015

State or country	Education	Jobs	Income	Safety	Health	Environment	Civic engagement	Accessibility to services	Housing	Total
ACT	9.1	9.6	10.0	10.0	9.9	9.5	10.0	9.6	8.5	86.2
NSW	7.2	8.3	7.1	9.2	9.1	10.0	10.0	8.1	7.4	76.4
NT	6.4	8.7	8.1	1.4	4.1	9.1	8.5	8.4	5.8	60.5
Qld	6.9	8.5	6.9	9.3	8.7	10.0	10.0	8.4	8.2	76.9
SA	6.4	8.3	6.6	8.8	8.8	9.9	10.0	7.8	8.3	74.9
Tas	5.6	7.5	6.2	8.7	7.2	10.0	10.0	7.3	8.3	70.8
Vic	7.4	8.5	6.4	9.6	9.4	9.2	10.0	8.2	7.6	76.3
WA	7.0	9.3	7.7	9.0	9.4	9.9	10.0	8.6	8.8	79.7
Australia	6.6	8.4	7.3	9.8	9	9.5	10.0	7.2	8.7	76.6
Austria	8.1	8.4	6.3	9.9	7.5	3.3	6.3	7.4	5.3	62.5
Belgium	7.3	5.9	5.1	9.5	7.0	3.0	9.1	7.4	8.4	62.6
Canada	9.0	7.7	6.3	9.5	8.5	7.8	3.7	8.2	10.0	70.7
Chile	7.0	6.5	0.0	8.8	7.0	8.1	8.7	1.4	1.8	49.2
Czech Republic	10.0	6.9	2.4	9.6	3.8	3.1	3.3	5.8	3.0	47.9
Denmark	6.8	7.9	3.5	9.9	6.0	5.9	8.8	8.7	8.3	65.8
Estonia	9.3	6.4	1.0	8.3	2.3	7.5	4.1	7.0	1.9	47.7
Finland	8.4	7.1	4.0	9.9	7.0	8.3	5.1	8.6	6.1	64.6
France	6.9	5.4	5.5	9.7	8.9	5.3	7.4	7.2	5.6	62.0
Germany	8.5	8.3	6.0	9.9	7.3	4.1	5.7	8.2	8.2	66.1
Greece	5.7	0.7	3.8	9.6	6.6	3.8	5.5	3.7	1.6	41.0
Hungary	8.7	4.4	1.2	9.6	0.4	2.5	4.3	6.0	1.1	38.2
Iceland	5.1	9.0	3.8	10.0	8.8	10.0	5.2	9.7	4.0	65.7
Ireland	7.5	4.2	4.9	9.5	7.2	8.5	5.3	5.9	7.5	60.6
Israel	9.0	7.1	1.4	9.4	8.5	0.5	4.9	6.6	0.9	48.3
Italy	4.7	4.7	4.4	9.9	9.3	3.3	6.4	4.8	2.8	50.3
Japan	7.6	9.2	4.7	9.9	10.0	4.5	3.3	6.9	6.5	62.6
Korea	7.5	7.8	3.3	9.3	8.2	0.0	6.5	10.0	2.6	55.2
Luxembourg	7.6	6.9	8.8	9.8	7.6	4.4	9.4	6.3	6.9	67.5

continued

Table 9.2 *continued*

State or country	Education	Jobs	Income	Safety	Health	Environment	Civic engagement	Accessibility to services	Housing	Total
Mexico	0.3	6.8	0.4	0.0	1.5	5.7	0.4	0.0	0.0	15.3
Netherlands	6.6	8.5	4.3	9.9	7.6	3.8	6.4	8.6	7.1	62.8
New Zealand	6.2	8.2	3.5	9.8	7.6	10.0	6.2	7.2	8.1	66.9
Norway	7.6	9.4	6.1	10.0	7.9	8.8	7.0	8.6	6.9	72.3
Poland	9.6	4.6	1.5	9.5	2.8	2.9	1.3	5.9	0.3	38.3
Portugal	0.5	5.0	3.1	9.8	6.8	7.3	3.0	5.0	6.4	46.9
Slovak Republic	9.9	4.1	1.9	9.5	1.3	3.0	3.2	5.9	1.4	40.3
Slovenia	8.8	6.1	3.3	9.3	6.4	3.4	0.0	6.5	3.3	47.2
Spain	3.6	0.9	4.3	9.9	9.0	6.4	5.1	5.9	6.3	51.5
Sweden	8.0	8.0	4.7	9.9	8.2	7.7	8.2	8.9	5.1	68.7
Switzerland	8.1	9.8	8.5	10.0	9.4	3.5	1.1	8.1	4.8	63.3
Turkey	0.0	3.7	2.5	9.2	1.7	2.6	8.8	3.0	0.1	31.6
United Kingdom	7.8	7.3	5.8	9.8	7.5	6.6	4.4	8.6	6.3	64.0
United States	8.5	6.7	10.0	8.1	5.7	7.2	5.0	6.8	9.7	67.7

ACT = Australian Capital Territory; NSW = New South Wales; NT = Northern Territory; Qld = Queensland; SA = South Australia; Tas = Tasmania; Vic = Victoria; WA = Western Australia

Other indices

Several other indices of livability are constructed internationally by various commercial organisations to inform the setting of remuneration for expatriate employees of international organisations and so do not necessarily reflect the livability of a city for residents.

Canberra achieves high scores in those indices in which it is included. One index that is calculated for Canberra is the Mercer Quality of Living Survey. In this survey for 2015, Canberra ranked 30th out of 230 cities. Other Australian cities ranked included Sydney (10th), Melbourne (16th), Perth (22nd), Adelaide (27th) and Brisbane (37th).¹³

9.2.3 Access to open space and green infrastructure

The ACT's natural environment and access to open space and outdoor recreation opportunities are widely recognised as contributors to the livability of Canberra. The *Canberra plan: towards our second century* (2008) said in its vision for Canberra in 2020 that:¹⁴

Canberra will be recognised throughout the world as a truly sustainable and creative city as a community that is socially inclusive – acknowledging and supporting those who are vulnerable and in need and enabling all to reach their full potential; as a centre of economic growth and innovation; as the proud capital of the nation and home of its pre-eminent cultural institutions; and as a place of great natural beauty.

Also, the *Canberra Social Plan 2011* states that:¹⁵

Canberra's reputation as the 'bush capital' is central to the city's character, identity and liveability. Access to shared open space and Canberra's trees improve the amenity of urban life, as well as individual health and wellbeing.

The importance of maintaining a local natural environment is also recognised in discussions about the future growth of Canberra. For example, Catherine Carter, ACT Executive Director of the Property Council of Australia, has stated:¹⁶

Smart growth means increasing density in places that support it – such as along transport corridors, in our town centres and suburban shops – while also protecting the precious natural environment and the lifestyle that we so love.

Natural and seminatural ecosystems – such as nature reserves, river areas and parks – can boost local economies and enhance health, security and good social relations.¹⁷⁻²³ One of the ways in which people benefit directly from a city's green infrastructure is through being able to access open spaces where they can exercise, relax, interact with their community and develop a strong sense of place. Green infrastructure not only includes a city's natural environment, but also built components that enable people to interact in green spaces such as pathways, cycle paths, jogging tracks, town squares and urban spaces.^{24,25} Studies have shown a clear positive link between access to green space, and wellbeing and health.^{26,27}

Green infrastructure is also recognised as a means of responding to some environmental pressures. Commonly cited environmental benefits of natural environments within cities include reducing air pollution, buffering noise pollution and regulating temperatures.^{17,28,29} For example, constructed wetlands are a well-recognised way to address impacts on water quality caused by human settlements, and vegetation provides shade, cooling and protection from winds, and noise buffering.²⁴

In the ACT, we have a mix of human-built environments, nature reserves, remnant bush and grasslands, as well as parks and other forms of urban open space. Together these areas contribute a range of benefits to human wellbeing and are important components of our city's livability.

Urban open space and reserves

The ACT's urban open space and reserves (at the end of 2013–14) consist of Canberra Nature Park, 8 town parks, 21 district parks, 88 shopping centres and 6012 hectares (ha) of urban open space.³⁰ There is also a considerable amount of open space accessible to Canberrans in Tidbinbilla Nature Reserve, Birrigai, Murrumbidgee River Corridor and Namadgi National Park. Including land outside reserves, the open space managed by Territory and Municipal Services (TAMS) totals more than 70% percent of the ACT land area.³⁰

In 2011–2015, the amount of managed urban open space increased by 4.4% (Table 9.3). Of particular note is the establishment of the National Arboretum Canberra, which has added 250 ha of managed and accessible urban open space. Planting began in 2005 on land occupied by commercial pine forests before the bushfires of 2003, and the arboretum was officially opened in February 2013. The area of reserves, which includes Tidbinbilla Nature Reserve, Birrigai, the Murrumbidgee River Corridor, Namadgi National Park and Canberra Nature Park (33 separate reserves) has declined slightly since 2011.

At present, the rate of increase in open space (4.4%) is slightly more than the rate of population growth (4.3%). Continuing population growth puts significant pressure on our green spaces, through the push to replace open space with residential and commercial development and through greater use by resident and visitors.

Through TAMS, the ACT Government currently owns and manages more than 7500 ha of pine forest planted with *Pinus radiata* trees up to 40 years of age. These commercial forests, mainly situated at Kowen (4658 ha), Pierces Creek (1552 ha) and Uriarra (1175 ha), produce timber and provide recreational opportunities, and have some environmental benefits including soil protection and carbon sequestration.³¹

TAMS measures customer satisfaction with TAMS management of urban open space through random telephone surveys of Canberrans, visitor surveys, and face-to-face interviews with visitors to parks and recreation areas. In 2010–2014, satisfaction levels were generally high for town and district parks and shopping centres (Table 9.4). However, satisfaction has declined for Tidbinbilla Nature Reserve and Namadgi, and children's play equipment.

Table 9.3 Urban open space and reserves assets managed by Territory and Municipal Services

Asset type	2010–11	2011–12	2012–13	2013–14	2014–15
Urban open space (ha)	5 783	5 862	5 889	6 038	6 134
National Arboretum Canberra, developed land (ha)	0	250	250	250	250
Forests (ha)	NA	11 393	11 337	11 323	10 982
Reserves (ha)	NA	146 382	146 381	146 312	146 611
Community paths (km)	NA	2 190	2 237	2 309	2 384

ha = hectare; km = kilometre; NA = not available

Source: Territory and Municipal Services^{32–36}

Table 9.4 Customer satisfaction with Territory and Municipal Services management of urban open space, 2010–2014

Element	2010–11	2011–12	2012–13	2013–14
Customer satisfaction with management of nature parks (Tidbinbilla Nature Reserve and Namadgi) (%)	99	99	98	99
Customer satisfaction with management of town and district parks (%)	96	97	91	92
Customer satisfaction with maintenance of children's play equipment (%)	97	89	86.5	89
Customer satisfaction with the general look and feel of local suburban shopping centres (%)	84	65	82	81
The level of visitor satisfaction at the National Arboretum Canberra (%)	–	–	–	96

– = not applicable

Source: Territory and Municipal Services^{37–40}

Urban trees

Urban trees provide a range of benefits to humans and the environment. For example, they:

- remove air pollution
- provide shade and cooling in summer, and shelter in winter
- help reduce energy use by shading buildings
- contribute to carbon sequestration and storage
- help manage stormwater run-off
- provide aesthetic, social and health benefits
- provide habitat for wildlife.

Canberra's urban forest consists of some 300 species, making it one of the largest and most diverse urban forests in Australia.³⁰ Urban tree management on public land in the ACT is a responsibility of TAMS and the National Capital Authority (NCA) (Table 9.5).

Although information on the number of trees on privately leased public land in Canberra is not

available, such trees also provide public benefits and larger trees are subject to tree protection.

Customer satisfaction with TAMS management of trees, measured by a random telephone sample of 1200 Canberra residents over the age of 18 years, varies considerably over the years (Table 9.6).

Urban lakes, ponds and wetlands

Urban wetlands in Canberra are almost entirely constructed wetlands aimed at improving the quality of run-off water before it enters creeks, rivers and lakes. Canberra's large lakes – Lake Burley Griffin, Lake Tuggeranong and Lake Ginninderra – are constructed urban wetlands designed to improve downstream water quality in the Murray–Darling Basin.

Water quality issues are discussed in Chapter 6: Water, but the extent of urban wetlands and assets is reported here as an indicator of the state of green infrastructure (Table 9.7). The extent of TAMS-managed lakes, ponds and wetlands is increasing, as are stormwater management assets.

Table 9.5 Urban trees managed by Territory and Municipal Services and the National Capital Authority

Tree management	2010–11	2011–12	2012–13	2013–14	2014–15
Urban trees managed by TAMS	715 000	732 000	736 527	746 221	751 624
Urban trees managed by the NCA	20 000	20 000	20 000	20 000	20 000'
Total	735 000	752 000	756 527	766 221	771 624

NCA = National Capital Authority; TAMS = Territory and Municipal Services

Note: Estimate

Source: Territory and Municipal Services^{32–35,41–43}, National Capital Authority^{41–43}

Table 9.6 Customer satisfaction with Territory and Municipal Services tree management, 2010–2015

Tree management	2010–11	2011–12	2012–13	2013–14
Customer satisfaction with maintenance and pruning of street trees (%)	73	55 ^a	55	85

a Includes 'somewhat satisfied' responses

Sources: Territory and Municipal Services^{37–40}

Table 9.7 ACT lakes and ponds, and related stormwater assets

Asset	2010–11	2011–12	2012–13	2013–14	2014–15
Lake Burley Griffin managed by NCA (ha)	664	664	664	664	664
Lakes and ponds managed by TAMS (ha)	NA	418	419	438	435
Stormwater managed by TAMS (km of pipe)	3529	3443	3480	3701	4176

NA = not available; ha = hectare; km = kilometre; NCA = National Capital Authority; TAMS = Territory and Municipal Services

Source: Territory and Municipal Services^{32–36}, National Capital Authority^{41–43}

Canberra's lakes and ponds are mostly designed as settling ponds to trap nutrients, soil and debris, and improve downstream water quality. They also increase the biodiversity of an area by providing a sanctuary for plants and animals, improve visual amenity and create a leisure area for the community. For example, Lake Burley Griffin contributes substantially to the livability of Canberra. Its shoreline is fully accessible to people and has numerous recreational facilities. Lakes Ginninderra and Tuggeranong also contain major recreational facilities, including beaches, designated swimming areas, jetties, boat ramps for nonpetrol powered boats, barbecues and playgrounds.

The Jerrabomberra Wetlands combine the functions of nature and recreation, with water quality improvement as an adjunct benefit. The Jerrabomberra Wetlands are part of Canberra Nature Park and were created from the Molonglo River floodplain by the filling of Lake Burley Griffin in 1964. The wetlands extend across 201 ha. Management is shared between TAMS and a management committee of the Capital Woodlands and Wetlands Conservation Trust. A refuge for migrating birds from the Northern Hemisphere and inland Australia, sections of the Wetlands provide important habitat and sensitive riparian areas. The central location of the wetlands – only four kilometres from Canberra's city centre – offers valuable recreational, experiential and educational opportunities. However, the combined effects of encroachment and isolation from other ACT reserves creates risks so that the existing ecological values of the wetlands may be diminished.⁴⁴

All lakes and wetlands clearly contribute positively, because they are considered to be green infrastructure that adds to livability. However, their primary functions – particularly water quality improvement – mean that other direct human uses such as swimming, boating and fishing need to be regulated. Such activities are prohibited in some ponds and wetlands, and may be subject to closures in the large lakes. Activity zones have been determined for each TAMS-managed water body, which are based on water quality and ecological criteria.⁴⁵ Therefore, to some extent, the contribution that urban lakes, ponds and wetlands make to the livability of Canberra is constrained by the need to control and restrict the use of these water bodies.

Balancing the various contributions of our water bodies with livability – particularly when the balance is in competition – is challenging given that a local catchment can spread across Australian, ACT and New South Wales (NSW) government jurisdictions. For example, the Commissioner for Sustainability and the Environment reported on water quality in Lake Burley Griffin and the state of its catchments in 2012. Currently, the recommendations made by the Commissioner are being progressed across the three jurisdictions, largely in the context of the implementation of broader ACT water policy (see Chapter 6).

For the future, maintaining the contribution of urban lakes, ponds and wetlands to the livability of Canberra will depend on implementation of best-practice water quality infrastructure, and management in the face of growing population and increasingly dense urban development.

Community gardens

Community gardens are a form of open space that is increasingly popular, according to ACT Government studies.^{46,47} (See Community case study 5.1 on page 131). In common with other initiatives by volunteer groups, maintaining viability over time is a challenge. However, the studies showed that having community gardens within walking distance of people's place of residence, access to good information and effective cross-sectoral partnerships can increase the chances of long-term success of these enterprises.

Sharing knowledge and work collectively in healthy and social environments around common interests are the main reasons people give for being involved. However, the studies also found some evidence that community gardeners are motivated by a desire to live more sustainably, take action to address climate change, promote food security and reduce food miles.

The potential of community gardens to strengthen and extend environmental awareness, especially for urban populations, should not be underestimated. For many people, gardens are the main location for engaging with the 'natural' world. With the global shift towards urbanisation, small residential blocks and apartment dwelling, private and public gardens are increasingly important as safe and inviting places where individuals and groups can experience and learn about aspects of the natural world. Community gardens can serve as learning and information hubs that offer connection with more explicitly ecological networks and, in turn, build and extend community action towards environmental protection and more sustainable living.

9.2.4 Built environment

The state of the built environment for the ACT, where 98% of the population lives within the city of Canberra, is a key determinant of livability for the residents.

Urban density

Although Canberra has a lower population density than other Australian capital cities, its population density is increasing (see Chapter 3).

The *Canberra spatial plan*, published in 2004, aimed to keep 50% of growth within 7.5 km of Civic and 50% within 15 km of Civic.⁴⁸

The *ACT Planning Strategy: Planning for a sustainable city*, published in 2012, now encourages residential construction in 'urban intensification localities', and aims for the proportion of new housing delivered through urban intensification to be 50% or more.⁴⁹

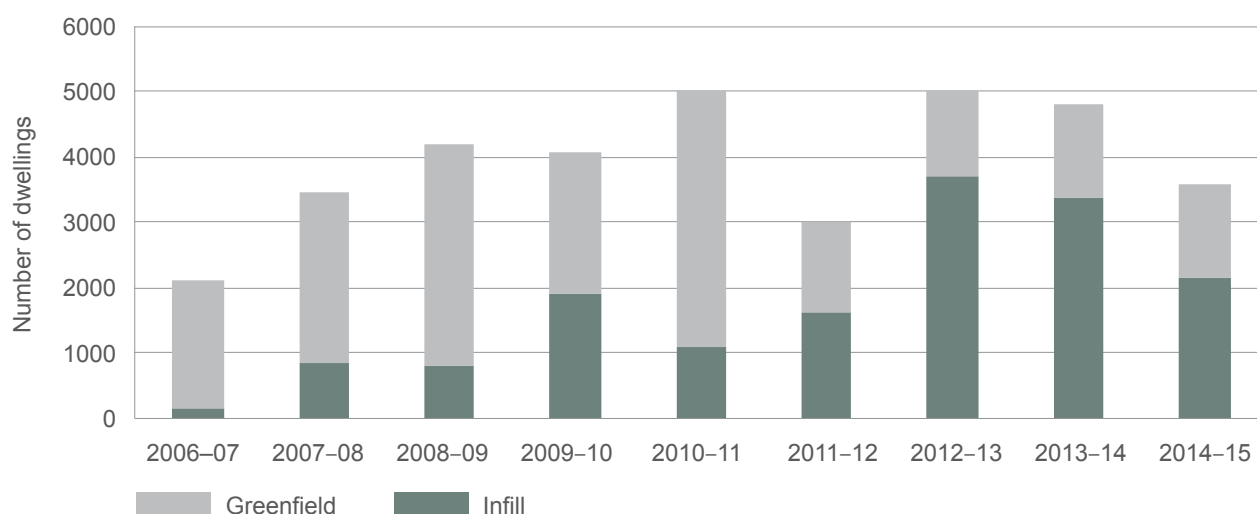
Data on infill development and greenfield development has been provided for this report by the ACT Land Development Agency (LDA). The LDA has the following definitions:

- Greenfield land – land that is located outside the existing urban boundary of the ACT. The land is generally located on the outer edge of the existing urban area and requires subdivision, road construction, connection to services and new retail, educational and community facilities. It includes land in Gungahlin and Molonglo.
- Urban infill – any redevelopment of serviced land within the urban boundary. Generally, the land has previously been used for an urban use, including car parking. Examples include development in Civic, local and town centres, dual occupancies and any redevelopment on leased land.
- Urban consolidation – the development of unserviced land within the existing urban boundary. Generally, the land requires servicing; however, the residents can rely on existing retail, educational and community facilities. For example, Lawson and East Lake.

The LDA included urban consolidation within urban infill in the data that it provided for this report.

Infill development was particularly high in 2012–2014, and still represents 59.7% of development in 2014–15 (Figure 9.3).

The land release program of the ACT Economic Development Directorate for 2014–15⁵⁰ indicates that, of the 13 500 proposed dwelling sites, 55% will be in infill areas and 45% in greenfield areas.



Source: Data provided by the ACT Land Development Agency, February 2015

Figure 9.3 New infill and new greenfield residential development in Canberra, 2006–2015

Housing

Housing standards and affordability are the result of many aspects of society, including the economy, individuals' lifestyle choices, the environment, planning systems and the state of housing markets. Housing is included in this report because it reflects key aspects of the government management of the natural and built environments. The impact of the ACT Government's policies on these are of great interest to the ACT community.

On the OECD regional wellbeing measure for housing, the ACT index number at 8.5 is higher than any other Australian state or territory except WA, and higher than any OECD economy except Canada and the United States (see Table 9.2).

Housing quantity

The Australian Census measures housing quantity in terms of dwelling type and number of rooms. In 2011, Canberra had 129 103 dwellings; 71.7% were separate houses, 14.6% were semidetached houses, and 13.4% were flats, units or apartments. From 2001 to 2011, the percentage of dwellings that are separate houses has declined and the percentages of semidetached dwellings, flats, units and apartments have increased (Table 9.8).

The quantity of housing in Canberra as indicated by persons per private dwelling or persons per bedroom is similar to the greater city areas for other Australian capitals (Table 9.9).

Table 9.8 Composition of dwelling types in the ACT (%), 2001–2011

Type of dwelling	2001	2006	2011
Separate house	76.4	75.0	71.7
Semidetached, row or terrace house, townhouse, etc			
One storey	8.8	8.3	9.1
Two or more storeys	4.2	5.2	5.4
<i>Total semidetached row or terrace house, townhouse, etc</i>	13.0	13.5	14.6
Flat, unit or apartment			
In a one- or two-storey block	4.0	4.2	4.3
In a three-storey block	3.6	4.1	4.8
In a four- or more storey block	1.4	2.6	4.0
Attached to a house	0.6	0.3	0.3
<i>Total flat, unit or apartment</i>	9.6	11.2	13.4
Other dwelling			
Caravan, cabin, houseboat	0.2	0.1	0.2
Improvised home, tent, sleepers out	0.0	0.0	0.0
House or flat attached to a shop, office, etc	0.0	0.0	0.0
<i>Total other dwelling</i>	0.3	0.2	0.3
Dwelling structure not stated	0.7	0.0	0.0

Source: Percentages calculated from Australian Bureau of Statistics data,
http://stat.abs.gov.au/Index.aspx?DataSetCode=ABS_CENSUS2011_T14_LGA

Table 9.9 Persons per private dwelling and bedroom, Australian cities, 2011

City	Persons per private dwelling	Persons per bedroom
Canberra	2.54	1.25
Greater Sydney	2.69	1.09
Greater Melbourne	2.62	1.14
Greater Brisbane	2.64	1.20
Greater Darwin	2.69	1.05

Source: Australian Bureau of Statistics⁵¹

Housing affordability

Housing affordability is calculated based on the incomes of residents, home purchase prices and rent. Some indicators are constructed to indicate affordability for purchasers of housing on average income levels. Other are constructed to indicate the level of unaffordability of home rental or purchase for low-income and disadvantaged groups. The rate of homelessness reflects the proportion of residents for whom housing is completely unaffordable.

The available indicators are:

- housing stress estimates made by Rahman and Harding (National Centre for Social and Economic Policy) for statistical subdivisions of Australia for 2011, covering owners, buyers, public renters and private renters separately
- Australian Bureau of Statistics (ABS) Consumer Price Index components for home purchase and rental

- price estimates for established houses compiled by the ABS, up to 2015
- assessments by the community welfare organisation Anglicare of the numbers of dwellings that are affordable for low-income households, up to 2014
- the rate of homelessness, measured five-yearly in the ABS Census of Population and Housing.

Housing stress estimates

Households in housing stress are defined as those with equivalised household gross income in the bottom 40% of all household incomes in Australia that are spending more than 30% of their gross household income on either renting costs or mortgage repayments.

In 2011, housing stress was lower in the ACT than in all other state and territories (Table 9.10).

Table 9.10 Housing stress estimates by tenure types, 2011

Jurisdiction	Percentage of households in housing stress					
	Overall total	Owners	Buyers	Public renters	Private renters	Other tenure
ACT	6.6	0.0	4.5	20.0	15.4	0.0
NSW	11.6	0.1	11.0	17.8	29.9	0.1
NT	9.4	0.4	7.1	19.3	15.7	0.0
Qld	11.3	0.1	9.8	15.7	27.9	0.1
SA	10.5	0.1	9.9	15.2	32.7	0.1
Tas	10.1	0.1	10.3	14.0	32.0	0.1
Vic	10.4	0.1	11.0	17.2	28.6	0.1
WA	9.9	0.1	8.9	14.9	26.9	0.2
Australia	10.9	0.1	10.3	16.7	28.7	0.1

ACT = Australian Capital Territory; NSW = New South Wales; NT = Northern Territory; Qld = Queensland; SA = South Australia; Tas = Tasmania; Vic = Victoria; WA = Western Australia

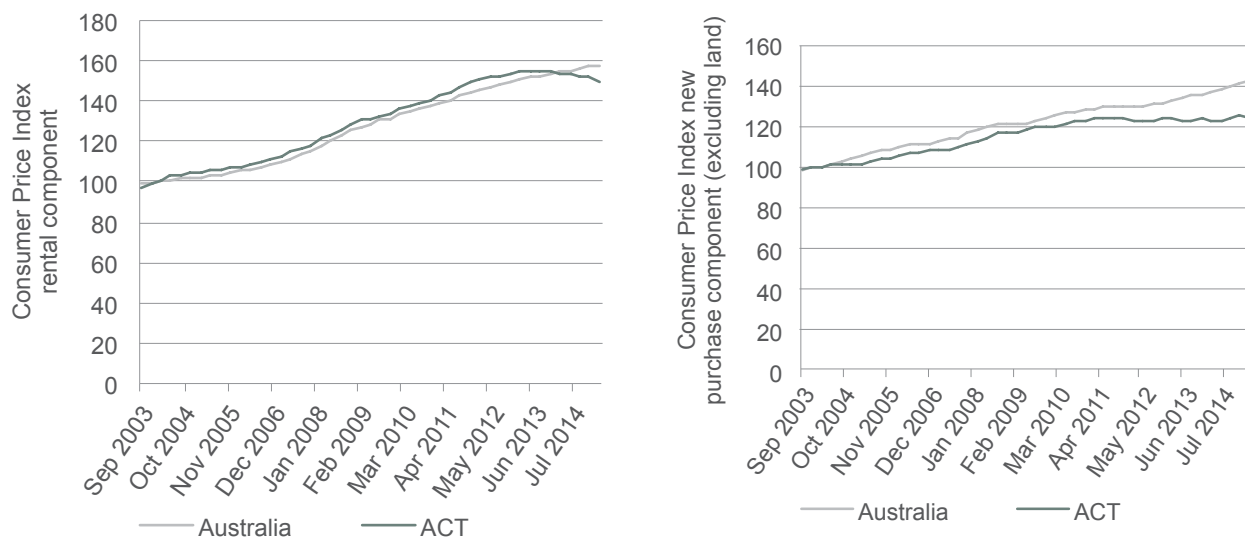
Note: Figures have been rounded to one decimal place. Rahman and Harding⁵² provided figures up to three decimal places.

Source: Rahman & Harding⁵²

Australian Bureau of Statistics Consumer Price Index

The ABS Consumer Price Index contains components for housing cost as a whole, housing rents and new

house purchases (excluding land). In 2003–2012, all these measures increased at a similar rate to those for all of Australia, but in the ACT in 2012–2014, these have slowed to fall below the rest of Australia (Figure 9.4).



Note: Calculations were rebased to 2003–04 = 100 by the Office of the Commissioner for Sustainability and the Environment.
Source: Australian Bureau of Statistics Consumer Price Index Australia, cat no 6401.0, components

Figure 9.4 Australian Bureau of Statistics Consumer Price Index components for housing, rentals and new purchases, 2003–2015



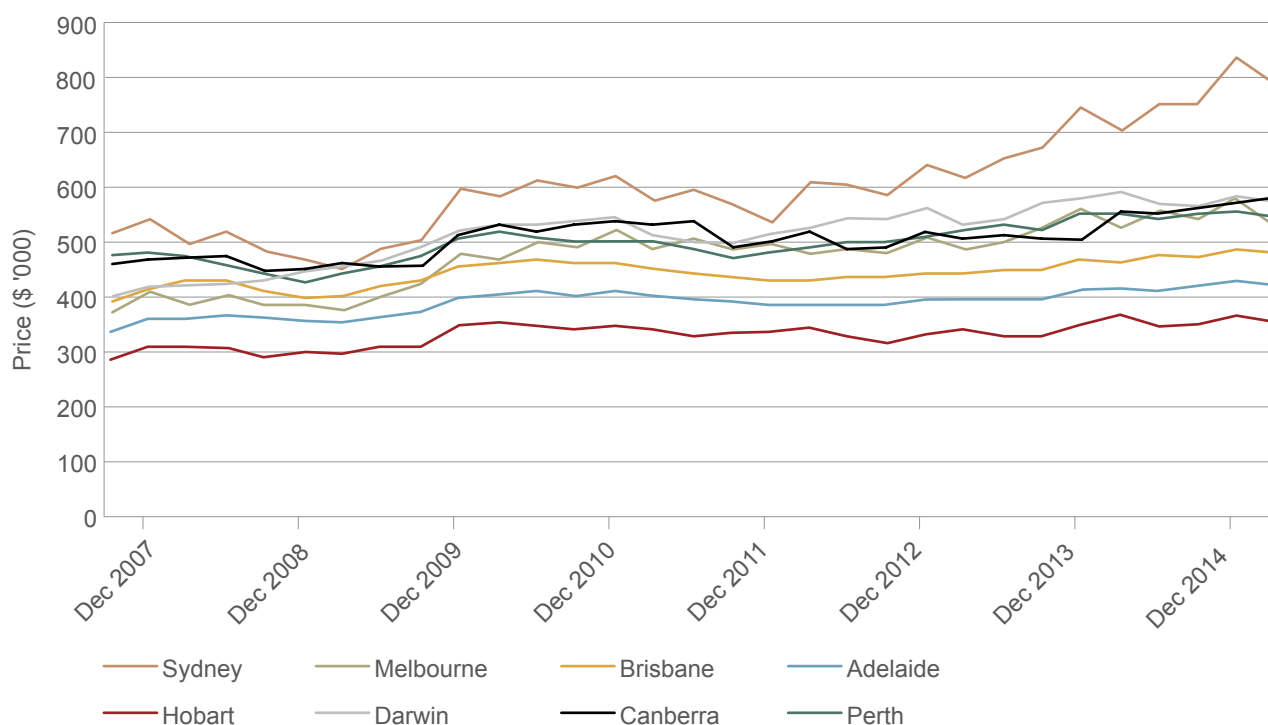
Canberra has a mixture of housing types, as well as a mix of infill and Greenfield development. Photo shows Greenfield development at Molonglo
Photo: Office of the Commissioner for Sustainability and the Environment

Price of established housing

ABS data show that Canberra house prices, including land, have increased from 2007, but have maintained their relativity with prices in other capital cities (Figure 9.5). The average 2013–14 median price of an established house in Canberra was \$520 950

compared with \$719 700 in Sydney and around \$544 000 in Melbourne and Perth.

However, it should be noted that these data are based on prices recorded in the housing market and make no allowance for changes in the composition of housing types or quality of dwelling that appear on the market.



Source: Australian Bureau of Statistics⁵³

Figure 9.5 Median price of established houses, Australia capital cities, 2007–2014

Affordable dwellings for low-income households

The community welfare organisation Anglicare surveys rental markets across Australia to determine the number of private properties that are affordable for low-income households within those advertised as vacant in local newspapers and real estate websites (Table 9.11). Low-income households are defined in terms of payment types received (eg Newstart allowance, age pension, minimum wage; and family

structure). An affordable rental is defined by Anglicare as one that takes up less than 30% of the household's income.

Anglicare concludes that:⁵⁴

The private rental market in Canberra and Queanbeyan is extremely unaffordable for persons on a low income such as minimum wage or government benefits. (p 44)

Table 9.11 Affordable housing in Canberra and Queanbeyan for low-income households, 2015

Household type	Payment type	Number affordable and appropriate	Percentage affordable and appropriate
Couple, two children (one aged less than 5, one aged less than 10)	Newstart allowance (both adults)	0	0.0
Single, two children (one aged less than 5, one aged less than 10)	Parenting payment single	0	0.0
Couple, no children	Age pension	57	2.7
Single, one child (aged less than 5)	Parenting payment single	1	<0.1
Single, one child (aged over 8)	Newstart allowance	0	0.0
Single	Age pension	70	3.3
Single, aged over 21	Disability support pension	0	0.0
Single	Newstart allowance	1	<0.1
Single, aged over 18	Youth allowance	0	0.0
Single in share house	Youth allowance	0	0.0
Couple, two children (one aged less than 5 one aged less than 10)	Minimum wage plus Family Tax Benefit A (both adults)	153	7.2
Single, two children (one aged less than 5 one aged less than 10)	Minimum wage plus Family Tax Benefits A and B	1	<0.1
Single	Minimum wage	160	7.5
Couple, two children (one aged less than 5 one aged less than 10)	Minimum wage plus parenting payment (partnered), plus Family Tax Benefits A and B	3	0.1

Note: The total number of properties was 2125.

Source: Anglicare Australia,⁵⁴ p 43

Homelessness

In 2011, the rate of homelessness in the ACT was 50 people per 10 000 in the population, or 0.5%,⁵⁵ substantially higher than the rate measured in the 2006 Census (0.29%) and the 2001 Census (0.30%).

The rate of homelessness in the ACT in 2011 was similar to that for other states and territories, with the exceptions of the Northern Territory, which

experiences very high homelessness rates of 7–9%, and Tasmania, where homelessness rates are low. However, there is more uncertainty in the level of homelessness measured for the ACT than in larger states because the ABS Census covers fewer people in the ACT. As measured in the 2001 and 2006 censuses, homelessness in the ACT was below that of other states and territories except Tasmania (Table 9.12).

Table 9.12 Australian homelessness, by jurisdiction, 2001, 2006 and 2011

State or territory	2001		2006		2011	
	Number	Percentage of population	Number	Percentage of population	Number	Percentage of population
ACT	943	0.304	949	0.293	1 785	0.500
NSW	23 041	0.364	22 219	0.339	28 190	0.408
NT	16 948	9.040	15 265	7.917	15 479	7.307
Qld	19 316	0.548	18 856	0.483	19 838	0.458
SA	5 844	0.398	5 607	0.370	5 985	0.375
Tas	1 264	0.275	1 145	0.240	1 579	0.319
Vic	18 154	0.389	17 410	0.353	22 789	0.426
WA	9 799	0.536	8 277	0.423	9 592	0.428
Total	95 314	0.508	89 728	0.452	105 237	0.489

ACT = Australian Capital Territory; NSW = New South Wales; NT = Northern Territory; Qld = Queensland; SA = South Australia; Tas = Tasmania; Vic = Victoria; WA = Western Australia

Source: Australian Bureau of Statistics⁵⁶

9.2.5 Connectivity, transport and congestion

Transport is an essential part of modern living – it supports our work, education, industry, social connection and recreation.

Viv Straw, President, Planning Institute Australia (ACT Division), said that the livability of cities depends on interconnection:

No place exists in isolation; every place is connected to its hinterland, other urban areas, food sources, water supplies, to other people and information. How these connections function is fundamental to the liveability and efficiency of the city. The most liveable cities are ones that facilitate freedom of movement and access for everyone. Trobe⁵⁷

Transport assets

ACT transport assets consist of the road and path networks for vehicular and pedestrian traffic, vehicles, and supporting facilities such as bus stations, parking facilities and bike racks.

Roads and paths

The growth rate of roads and paths has exceeded population growth during the reporting period.

Lane length of roads grew by 5.6% between 2010–11 and 2014–15, while on-road and off-road cycle path length combined grew by 25.4%, Community paths grew in length by 8.8% between 2011–12 and 2014–15 (Table 9.13).

On 28 May 2015, the ACT Government foreshadowed new funding initiatives to be announced in the budget to improve cycling and walking infrastructure:

- \$250 000 to fund the design of an upgrade for new and existing shared paths and cycle infrastructure in and around the Woden Town Centre
- \$600 000 to construct a new shared walking and cycling path through Bowen Park, connecting it to the Kingston Foreshore and making it easier to ride a loop around Lake Burley Griffin
- \$1.5 million to facilitate the final design and construction of new road crossings on the busy Sullivan's Creek cycle path
- \$200 000 to design stage 1 of the Molonglo Cycle Highway from the city centre to Acacia Inlet
- \$150 000 to design improvements to increase ease of cycling and walking to and from the Kingston Group Centre
- \$100 000 for Belconnen, West Belconnen and Tuggeranong feasibility studies to identify local walking and cycling path connections.

Table 9.13 Publicly owned and managed transport assets in the ACT, 2010–2015

Year	Road length (lane km)	On-road cycle lane length (km)	Off-road cycle lane length (km)	Community paths (km)
2010–11	6394	377	342	NA
2011–12	6580	403	343	2190
2012–13	6623	402	396	2237
2013–14	6680	416	420	2309
2014–15	6751	466	436	2384

km = kilometre; NA = not available

Source: Territory and Municipal Services Directorate

Buses

The ACT Internal Omnibus Network (ACTION) is responsible for public transport services in the ACT. ACTION is a branch in the Roads and Public Transport Division of TAMS.

The number of public buses in service in the ACT has declined since 2010–11, but the number of wheelchair-accessible buses has grown by around 40% (Table 9.14).

In 2013–14, ACTION continued a bus replacement program, with 13 articulated buses entering service. The delivery of 77 low-emissions buses is scheduled between 2014 and 2017.

Taxis

There are 288 standard taxis operating in the ACT, and there is a Government-imposed cap on the number of taxi licences (currently set at 332). There are 19 wheelchair-accessible taxis operating and there is a cap of 26 on the number of licences. In addition, there are 20 taxi licences issued in

NSW that allow cross-border operation into the ACT. There are 72 000 to 105 000 hirings of standard taxis in the ACT per month,⁵⁸ and 2000 to 2700 hirings of wheelchair-accessible taxis.⁵⁹

In 2014 and 2015, the ACT Government looked at ways to expand the range of, and access to, reliable and convenient on-demand public transport options through new digital technologies and emerging alternative business models.⁶⁰ Public consultation on the Taxi Industry Innovation Review was completed at the end of June 2015⁶¹ and reforms were announced after the end of the reporting period, on 30 September 2015. As a result, Uber and other ridesharing businesses were to legally enter the Canberra market from 30 October 2015.

Private vehicles

The ACT has fewer motor vehicle registrations per person than the Australian average, but a higher number of registered passenger motor vehicles per person, and our vehicle registrations per person are rising (Table 9.15).

Table 9.14 ACT buses in service, 2010–2015

Year	Total buses in service	Wheelchair-accessible buses in service	Buses with bike racks
2010–11	458	200	NA
2011–12	403	221	326
2012–13	411	242	335
2013–14	408	251	335
2014–15	416	281	394

NA = not available

Source: Territory and Municipal Services Directorate

Table 9.15 Private vehicle registrations, 2010, 2014 and 2015

Registrations	2010	2014	2015
ACT registrations per head	0.704	0.728	0.733
Australia registrations per head	0.731	0.756	0.764
ACT passenger vehicles registrations per head	0.592	0.608	0.612
Australia passenger vehicles registrations per head	0.559	0.570	0.575

Source: Australian Bureau of Statistics⁶²

In addition, motor vehicle use is increasing more in the ACT than in the rest of Australia (Table 9.16).

Parking

In 2014, a survey of ACT parking areas⁶⁴ showed that, at peak times, long-stay parking was in very high demand in the city centre, inner south, Belconnen and Tuggeranong (the percentage of parks filled ranged

from 80% to 85%), and was almost at capacity in Woden (93%) (Table 9.17). Demand for short-stay parking was also high, with the percentage of filled parks ranging from 79% to 87% across all centres.

Parking is recognised by the ACT Government as a crucial component of an integrated transport network, particularly given Canberra's dependence on car-based passenger travel and the need for delivering goods and services by motor vehicle.

Table 9.16 Increase in vehicle use, ACT and Australia, 2010–2014

Vehicle-use indicator	ACT increase (%)	Australia increase (%)
Total km travelled	4.8	7.8
Number of vehicles	7.6	10.2
Average kilometres per vehicle	-2.9	-2.1

Source: Australian Bureau of Statistics⁶³

Table 9.17 Preliminary 2014 parking survey results

Survey	Long-stay parking supply	Weekday long-stay parking filled at demand peak (%)	Short-stay parking supply	Weekday short-stay parking filled at demand peak (%)
City centre	10 380	85	2608	75
Inner south ⁴	4 204	84	3636	72
Belconnen Town Centre ⁵	6 098	82	1943	87
Gungahlin Town Centre ^{6,7}	2 456	65	1019	79
Tuggeranong Town Centre	3 390	80	1030	77
Woden Town Centre ⁵	6 120	93	1946	82

Source: ACT Government⁶⁴

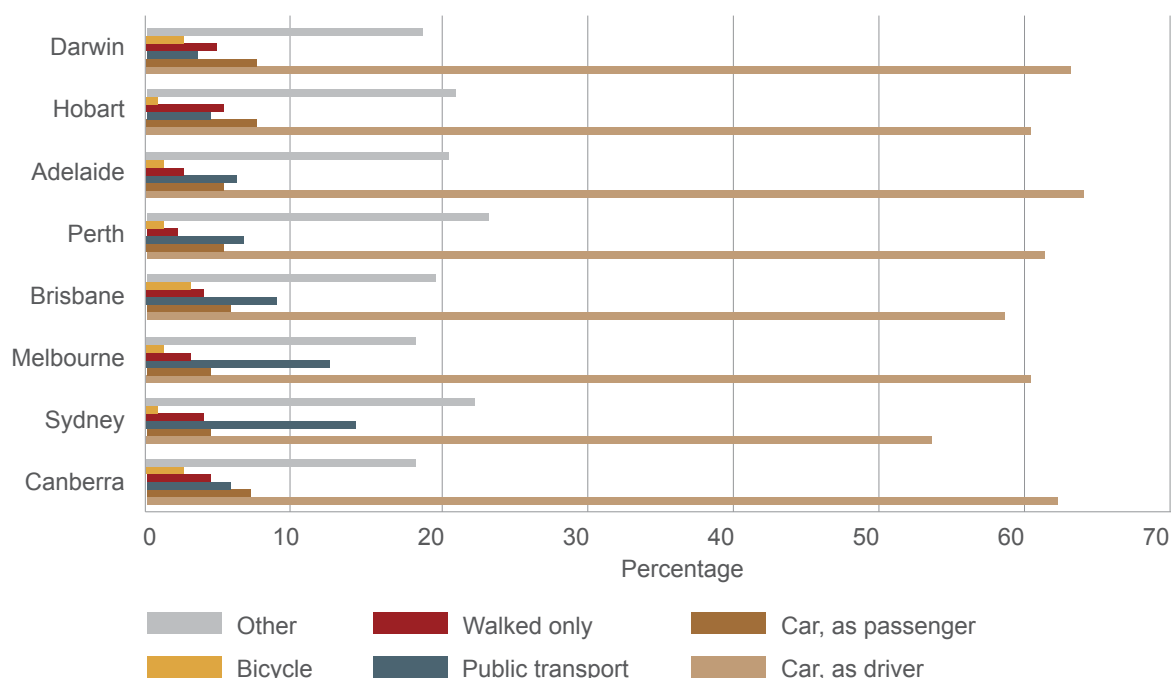
The ACT Government's parking action plan, *Building an integrated transport network: parking*,⁶⁴ released in June 2015, is designed to make parking more accessible by:

- reducing free surface parking in the city and town centres, and replacing it with pay parking
- prioritising short-stay parking, and providing mobility, taxi, loading and other priority parking requirements
- moving long-stay and commuter parking to the periphery of the city centre and town centres
- replacing surface car parks with car park structures
- using technology to better manage the supply of parking and to better inform and guide motorists to fit-for-purpose parking – for example, by informing motorists of vacancies in car parks via a smart phone app
- using pricing, time and capacity limits to ration demand in high-demand areas, to encourage using public transport and active travel

- not providing any form of preferential access to on-street parking for residents of high-density residential developments
- considering opportunities for additional 'park-and-ride' facilities in the context of existing transport and land uses at centres, and establishing such facilities, particularly for people who are not able to access the frequent bus network by walking, cycling or using the feeder bus service
- implementing parking options at ACT schools that support safe school environments and increased active travel to school.

Transport modes and use

Comparisons of the modes of transport to work used in Australian capital cities confirms that the ACT is highly dependent on cars, as are most other cities (Figure 9.6). In most cities, more than 60% of trips to work are made in cars. The ACT has the third-lowest use of public transport among Australian capital cities. However, the ACT also has one of the highest rates of bicycle use and walking in Australian capital cities, based on data collected in the 2011 Census.



Note: 'Other' comprises commuters who used multiple modes of transport.

Source: Australian Bureau of Statistics⁶⁵

Figure 9.6 Modes of transport to work, Australian capital cities, 2011

Buses

Bus use in the ACT sharply declined from the 1980s to the 2000s (Table 9.18), probably in response to an increase in car affordability. Since then, bus use has remained stable at 40–50 boardings per person each year.

Data on ACTION expenses, revenue and kilometres travelled shows that fare revenue is only around 15% of total expenses, and the gap between revenue and

expenses has been increasing until the final year of the reporting period (Figure 9.7).

The in-service kilometres travelled by ACTION buses, which generates revenue, and total kilometres travelled, which includes distances travelled by buses that are out of service (known as ‘dead running’), are shown in Figure 9.8. The amount of ‘dead running’ has been reduced in the final year of the reporting period following a long-term increase.

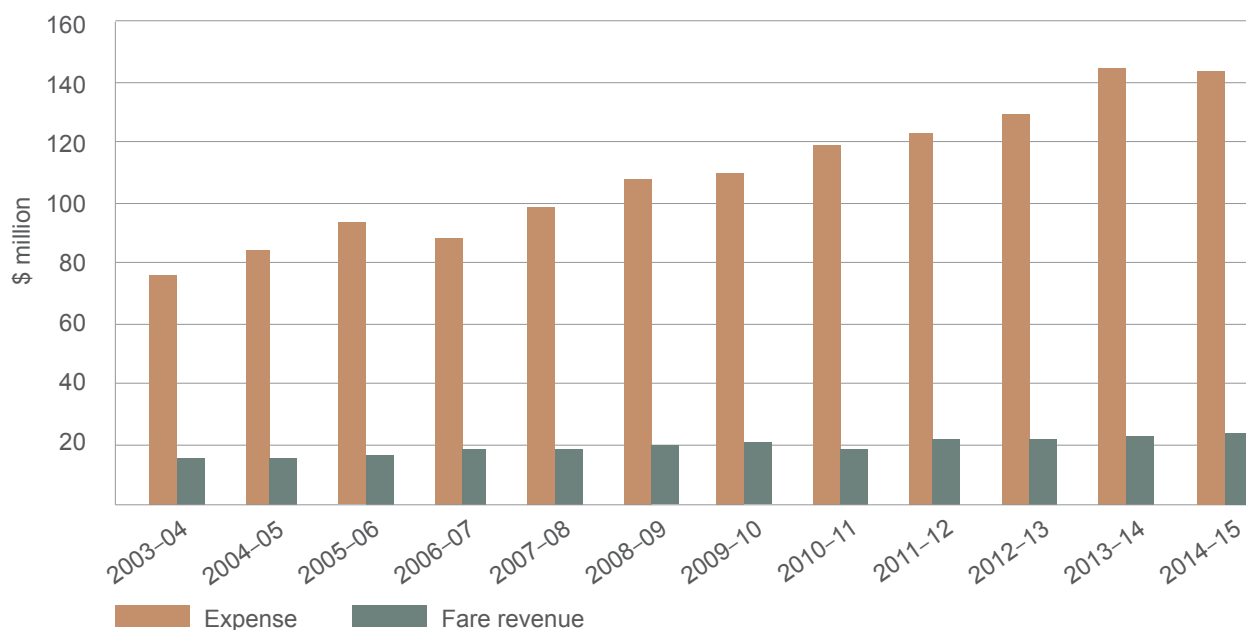
Table 9.18 ACT bus use, 1983–2015

Year	Annual ACTION bus boardings (million)	ACT population (30 June)	Per capita ACTION bus boardings
1983–84	23.2	245 000	95
1989–90	25.1	273 000	92
2002–03	16.3	327 357	50
2003–04	16.3	328 940	50
2004–05	16.8	331 399	52
2005–06	17.1	335 170	51
2006–07	16.8	342 644	49
2007–08	16.9	348 368	49
2008–09	17.6	354 785	50
2009–10	16.9	361 766	47
2010–11	16.7	367 985	45
2011–12	18.2	375 183	49
2012–13	18.1	381 488	48
2013–14	17.8	385 996	46
2014–15	17.6	388 000 ^a	45

ACTION = ACT Internal Omnibus

a Estimate

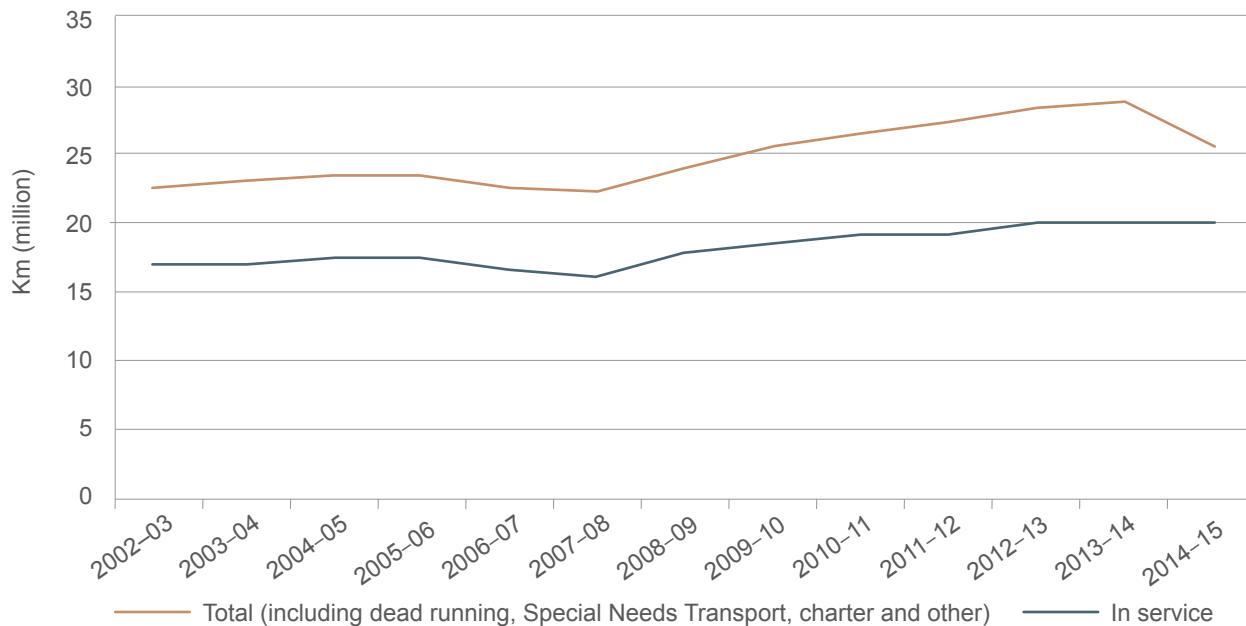
Source: Data provided by Territory and Municipal Services Directorate



ACTION = ACT Internal Omnibus

Source: Data provided by Territory and Municipal Services Directorate

Figure 9.7 ACTION expenditure and fare revenue, 2002–2014



ACTION = ACT Internal Omnibus; km = kilometre

Source: Data provided by Territory and Municipal Services Directorate

Figure 9.8 In-service and total kilometres travelled by ACTION buses

Cycling

The 2015 National Cycling Participation Survey found that:⁶⁶

- 81 900 people in the ACT ride their bike at least once a week
- absolute cycling numbers in the ACT have increased by 3.7% since 2011
- the overall participation rate of riders in the ACT is 23% higher than the national average.

Pedal Power ACT surveys show that bicycle use has increased most in Civic and Belconnen, but has declined in Woden (Figure 9.9).⁶⁷

The Strategic Active Travel Network sets out the preferred strategy for the development of the walking and cycling network for the next 10–15 years. The network links with future land development and urban growth, and identifies infrastructure projects and non-infrastructure initiatives to increase active travel in the ACT.

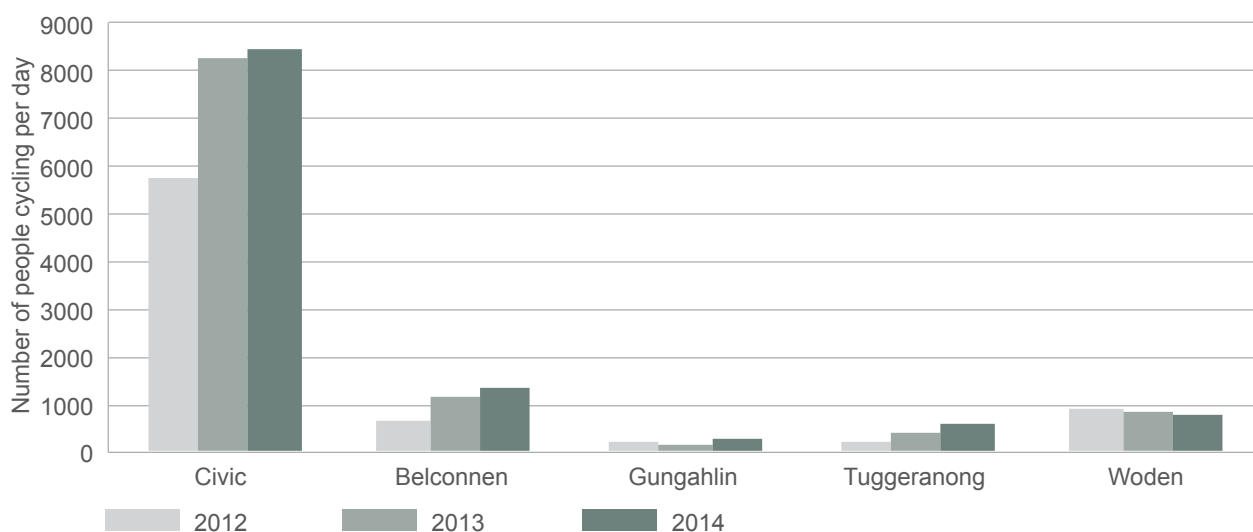
Walking

In 2011, Canberra had the third-highest mode share of walking to work (when not combined with other modes) within Australian capital cities at 4.2%, behind Darwin and Hobart.⁶⁵ Data on the ACT's frequency of walking in the reporting period are not available.

Congestion

The amount of time that urban residents spend on travel between daily activities, and the level of convenience and stress experienced in travel, are major factors affecting the livability of a city.⁶⁸ As well as affecting livability, congestion also has an economic cost because of lost work time.

Two indicators of congestion are the international TomTom Traffic Index, and Infrastructure Australia estimates of time lost through congestion and valuation of the time lost.



Source: Pedal Power ACT⁶⁶

Figure 9.9 Bicycle use in Canberra areas, 2012–2014

TomTom Traffic Index

The TomTom Traffic Index indicates that Canberra is among the least-congested cities internationally. In this index for 2015, Canberra ranked as the 185th most congested out of 218 cities, and the 59th most congested out of 72 small cities (those with a population under 800 000). Canberra has the lowest congestion ranking of any Australian city (Table 9.19).

Infrastructure Australia data on congestion and costs

The 2015 Australian Infrastructure Audit Report⁶⁹ estimates the costs of road congestion for 2011 and projected for 2031. The cost of congestion is projected to increase substantially by 2031 in Canberra and other Australian cities. As shown with the TomTom data, Canberra has the lowest cost of congestion of any Australian city (Table 9.20).

Table 9.19 TomTom Traffic Index for Australian cities, 2015

City	World ranking as most congested city out of 218	Average all day congestion level (%)	Morning peak congestion level (%)	Evening peak congestion level (%)	Highways congestion level (%)	Non-highways congestion level (%)
Sydney	27	35	66	64	31	37
Melbourne	75	28	52	51	21	35
Perth	92	27	46	46	20	29
Adelaide	104	25	45	41	25	26
Brisbane	115	25	43	46	18	28
Canberra	185	17	33	28	18	17

Notes:

1. The TomTom Traffic Index measures travel times during the whole day and during peak periods, and compares these with measured travel times during noncongested periods. The congestion level is the average percentage increase in travel time in congested periods compared with noncongested periods.
2. The 2015 index is based on data for all of 2014.

Source: TomTom traffic index, https://www.tomtom.com/en_au/trafficindex/#

Table 9.20 Cost of road congestion, 2011 and projected 2031 (\$ million, 2011 prices)

	Sydney, Newcastle, Wollongong	Melbourne, Geelong	Brisbane, Gold Coast, Sunshine Coast	Greater Perth	Greater Adelaide	Greater Canberra
2011	5 555	2 837	1 914	1 784	1 442	208
2031	14 790	9 006	9 206	15 865	3 747	703

Note: The methodology does not account for new investments in infrastructure that will happen between 2015 and 2031, apart from infrastructure that is already under construction and for which a firm funding commitment has been made. For Canberra, the estimates do not assume that the Gungahlin to Civic light rail will proceed.

Source: Infrastructure Australia,⁶⁹ p 32, using data from ACIL Allen Consulting⁷⁰

More useful is the audit's comparison of Canberra's top 10 road corridors by delay cost. The high delay cost in the Barton Highway – Northbourne Avenue corridor confirms the importance of the ACT Government's focus on that corridor (Table 9.21),⁷¹ and its plans for the Capital Metro project to construct a light rail connection between Gungahlin and Civic to increase the mode share of public transport.

Road accidents

The safety of ACT roads is another measure of livability.

The total number of vehicle crashes in the ACT peaked in 2011 and has declined since then (Figure 9.10).

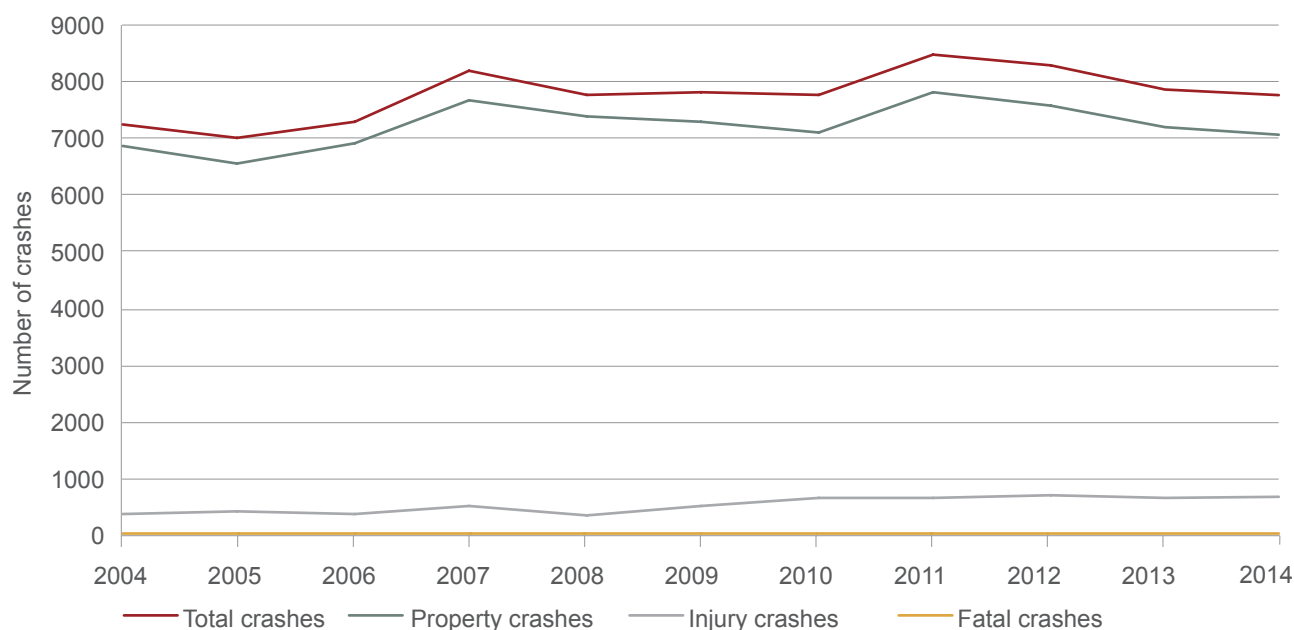
The number of fatal crashes has also declined (Figure 9.11). In particular, lower numbers of drivers and motorcycle riders have been killed on ACT roads since 2011.

Table 9.21 Top 10 road corridors in greater Canberra, by delay cost, 2011 and projected for 2031 (2011 prices)

Road corridor	Delay cost per lane km 2011 (\$ million)		Direct economic contribution per lane km 2011 value (\$ million)		Volume capacity 2011 7–9 am peak (%)	
	2011	2031 projected	2011	2031 projected	2011	2031 projected
Barton Highway – Northbourne Avenue	0.43	1.22	2.16	3.69	54	68
Canberra Avenue	0.38	1.18	1.85	3.82	57	72
Belconnen Way – Barry Drive	0.35	1.15	1.82	3.54	52	67
Canberra Airport to Civic	0.32	1.11	1.62	3.32	60	79
Tuggeranong Parkway	0.28	0.76	1.58	2.98	58	64
Macarthur Avenue – Limestone Avenue – Fairbairn Avenue	0.20	0.68	1.37	2.55	52	68
William Slim Drive – Coulter Drive	0.20	0.63	1.04	1.96	61	72
Erindale Drive – Yamba Drive	0.18	0.60	1.03	2.53	52	NA
Ginninderra Drive	0.18	0.59	1.16	2.98	55	NA
East–West corridors	0.16	0.58	1.12	2.06	56	NA

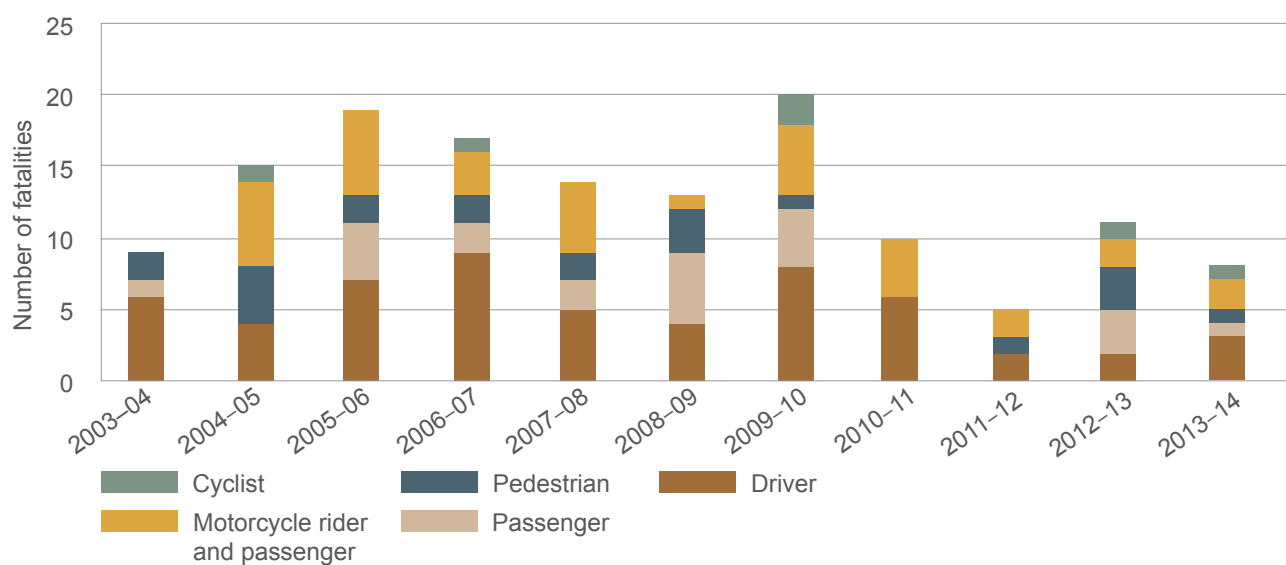
km = kilometre; NA = not available

Source: Infrastructure Australia⁷¹



Source: ACT Justice and Community Safety Directorate⁷²

Figure 9.10 ACT road crash trends, 2004–2014



Source: Bureau of Transport and Regional Economics^b

Figure 9.11 ACT road crash fatalities, 2003–2014

^b Australian Road Deaths Database, https://bitre.gov.au/statistics/safety/fatal_road_crash_database.aspx

A decline in road crash fatalities is also seen in national data (Table 9.22). Comparison with other states and the Northern Territory also shows that the ACT has a relatively low rate of fatalities; however, the data do not account for deaths of ACT citizens in the adjoining regions of NSW.

9.2.6 Human health

Individual human health and the health levels of populations are the result of many environmental, behavioural, cultural, genetic, social and economic influences. Many of the environmental factors do not noticeably affect health levels in the ACT, because they are effectively managed to prevent any impacts on human health. For example, drinking water quality, air quality, sewage and solid waste are managed using large physical infrastructure, labour and financial resources. Assessment of these is presented in the relevant chapters of this report.

Human health impacts are also a result of our broader management of the environment and choices about the form of human settlements.⁷⁴ As stated in the 2011 State of the Environment Report:⁷⁵

Increasingly, connections are being made between the design and layout of urban areas and aspects of human health such as obesity, mental health and respiratory problems such as asthma.

State and trend

In the ACT, human health is monitored by the ACT Chief Health Officer who publishes the Chief Health Officer's report every two years. The 2014 report, which covers 1 July 2010 to 30 June 2012, states that:⁷⁶

I am pleased to report a continuing trend of good health in the ACT. Our Territory enjoys a relatively clean climate, good employment, affluence of income, education and housing, has excellent social, community and health services and has the highest life expectancy of all states and territories in Australia.

Table 9.22 Annual road crash fatalities, by jurisdiction, per 100 000 population, 2005–2014

Year	ACT	NSW	NT	Qld	SA	Tas	Vic	WA	Australia
2005	7.8	7.6	26.7	8.4	9.6	10.5	6.9	8.1	8.1
2006	3.9	7.4	21.5	8.4	7.5	11.2	6.7	9.8	7.8
2007	4.1	6.4	27.1	8.8	7.9	9.1	6.4	11.2	7.7
2008	4.0	5.4	34.1	7.8	6.2	7.8	5.8	9.4	6.8
2009	3.4	6.4	13.7	7.6	7.4	12.5	5.4	8.5	6.9
2010	5.3	5.7	21.8	5.7	7.3	6.1	5.3	8.4	6.1
2011	1.6	5.0	19.5	6.0	6.3	4.7	5.2	7.6	5.7
2012	3.2	5.0	20.8	6.1	5.7	6.1	5.0	7.5	5.7
2013	1.8	4.5	15.3	5.8	5.9	7.0	4.2	6.4	5.1
2014	2.6	4.1	15.9	4.7	6.3	6.8	4.3	7.0	4.9

ACT = Australian Capital Territory; NSW = New South Wales; NT = Northern Territory; Qld = Queensland; SA = South Australia; Tas = Tasmania; Vic = Victoria; WA = Western Australia

Source: Bureau of Infrastructure, Transport and Regional Economics,⁷³ Table 5.4

However, some data from the Chief Health Officer's Report indicate negative health impacts (Table 9.23). Although physical activity and vegetable consumption are increasing, the prevalence of overweight and obesity is not decreasing. The occurrence of asthma (which may be related to air quality) has increased slightly since 2007–08. The rate of mental health and behavioural problems is increasing.

Similar findings were reported in the 2011 State of the Environment Report. For example:⁷⁵

While Canberra's liveability and health indicators compare favourably with other jurisdictions, reliance on car travel is likely to contribute to overweight and obesity.

According to the Chief Health Officer's Report, the main health issues in 2010–12 included:

- improving health status is challenging in the areas of severe poverty in our community
- living in an ageing society, and already noticing the increase in age-associated chronic disease
- the continuing rise of obesity, its determinants (including suboptimal physical activity and high-energy, nutrient-poor diets) and consequences (including diabetes, cardiovascular disease, arthritis and some types of cancer) are of concern
- an encouraging reversal in a previous trend for lower physical activity in adults, but not in children; urgent, sustained, intersectoral action is required to address this problem at the societal level
- living with a mental illness; there is a mixed picture for mental health, with prevalence higher than elsewhere in Australia, but with higher-than-average access to specialist services and to out-of-hospital follow-up care.

9.2.7 Response

'Livability' has become a core orienting principle in national and international government policy and initiatives.^{3,7}

In the ACT, the Government has recently articulated four strategic themes to which all ACT Government directorates contribute: livability and opportunity, growing the economy, healthy and smart, and urban renewal.⁸⁰

These themes are implemented under the overarching framework of *The Canberra plan: towards our second century* (2008). This built on the original Canberra Plan launched in 2004, which established a vision for Canberra as a sustainable and creative city.¹⁴ The plan includes a range of policies and strategies across social, economic and environmental matters.

Table 9.23 ACT human health indicators, 2007–2012

Indicator	2007–08	2009–10	2011–12
Overweight or obese (%)	57.8	52.9	52.3 ^a
Sufficient physical activity (%)	57.0	56.9	59.6
Sufficient daily vegetable consumption (%)	7.2	9.9	11.0
Adults reporting asthma (%)	9.6	NA	10.2
Mental health or behavioural problems (%)	11.8	NA	15.5

NA = not available

a From the Australian Health Survey. The ACT Government Health Service survey reports this as higher, at 63.0%.

Sources: ACT Health^{77–79}

This section considers the environmental aspects of five ACT Government policy documents under the framework of the Canberra Plan that are particularly relevant to livability.^c These are:

- *People, Place, Prosperity: the ACT's Sustainability Policy 2009*
- *ACT Government Infrastructure Plan 2011–12*
- *ACT Planning Strategy: Planning for a sustainable city (2012)*
- *Transport for Canberra: Transport for a sustainable city 2012–31*
- *Building an Integrated Transport Network: Active Travel (2015).*

Together, these policies and strategies aim to maintain and improve Canberra's livability.

This section will also consider specific management activities around some of the livability indices, such as the management of open space and trees, and activities directed at maintaining and improving human health.

People, Place, Prosperity

The ACT Government's sustainability policy *People, Place, Prosperity* emphasised that the concept of sustainability has several key components: recognition of the interdependence of social, economic and environmental wellbeing; a focus on equity and fairness; that we need to take account of the effect of our actions on others in an interdependent world; and recognition that meeting the needs of today must not be at the expense of future generations being able to meet their own needs. *People, Place, Prosperity* described a future work program that was to include:

- embedding community inclusion policy and practice in ACT Government
- preparing a scoping study that will be used to shape a clean economy strategy
- developing a triple-bottom-line assessment framework for government policies, programs, projects and initiatives, and introducing triple-bottom-line annual reporting

- monitoring and reporting on progress towards sustainability
- developing a second action plan under the ACT's *Weathering the Change: the ACT climate change strategy 2007–2025*
- developing a framework for embedding environmental sustainability in ACT Government operations.

Progress against this work plan has been considerable (Table 9.24).

ACT Government Infrastructure Plan

The second ACT Government Infrastructure Plan⁸¹ was released by the Chief Minister in July 2011. Building on the first infrastructure plan from 2008, it sets out the ACT Government's policy strategic infrastructure priorities in 2011–2021. These cover a number of areas:

- a vibrant city with great neighbourhoods
- high-quality services
- a fair, safe, healthy and prosperous ACT
- excellent education and skills development
- a sustainable ACT (Table 9.25).

On advancing the objective of a sustainable ACT, the strategy states:⁸¹

The Government's triple-bottom-line approach integrates strategies to maintain Canberra's social character, and safeguard its economic future, while protecting our natural and built environments and reducing our carbon emissions. Designing infrastructure that supports low-carbon energy supply, enhances water security and maintains our natural assets is central to creating a sustainable city. (p 67)

^c Several other environmentally focused strategies have been analysed in Chapter 10. These are the ACT Water Strategy, Plans of Management for public lands under the Territory Plan, the AP2 climate change strategy, the ACT Nature Conservation Strategy and its implementation plan, the ACT Weeds Strategy and the ACT Pest Animal Management Strategy.

Table 9.24 People, Place, Prosperity commitments and results, 2015

People, Place, Prosperity commitment	Result
Developing a second action plan under the climate change strategy <i>Weathering the Change</i>	<i>AP2: A new climate change strategy and action plan for the Australian Capital Territory</i> was published in 2012
Reviewing the ACT's waste strategy to further improve rates of reuse, recycling and potential energy recovery, and to minimise waste going to landfill and reduce greenhouse gas emissions	The ACT <i>Waste Management Strategy 2011–2025: Towards a sustainable Canberra</i> was adopted in 2011
Reviewing the <i>Nature Conservation Act 1980</i>	Review was completed and the new <i>Nature Conservation Act 2014</i> commenced in June 2015
Developing a triple-bottom-line (TBL) assessment tool	A <i>Triple-Bottom-Line Assessment Framework for the ACT Government: Framework and Templates</i> has been available since July 2012. TBL assessments are a standing requirement in the preparation of all proposals for a new policy or policy change for ACT Government consideration
Annual TBL reporting by agencies, to be piloted by the Chief Minister's department in 2008–09	TBL reporting is part of directorate and other agency annual reports from 2009–10
Developing a live website that provides up-to-date data on a set of high-level performance indicators	The website is not available in 2015

Table 9.25 ACT Government Infrastructure Plan policy and infrastructure priorities for a sustainable ACT

Policy priorities	Strategic infrastructure priorities
<ul style="list-style-type: none"> Implementing policies and programs to reduce demand for water Developing a new waste strategy Reviewing the ACT Government's air quality strategies and programs 	<ul style="list-style-type: none"> Progressing major water security projects Increasing the use of nonpotable water Modifying selected stormwater systems Supporting regional and community partners working towards developing a sustainable city and region
<ul style="list-style-type: none"> Maintaining and promoting continual improvements in environment protection Transitioning the ACT towards zero net emissions by 2060 Taking forward an energy reform agenda at the Territory and national level Releasing the ACT Sustainable Energy Policy 	<ul style="list-style-type: none"> Enhancing our built and natural environment as part of the sustainable development of the ACT Exploring low-emissions and renewable energy options Investigating the development of major solar power capacity in the ACT

Source: ACT Government,⁸¹ p 67

There is no specific reporting on the delivery of the ACT Government Infrastructure Plan, although the website of the Chief Minister, Treasury and Economic Development states that the Policy and Cabinet Division coordinates the strategic infrastructure planning work program across government. The development of the annual infrastructure plan has been coordinated by the Economic Development Directorate since 2012. Some key infrastructure projects have been completed in this reporting period or are under way. For example, the completion of the expanded Cotter Dam, the Murrumbidgee to Goongong pipeline and the 20-megawatt solar farm at Royalla have been completed.

ACT Planning Strategy

The 2012 Planning Strategy departed from previous planning strategies in recognising the challenges of sustainability and climate change alongside global challenges posed by population growth, climate change, energy and food security. Specific challenges were seen to be:

- the implications of a growing population and demographic change

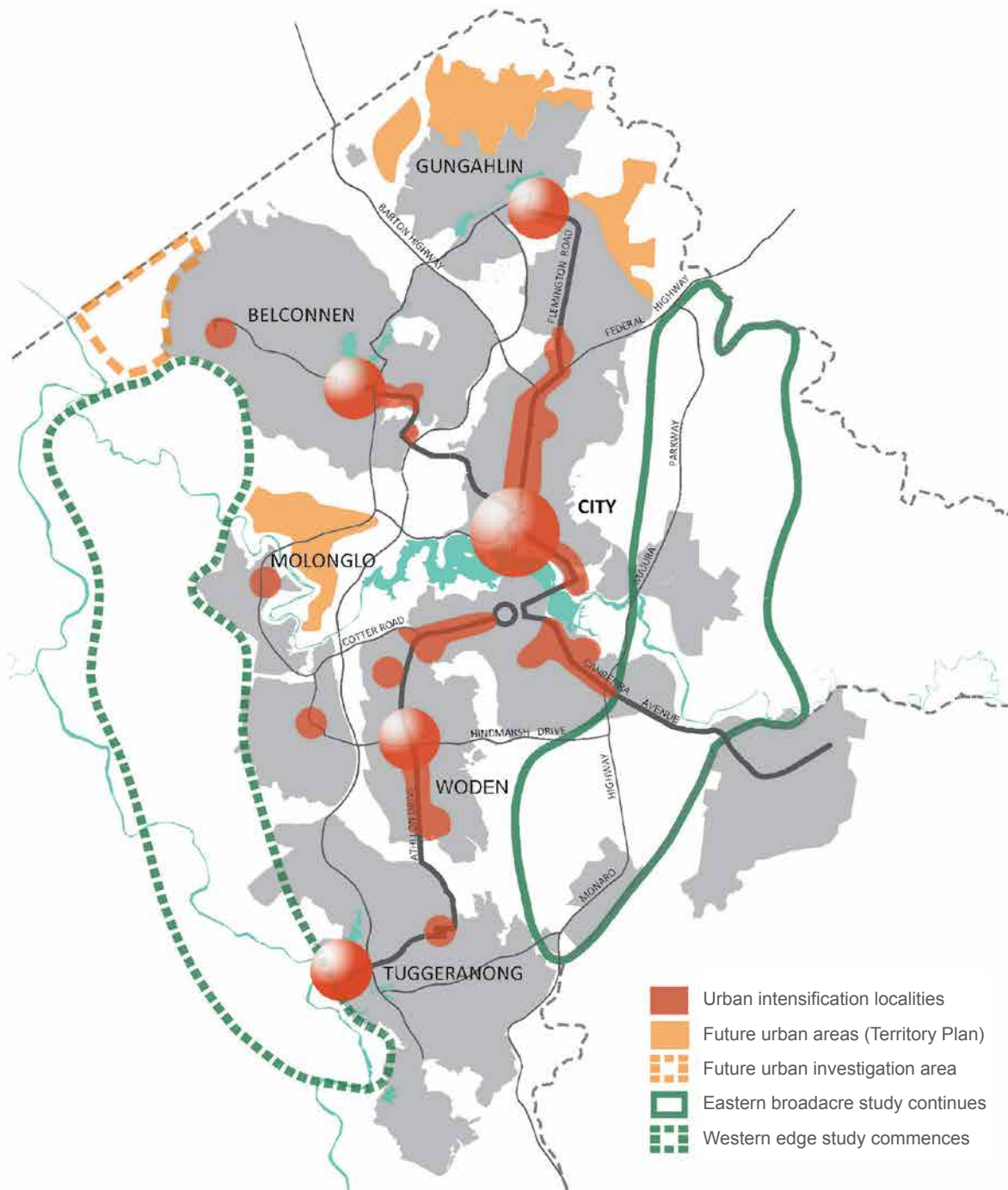
- building a more diverse and resilient economy
- reducing our reliance on the car and making it easy for everyone to get around
- identifying where people will live for a more sustainable city
- making Canberra a more affordable place to live
- the potential implications of climate change
- reducing consumption of land and natural resources, and protecting biodiversity
- population driving our resource consumption
- developing a healthy community and city
- improving quality and amenity in the architecture and urban environment.

In general, the ACT Planning Strategy pursues increased urban density, reinforcing the broad approach of the 2004 Canberra Spatial Plan, but also establishing specific urban intensification localities. Figure 9.12 shows the intentions expressed in the Planning Strategy for managing population growth and urban development.



Garema Place, Canberra City

Photo: ACT Government



Note: The layout and extent of these future areas are subject to detailed review and the outcomes of statutory approval processes.
 Source: Environment and Sustainable Development,⁴⁹ p 40

Figure 9.12 Managing population growth and urban development in the ACT

The ACT Planning Strategy aims for five outcomes for 2030 (Table 9.26).

Table 9.26 2012 ACT Planning Strategy outcomes, indicators and measures

Outcome	Indicators	Measures
Outcome A: In 2030, Canberra will be a city that makes it easy for people to make more sustainable living choices and has the resourcefulness and capacity to manage change	<ul style="list-style-type: none"> The ACT SoE Report shows continuously improving trends in the seven headline measures, including the land, water, biodiversity, greenhouse gas emissions, climate effects, waste and ecological footprint 	<ul style="list-style-type: none"> Data is collected by the Office of the Commissioner for Sustainability and the Environment for the SoE and will be reported against by the ESDD
	<ul style="list-style-type: none"> The proportion of new housing delivered through urban intensification is 50% or more 	<ul style="list-style-type: none"> Data from building approvals by suburb and dwelling type and ABS Census
	<ul style="list-style-type: none"> There is greater diversity in the types of dwellings within each district in Canberra, with an increasing percentage of attached housing 	<ul style="list-style-type: none"> Percentage of dwelling types 'other' versus 'detached', using data from ABS Census collected on house categories in each district
Outcome B: In 2030, Canberra will be a city where everyone can take advantage of its network of centres, open spaces and modes of travel to enjoy a sense of wellbeing and participate in a vibrant civic cultural life	<ul style="list-style-type: none"> Transport for Canberra actions 1, 2, 3 and 8 are progressively implemented. 	<ul style="list-style-type: none"> Data collected and measured against Transport for Canberra will be incorporated into this reporting
	<ul style="list-style-type: none"> The diversity of facilities and functions within centres increases and there is a trend for these to be distributed across each of the districts 	<ul style="list-style-type: none"> Data from commercial floor space inventory Investment by public and private sectors in group and local centres at a rate above the ACT population growth, using data from Construction Snapshot and development applications
	<ul style="list-style-type: none"> An increasing number of children and adults across all age cohorts participate in sufficient physical activity every day 	<ul style="list-style-type: none"> Data collected and measured by ACT Health will be incorporated into this reporting Indicators from the Strategic Plan for Sport and Active Recreation in the ACT and Region – ACTIVE 2020 are increasingly achieved

Outcome	Indicators	Measures
Outcome C: In 2030, Canberra will be at the centre of an innovative, prosperous region that has established a diverse 'clean' economy and has a wide choice in jobs and lifestyles	<ul style="list-style-type: none"> There is sustained growth in employment in the ACT and across the region, with an increasing proportion of jobs in the private sector 	<ul style="list-style-type: none"> Data from ABS Census on employment rates in the ACT and national capital region
	<ul style="list-style-type: none"> An increasing number of jobs in the ACT and region are in the knowledge economy sectors, including businesses orientated towards 'clean tech' and environmental sustainability 	<ul style="list-style-type: none"> Data from ABS labour force survey (nominated employment sectors to be identified, and from Economic Development Directorate monitoring of business development strategy outcomes)
	<ul style="list-style-type: none"> An increasing proportion of the population has post-secondary education in the ACT and across the region 	<ul style="list-style-type: none"> Data collected and measured by the Directorate of Education and Training will be incorporated into this reporting
Outcome D: In 2030, Canberra will be the 'capital in the bush', recognised for the quality of its public places and buildings that reflect its unique climate, character and identity	<ul style="list-style-type: none"> An increasing number of recognised, exemplar developments with integrated public realm spaces, roads and/or buildings in Canberra 	<ul style="list-style-type: none"> Number of developments per year that receive industry or national awards and or precinct (or equivalent) accreditation, using data from ACTPLA development applications
	<ul style="list-style-type: none"> The environmental sustainability and quality of design and construction is increased, with a growing proportion of new and existing public and commercial buildings achieving 6-star Greenstar or equivalent 	<ul style="list-style-type: none"> Number of developments recorded with Greenstar or National Australian Built Environment Rating System accreditation using data from ACTPLA development applications
	<ul style="list-style-type: none"> The number of tourists visiting Canberra and the region continues to increase each year, with tourist spending increasing its contribution to Gross Territory Product 	<ul style="list-style-type: none"> Data collected and measured by ACT Tourism and from Economic Development Directorate will be incorporated into this reporting
Outcome E: In 2030 Canberra will be at the centre of a region that demonstrates the benefits of good stewardship of the land, its resources and the beauty of the rivers, mountains and plains	<ul style="list-style-type: none"> Land take per person in the ACT continues to reduce from 480 ha per 1000 people 	<ul style="list-style-type: none"> Developed land (excluding nature conservation areas) in hectares per person, using data from ESDD, ABS and SoE
	<ul style="list-style-type: none"> Involvement in natural resource management activities per person increases annually 	<ul style="list-style-type: none"> Number of groups or individuals per year undertaking activities using data from Natural Resource Management Council and local Catchment Management Authorities

ABS = Australian Bureau of Statistics; ACTPLA = ACT Planning and Land Authority; EPD = Environment Planning Directorate;

ESDD = Environment and Sustainable Development Directorate; ha = hectare; SoE = state of the environment

Source: Environment and Sustainable Development Directorate,⁴⁹ p 66

Although the data needed to track the measures in Table 9.26 are available, there is no published tracking of these measures by the ACT Government. Although the Environment Planning Directorate's annual report 2013–14 states the 'The ACT Planning Strategy commits to monitoring and annual reporting on the trends at the end of each calendar year, with the next report due in late 2014',⁸² this has not yet been published.

A key action implemented under the ACT Planning Strategy during this state of the environment reporting period has been the production of master plans for town and group centres. These master plans will be particularly important to implementing strategies to create a more compact, efficient city by focusing urban intensification in town centres, around group centres and along the major public transport routes. The strategy calls for master plans to respond to place-specific needs, so the community can take advantage of the city's network of centres, open spaces and modes of travel to enjoy a sense of wellbeing and participate in a vibrant civic and cultural life.

To date, master plans have been completed for the Dickson, Kingston, Kambah, Erindale and Weston group centres; Oaks Estate; Tuggeranong Town Centre; and Pialligo rural village. Studies currently under way include the Woden and Belconnen Town Centres; Tharwa rural village, and the Calwell, Curtin, Kippax and Mawson group centres.

It should be noted that the Planning Strategy was based on a population projected to grow from an estimated 365 000 in 2011 to 457 300 by 2030, with 606 000 people in our region by 2030. Those projections may be exceeded, with the most recently published ACT Government projections (made in 2013) showing that the ACT population is projected to be 487 413 in 2030.^d

Transport for Canberra

Transport for Canberra^e was published in 2012 to extend and replace the 2004 Sustainable Transport Plan. It aims to set new policy direction to 2031 around:

- transport and land-use integration through the network of public transport corridors
- social inclusion and transport disadvantage, including a draft minimum coverage standard to ensure public transport services reach those with the highest social need for transport
- active travel policy to make walking and cycling easy travel options
- strategic management of the road network, parking, motorised vehicles and freight to create a more efficient transport system
- travel demand management across all modes (pedestrians, cyclists, motorcyclists, cars, public transport, freight), including transport pricing
- transport system performance measurement and reporting, including new targets for different modes of travel (mode share targets) for 2016 and an annual transport report card.

The following six principles guide the new transport policies and the 34 action items required to implement them, creating a transport system that:

- is integrated with land-use planning
- makes active travel, like walking and cycling, the easy way to get around
- provides sustainable travel options and reduces transport emissions
- is safe for moving people however they get around
- is accessible for everybody whatever their level of mobility at any time or place
- is efficient and cost effective, providing value for money for the Government, business and the community by managing travel demand across the whole system.

Action 33 among the 34 action items is the release of an annual transport report card. The first of these, published by the ACT Government in September 2014, assessed progress against each objective and action contained in the strategy (Table 9.27).

d http://apps.treasury.act.gov.au/__data/assets/pdf_file/0007/534697/2013popprojections_overviewacttotal.pdf

e www.transport.act.gov.au

For the objectives, three are assessed as 'achieved' (relating to integration with land-use planning, efficiency and cost effectiveness, and safety), three as 'on track to be achieved' (relating to accessibility, sustainability and active transport) and one as 'needs improvement' (mode share on journeys to work). For the 34 actions, three are assessed as 'achieved', 28 are assessed as 'on track to be achieved' and four are assessed as 'needs improvement'.

The Capital Metro project to construct a light rail connection between Gungahlin and Civic is a key part of implementing Transport for Canberra policies. Its objectives include increasing the mode share of public transport, growing a more diversified Canberra economy, stimulating sustainable urban redevelopment along the Northbourne Avenue corridor, and reducing carbon and other emissions.

The Office of the Commissioner for Sustainability and the Environment (OCSE) considers that Transport for Canberra is integrated with the ACT Planning Strategy, and is enabling the ACT Government to grapple with transport as one of the key challenges to livability and sustainability.



The amount of time residents must spend travelling each day affects the livability of a city.

Photo: ACT Government

Table 9.27 Transport for Canberra Report Card assessment of progress against objectives, September 2014

Principle	Objective	Assessment	Summary of report card commentary
1. Is integrated with land-use planning	Increase the population living within 750 m (10-min walk) of a public rapid-transit corridor	Achieved	Based on 2007 and 2011 Australian Bureau of Statistics Census data, the Environment and Planning Directorate assesses that, before Transport for Canberra, 14.5% of the ACT population resided within 750 m of a stop within the Blue Rapid-transit corridor. Introduction of the Red Rapid increased the population to 23.7%. Objective will continue to be achieved as the ACT Planning Strategy is implemented and more frequent network routes are introduced
2. Makes active travel, like walking and cycling, the easy way to get around	Increase cycling and walking trips	On track to be achieved	Cycle volumes increased from 18 942 in 2011 to 23 278 in 2012, according to Territory and Municipal Services data. Walking accounted for 5% of journeys to work in 2006 and 2011, according to Census data. Continuing government investment in walking and cycling infrastructure, and a future Active Travel Framework will enable the objective to be met
3. Provides sustainable travel options and reduces transport emissions	By 2020, reduce ACT transport emissions by 138 000 tonnes	Needs improvement	ACT transport emissions grew by 29.5% between 1990 and 2011, and increased by 3.5% during 2010–11
4. Is safe for moving people however they get around	Annual ACT fatalities are below the national average	Achieved	Number of deaths per 100 000 people in the ACT is 3.20 compared with 5.78 nationally. Progress on achieving a safer transport system will also be measured through the ACT Road Safety Strategy and Action Plan
5. Is accessible for everybody whatever their level of mobility at any time or place	By 2017, achieve 80% compliance with Disability Standards for Accessible Public Transport 2002 (Cwlth) for buses and bus stops	On track to be achieved	There was 55% compliance with disability standards in 2012. Targets were set at 80% compliance for 2017 and 100% compliance for 2022. Funding in the 2012–13 and 2013–14 capital works budgets was allocated to ensure progress towards the 2017 target

Principle	Objective	Assessment	Summary of report card commentary
6. Is efficient and cost effective, providing value for money for the Government, business and the community by managing travel demand across the whole system	Invest in a transport system that supports the efficient and reliable movement of people and goods across the network	On track to be achieved	More than \$350 million has been invested in significant infrastructure. Recent investments include the Belconnen to City transit way, the Majura Parkway, real-time bus information system (NXTBUS), a park-and-ride program, the Barton bus station, Canberra Avenue bus priority measures, targeted intersection upgrades and Parkes Way widening
7. Mode share for journeys to work	By 2016, increase journeys to work trips for: <ul style="list-style-type: none"> walking to 6.5% cycling to 6% public transport to 10.5% 	Needs improvement	In 2011, the ACT's journey-to-work mode share was walking at 4.9%, cycling at 2.8% and public transport at 7.8% (2011 Census data). Continued investment in public transport (such as Capital Metro), cycling and walking infrastructure will encourage more people to use public transport and active travel

Note: The report card does not provide information on the methods used to assess progress, and assessment is made difficult in some cases by a lack of data more recent than the 2011 Census.

Building an integrated transport network

Active travel is an approach to travel and transport that focuses on physical activity (walking and cycling) as opposed to motorised and carbon-dependent means. Active travel is often combined with motorised forms of travel, particularly public transport, so that people can use active travel as part of longer journeys (see Case study 9.1 on page 402).

The ACT Government's active travel strategy, *Building an Integrated Transport Network: Active Travel*, was released in May 2015.⁸³ The strategy seeks to expand active travel through a number of actions:

- Develop a policy that guides the circumstances where cycling will be explicitly and implicitly provided within the transport infrastructure hierarchy as part of planning, project development, implementation and corridor protection.
- Continue integration (including improved data collection) of walking and cycling travel modes into the Canberra Strategic Transport Model.
- Audit walking and cycling connections to the public transport network and complete missing connections, subject to government funding decisions.
- Undertake ongoing data collection to improve monitoring of route usage, including user numbers, user demographics and trip generators.
- Prepare an investment plan for walking and cycling infrastructure.
- Develop a walking and cycling network with high-quality cycling infrastructure that is safe and well signposted, offering direct routes to destinations and integrated with public transport.
- Ensure that Active Living Principles are embedded in planning policy.
- Identify main walking and cycling routes within statutory/strategic planning policy documents (ie the Territory Plan, the National Capital Plan), including a new cycling and walking general code within the Territory Plan.
- Embed walking and cycling network maps and documentation into the planning process.
- Complete the walking and cycling network within and between the town and group centres, and major employment areas, subject to funding.
- Identify barriers for access to and within major centres.
- Support mixed land use and the vitality of town and group centres through implementation of master plan recommendations.

Case study 9.1

Active travel and Canberra's Active Travel Framework

Building an integrated transport network that provides options to reduce our dependence on private vehicles is part of Canberra's overall urban planning, transport, health, environment and education systems. This network includes all transport modes (walking, cycling, public transport, roads, freight and motor vehicles) and is part of delivering on key government policies, including Transport for Canberra, the Australian Capital Territory (ACT) Planning Strategy, Action Plan 2 (the ACT climate change strategy), the City Plan and other master plans, and the Healthy Weight Action Plan.

Active travel (walking and cycling) is increasingly recognised as a key feature of the world's best cities. Rising obesity, traffic congestion and reducing carbon emissions in the face of climate change all present significant challenges for the ACT. Whether for recreation or as a mode of transport, active travel provides many benefits for individuals, families, businesses and local communities:

- health benefits, such as improved mental and physical health
- economic benefits, such as reduced health-care costs, increased property values, increased retail expenditure and reduced construction costs
- environmental benefits, such as reduced congestion, air and noise pollution
- social benefits, such as improved community wellbeing and social cohesion.

In its Active Travel Framework, the ACT Government recognises that investment is essential for encouraging people to make active travel an option more often. The Government has committed more than \$87 million in 2012–2018 to extend and improve active travel infrastructure, such as walking and cycling paths. This funding is part of the ACT Government's Healthy Weight Action Plan, which supports healthy decision-making through good urban planning and encouraging people to choose active travel options.

The Active Travel Framework also seeks to remove obstacles to walking, cycling and riding by:

- improving access to public transport stops
- improving the connectivity of walking and cycling networks
- integrating active travel networks with public transport hubs
- ensuring active travel connections within and through town and group centres
- improving safety for pedestrians and cyclists
- providing supportive infrastructure such as lighting, shade, signs, seating and drink fountains
- encouraging employers to provide end-of-trip facilities.

Source: ACT Government⁸³

Management

Specific activities are undertaken each year to manage some aspects of ACT livability. Examples are provided in the following sections.

Open space and reserves

TAMS is responsible for managing ACT urban and rural parks and reserve areas. It prepares conservation management plans for urban and public land, determines design guidelines for public open space and coordinates the capital works projects for these spaces. Maintenance of the urban assets carried out by TAMS includes mowing, cleaning, litter picking, painting, pruning, mulching, safety inspections and repairs.³⁰

TAMS activities in 2013–14³⁰ indicate the broad range and geographical spread of their activities, and include:

- the completion of upgrades at the Chapman, Charnwood, Griffith and Theodore shopping centres, and the design of minor upgrade works to Cook, Rivett and Mannheim streets, and the Kambah shopping centre
- a major upgrade to Corroboree Park
- improvements to the function and safety of Canberra's skate parks, which included improving the skating surfaces and installing safety panels
- installation of new barbecues in open spaces at Yarralumla Bay, Lake Ginninderra, Bowen Park, Yerrabi Pond District Park and Lennox Gardens, barbecue refurbishment in Umbagog District Park
- major improvements to Tuggeranong District Park, including a new shared lakeside pathway, shade structure over the playground, new open-space fitness equipment, information signage at the entry and exit points, and signage confirming the gate opening and closing times within the park
- construction of stage two Weston Park, which upgraded the picnic areas and pathways throughout the park
- construction of open-space fitness stations at John Knight Park and Theodore neighbourhood oval
- completion of work on the new dog park in O'Connor, taking the number of fully fenced dog parks in the ACT to six
- installation of 24 water stations equipped with a drinking fountain and water refill nozzles across Canberra
- installation of new gate closure signs at Tuggeranong District Park, Kambah Adventure Playground, Fadden Pines and Point Hut Park
- works to upgrade the final section of the Mount Franklin Road, as required by the Strategic Bushfire Management Plan
- work, with the Capital Woodland and Wetlands Conservation Trust, on Jerrabomberra Wetlands infrastructure, including the baseline studies to identify the hydrology, vegetation, heritage, land form of the area and development of a concept plan, as well as upgrades to visitor facilities and security
- improvements to Majura Pines, including trail work, new signage, improvements to fencing, access and car parking, and installation of a water station and rest areas.

Much of TAMS' work in nature reserves consists of management to maintain or increase biodiversity in partnership with other stakeholders. In 2013, for example, 35 Landcare and volunteer groups were supported to carry out a variety of work, including controlling weeds, growing and planting seedlings for bush regeneration, mapping rabbit warrens, restoring and maintaining early European settlement heritage sites, and maintaining and repairing tracks. TAMS also expanded the support network provided to ParkCare and industry groups by engaging a ParkCare support officer and providing additional on-ground support such as restoration work.

Management of commercial forests aims to generate sufficient income from timber sales to offset land management costs while ensuring the maintenance of long-term social and environmental benefits.³⁰

The pine forests are extensively used for recreational activities, including walking, jogging, horse riding, cycling, camping, picnicking, fishing, musical events and car rallies.

Broader Government responsibilities for managing open space to ensure good water quality and biodiversity, prevent the spread of pest and weeds, manage fire risk and preserve heritage are assessed in other chapters of this report.

In general, however, the ACT Government faces significant challenges in managing all of these responsibilities effectively for all land under its control at all times.

Management difficulties are exemplified by the findings of the ACT Auditor-General's report on *Restoration of the Lower Cotter Catchment*,⁸⁴ which reviewed progress on the restoration of the lower Cotter region as a potable water catchment following the fires of 2003. The construction of the enlarged Cotter Dam expanded its capacity from 4.7 gegalitres to 78 gegalitres, and increased the catchment area from 33 000 ha to 53 000 ha. The Auditor-General found that, although efforts at restoring the catchment have been effective in steadily improving water quality and reducing turbidity and sedimentation:⁸⁴

... the LCC [Lower Cotter Catchment] is exposed to significant risks which are interrelated and which, under adverse conditions, could accumulate and lead to a catastrophic failure of the water catchment. (p 4)

It was not evident that the four agencies: the Environment and Planning Directorate, the Environment Protection Authority, Icon Water (ACTEW Water, ACTEW AGL) and the Territory and Municipal Services Directorate who shape the plans for or undertake management actions in the LCC, had a shared knowledge of the cascading effect of risks and their potential consequences. (p 4)

On 20 May 2015, the ACT Government announced that its 2015–16 Budget would provide \$7.8 million over four years to manage the Cotter Dam Catchment.⁸⁵ The continuing Australian Government responsibilities for open space under the National Capital Plan, along with the geographical and functional breadth of the ACT Government's responsibilities, poses a challenge for coordination. The 2014 *National capital open space system review report* from the NCA⁸⁶ indicated that the Australian Government maintains an interest in open space areas beyond direct NCA management, and recommended as follows:

Recommendation nine

Amend the General Policy Plan within the Plan to incorporate:

- a) *existing sections of Canberra Nature Park that are adjacent to and/or function as part of NCOSS [national capital open space system] landscapes, but are currently within Urban Areas, into the NCOSS.*

- b) *new sections of Canberra Nature Park or areas declared by the Territory Plan to form part of hills, ridges and buffers areas to be part of the NCOSS.*

Recommendation ten

The Plan be reviewed with the intent of recognising the need for consideration of environmental concepts such as connectivity, mitigation, plant and animal migration, biodiversity conservation and resilience – particularly in relation to bushfire risk – in the planning and management of the NCOSS. (p 11)

The Canberra Nature Park 1999 Management Plan is being reviewed by the ACT Government during the second half of 2015.

Trees

TAMS is responsible for managing and maintaining trees on public land. This includes trees on suburban streets, in parks, at local shopping centres, on major road nature strips and median strips, and in open spaces in Canberra. The key objectives of urban tree management are to improve the landscape setting for the city, to maintain a safe and sustainable urban forest, and to conserve the natural environment. These objectives are achieved through watering of trees; the regular inspection and pruning of trees; removal of dead, damaged or hazardous trees; and replacement of dead or ageing trees (Table 9.28).⁸⁷

The number in Table 9.28 understate the extent of activities to maintain urban trees. For example, removal of dead trees requires considerable resources every year, and 51 000 new trees were planted in the Murrumbidgee River Corridor under the One Million Trees initiative in 2011–12.⁹³

The NCA also implements a tree replacement strategy in the National Capital Estate for trees that die or become dangerous, aiming to maintain the current plantings and protect the heritage significance of individual trees.⁹⁴

Most trees on leased land in the ACT are protected under the ACT *Tree Protection Act 2005*. Any work that may cause damage to these trees – such as tree removal, major pruning or lopping, and groundwork near a tree – requires approval.⁹⁵

Table 9.28 Territory and Municipal Services tree management

Activity	2010–11	2011–12	2012–13	2013–14	2014–15
Number of developing urban trees watered	21 000	21 000	21 474	23 000	>25 000
Number of new trees planted	6 250	2 000	2 000	2 169	>3 000

Source: Territory and Municipal Services^{88–92}

In 2009–2011, the Commissioner for Sustainability and the Environment investigated the ACT Government's management of urban trees and the need for an enhanced program of urban tree renewal.⁹⁶ The ACT Government has implemented or is progressing most of the recommendations of this report. However, recommendation 4A – 'to improve decision-making processes and practices for tree protection and management by establishing an ACT tree curator responsible for statutory decision-making, leading TAMS in its management of urban street and park trees and ensuring consistency across all ACT Government agencies'⁹⁷ – has not been implemented, although the ACT Government agreed to it in principle.

Urban lakes, ponds and wetlands

TAMS maintains 3 lakes, and 49 ponds and wetlands under Canberra's urban lakes and ponds plan of management.⁹⁸

Since 2010, the ACT Government has constructed a number of wetlands that contribute to livability. These include wetlands at Banksia Street, O'Connor, completed in 2010; Hawdon Street, Dickson, completed in 2011; Goodwin Street, Lyneham, completed in 2012; and the Valley Ponds, the Valley Avenue, Gungahlin, completed in 2015.⁹⁹

Canberra also has extensive stormwater management infrastructure designed to manage water volume and quality. At June 2015, the ACT's stormwater assets include:

- 4176 kilometres (km) of pipes
- 80 588 sumps
- 31 780 access holes
- 65 km of lined channels
- 2 dams
- 18 weirs

- 214 gross pollutant traps
- 18 retarding basins.

Human health

A detailed assessment of the response to all health issues related to the environment is not possible in this report, but the absence of major health impacts due directly and mainly to the environment suggests that the responses are effective.

The Health Protection Service, Population Health Division of ACT Health, is responsible for monitoring and regulating environmental factors that have the potential to influence public health within the ACT (eg food safety, water surveillance, radiation safety, communicable disease control).⁷⁶

At the direction of the ACT Health Minister in 2010, the Chief Health Officer developed a model for action for key health issues, including the rising rates of overweight and obesity in the ACT. Key areas of focus include transport planning, access to healthier food options and promotion of physical activity. The stages of this are scoping areas for action (2011), convening a working group to develop programs (2011–12) and convening implementation groups to implement actions developed by the working group (2013 onwards).

In the future, the health impacts of climate change will need response. The annual number of cases of heat-related deaths in the ACT is expected to more than double, from an average of 14 cases for people aged over 65 (based on the average number of deaths for 1997–1999) to 37–41 cases.¹⁰⁰ By 2020, it is projected to increase to 62 deaths per year, and by 2050 to 92. Nonfatal heat-related illnesses are also expected to increase. The impact of severe weather events (bushfires and heatwaves) may also lead

to increases in food-borne infectious diseases, air pollution and mental health problems.

The ACT has implemented an Extreme Heat Management Plan (which is a Hazard Specific Plan of the ACT Emergency Plan). This does not have a source of funding; rather, it provides a management framework to guide a number of actions that are implemented by ACT Health and the ACT Emergency Services Agency.

The Implementation Status Report on the AP2 climate change strategy for the ACT reached the following conclusions:¹⁰¹

- The ACT health system has the ability to deal with future trends in disaster (primarily bushfires and heatwaves).
- There are effective connections between health services and emergency services in the ACT. They include clear notification protocols, an effective chain of command with clear roles and responsibilities, and a clear hierarchy of emergency management plans. In emergency situations, such as a bushfire, proactive health responses, such as air quality monitoring and water testing, are undertaken.
- Social and mental health services have the capacity to support changing community needs.
- The potential impacts of climate change on social and mental health services are not specifically considered, and there is no specific funding stream for mental and community health; rather, ACT Health considers sensitive populations and uses a holistic approach.



Urban lakes and wetlands in Canberra provide amenity to residents but also improve the quality of water run-off into creeks and streams

Photo: ACT Government

9.3 Ecosystem services

9.3.1 What are ecosystem services?

The term ‘ecosystem services’ is commonly used to describe the ways in which processes in ecological systems (ecosystems) contribute to human social and economic wellbeing. Other terms have been used, such as ‘environmental services’ and ‘nature’s benefits’. The many complex interrelationships among and between species and the nonliving environment in ecosystems make it possible for people to derive benefits from natural environments, such as provision of soil in which crops can grow, control of pests and a range of cultural benefits.

One important effect of applying the concept of ecosystem services has been the identification and classification of those services in ways that allow policy-makers, land managers and communities to cross-check their plans against the full range of possible ecological implications.¹⁰²

As discussed in Chapter 3: Human needs, most classifications of ecosystem services include components such as:

- provisioning services, which provide goods essential for human wellbeing, including food, clean water, building materials, fibre and medicines
- regulating services, which regulate the environments in which people live, including regulation of air quality; regulation of climate and weather; mitigation of floods and other extreme events; stabilisation of soils, waterways and landscapes; and control of pests and diseases
- cultural services, which lead to cultural, spiritual and emotional fulfilment, and mental and physical health, including educational and recreational opportunities; sense of place and cultural connection; and spiritual experiences
- supporting services, which support other services, including soil formation, nitrogen cycling and pollination (some recent classifications regard these as intermediate processes that are not direct services in their own right).



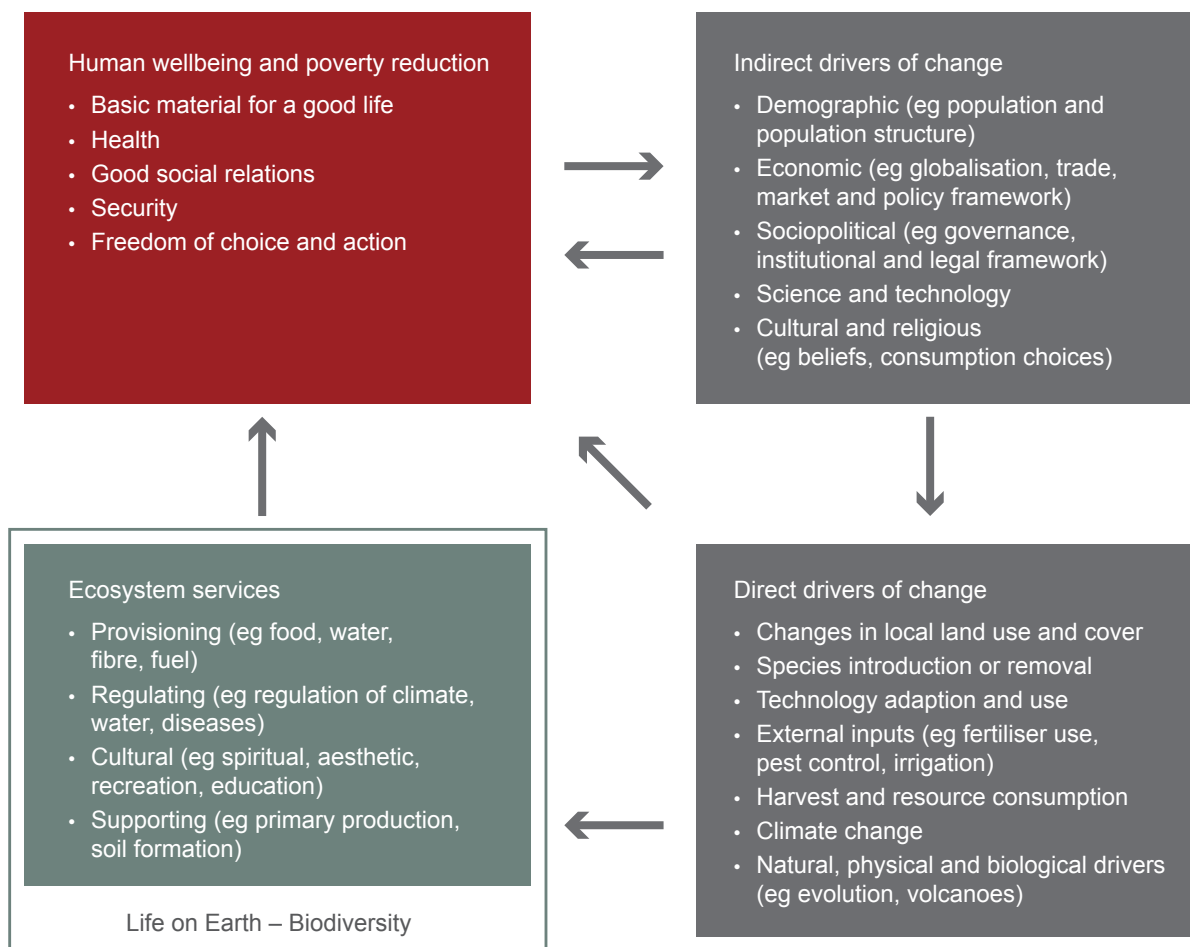
Green infrastructure at Cotter River

Photo: ACT Government

Increasingly, it has been found that the benefits from these services can be assessed in economic terms that allow them to be considered alongside more obvious financial benefits in decision-making. Often, just knowing what services are provided by the environment allows people from different backgrounds to be involved in productive conversations about their relationships with the natural world and how

their decisions might affect their own wellbeing in previously unrecognised ways.¹⁰³

The framework shown in Figure 9.13 was developed to describe how factors influencing the environment (drivers of change) affect ecosystems and ecosystem services, and how ecosystem services then influence human wellbeing.



Source: Hassan et al¹⁰⁴

Figure 9.13 A simplified version of the conceptual framework relating drivers of change, ecosystem services and human wellbeing

Table 9.29 shows a list of ecosystem services and how they relate to the theme chapters of this report:

Chapter 4: Air; Chapter 5: Land; Chapter 6: Water, Chapter 7: Biodiversity and Chapter 8: Heritage.

Table 9.29 Ecosystem services and their relation to State of the Environment Report themes

Services (underpinned by biodiversity and a range of ecosystem processes)		Air	Land	Water	Biodiversity	Heritage
Provision of:	food	✓	✓	✓	✓	
	water for consumption	✓	✓	✓	✓	
	building and fibre		✓	✓	✓	
	fuel		✓		✓	
	genetic resources		✓	✓	✓	
	biochemicals, medicines and pharmaceuticals		✓	✓	✓	
	ornamental resources		✓	✓	✓	
	transport infrastructure		✓	✓	✓	
Regulation of:	air quality	✓	✓	✓	✓	
	habitable climate	✓	✓	✓	✓	
	water quality	✓	✓	✓	✓	
	arable land		✓	✓	✓	
	buffering against extremes		✓	✓	✓	
	pollination, pests and diseases		✓	✓	✓	
	productive soils		✓	✓	✓	
	noise abatement		✓	✓	✓	

Table 9.29 *continued*

Services (underpinned by biodiversity and a range of ecosystem processes)		Air	Land	Water	Biodiversity	Heritage
Support for human culture and social values by provision of:	iconic species	✓	✓	✓	✓	✓
	diverse environmental characteristics of cultural significance	✓	✓	✓	✓	✓
	support for spiritual and religious beliefs	✓	✓	✓	✓	✓
	systems from which humans can increase their knowledge	✓	✓	✓	✓	✓
	inspiration	✓	✓	✓	✓	✓
	aesthetically satisfying experiences	✓	✓	✓	✓	✓
	mediation of social interactions	✓	✓	✓	✓	✓
	sense of place	✓	✓	✓	✓	✓
	iconic landscapes	✓	✓	✓	✓	✓
	recreational opportunities	✓	✓	✓	✓	✓
	therapeutic landscapes	✓	✓	✓	✓	✓

Note: Checkmarks indicate that the processes considered under a theme heading are involved in supporting and delivering a service.
Source: Maynard¹⁰³

Each theme chapter discusses the ecosystem services relevant to that theme. In the following sections, the key implications of each theme for ecosystem services are considered. Following these theme-specific treatments, conclusions about overall impacts on ecosystem services in the ACT are summarised in Table 9.30 on pages 414–415.

9.3.2 How is the state of the environment affecting ACT ecosystem services?

Air

Air is essential for sustaining life. Plants and soil organisms exchange gases with the air, which affects its composition and makes it suitable for human life.

Poor-quality air can affect ecosystems and the services they might provide to humans. The ACT generally has good air quality, so the ecosystem services provided to humans by air are rarely negatively affected. Conversely, the state of land, water and biodiversity all have potential impacts on the state of air.

Trees play an important role in improving air quality by removing air pollution.¹⁰⁵ Vegetation generally binds soil to limit the amount of dust stirred up by wind. Trees in particular have been noted for their ability to absorb gaseous pollution (eg ozone, sulfur dioxide, nitrogen dioxide) and to intercept particulate pollution on their leaf surface. Reduced air temperatures from vegetation shading can reduce the chemical reactions that produce secondary air pollution (secondary air pollutants, such as ozone, form in the air when primary pollutants react or interact).^{28,106-109}

Urban forests also contribute to a range of other functions, including sequestering carbon, regulating the local climate, reducing noise, mitigating run-off, intercepting stormwater, improving water quality, providing shading and cooling, enhancing aesthetic values and providing opportunities for recreation.^{105,106,110} The value of these services provided by urban forests can be substantial. One study estimated that the combined benefits of pollution mitigation, energy-use reduction and carbon sequestration by Canberra's urban forests in 2008–2012 would be valued at US\$20–67 million.¹⁰⁶

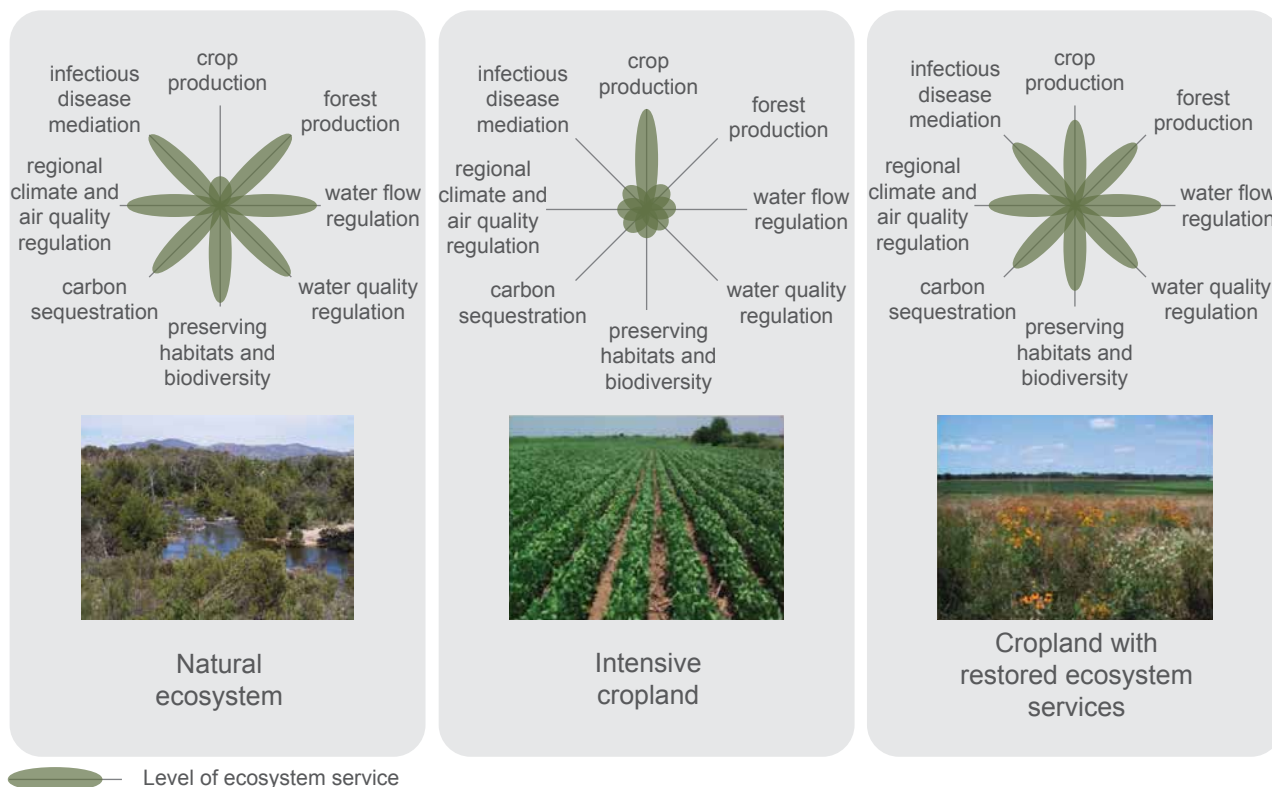
The assessment in Chapter 4: Air shows that the ACT has good air quality. Most emissions are controlled below levels of concern. Air quality measures are within compliance ranges, apart from occasional increases in carbon monoxide from motor vehicles and particulate matter from wood smoke.

Land

Humans benefit directly from land and fertile soils when crops or forests are grown, or when the land is used for a variety of economic and social reasons. They benefit indirectly from the many other roles of land and its soil, such as buffering and moderating the movement of water through ecosystems, disposing of wastes and dead organic matter, and regulating major element cycles such as carbon, nitrogen and sulfur.¹¹¹⁻¹¹³

In recent years, the capacity of soils to sequester carbon has become a major focus of policies and efforts aimed at reducing levels of atmospheric carbon dioxide.^{114,115} Carbon sequestration has the potential to indirectly benefit human wellbeing through reducing the impacts of climate change. However, there is debate around the technical and economic constraints to how effective agricultural soils are at offsetting greenhouse gas emissions, and more research is needed.¹¹⁶⁻¹¹⁸

Different land uses contribute to ecosystem services and human wellbeing in different ways and land management decisions often involve difficult trade-offs among ecosystem services (Figure 9.14). For instance, although converting natural ecosystems into agricultural land provides services like food and fibre production, this process typically degrades land and water resources, and leads to declines in other services like provision of clean water, pest control and regulation of river.¹¹⁹⁻¹²¹ The legacy of broadscale land-use change also creates substantial ongoing financial costs in managing things like soil erosion, salinity and weeds.¹²²⁻¹²⁴ Such trade-offs are inevitable, but understanding, acknowledging and factoring in the consequences of land management for the delivery of ecosystem services and the impact on human wellbeing are vital for effective decision-making.¹²⁵



Source: Adapted from Foley et al.¹²⁶

Figure 9.14 Hypothetical comparison between land in three different states and the mix of ecosystem services provided by each

In the ACT, urban development is increasing. Soon, it is anticipated to become the second-most dominant land use after conservation reserves.¹²⁷ Urban development usually involves converting open land with natural or seminatural ecosystems to built-up areas. In the process, soil is permanently covered with impermeable or semi-impermeable surfaces, which can have negative effects on the provision of ecosystem services. For instance, it can result in increased water run-off, increased localised temperatures, reduced ability for local food production, and the loss and fragmentation of flora and fauna.¹²⁸

The high proportion of land under conservation tenure in the ACT means that a wide range of regulating and cultural ecosystem services are maintained at high levels. Forestry and a small amount of farmland provide provisioning services. The question of whether the balance between provisioning and other ecosystem services is appropriate for meeting society's needs and demands is addressed through planning mechanisms that take account of those

needs and demands, and the overriding goal of sustainability. Chapter 10 focuses on whether these mechanisms are functioning effectively. The growth of urban development should be monitored in terms of how it affects the production and availability of ecosystem services in the ACT.

Water

The values and benefits provided by water for residents of the ACT include the supply of sufficient, high-quality water for drinking, as well as water that can be used for cultural and recreational activities. Water management systems also contribute to human wellbeing through the appropriate management of stormwater to protect human health, private property, public infrastructure and downstream ecosystems.

Healthy soils, terrestrial environments and aquatic ecosystems help to filter and purify water after it falls as rain and snow, before it flows into our rivers and streams, and before it is collected and distributed for human use. The quality of water can decline significantly when it passes through ecosystems and

soils that have been degraded by poor management, or where they have been disturbed by events such as fire.¹²⁹⁻¹³²

The assessments in Chapter 6: Water show that overall surface water quality is in a good state and improving relative to 2007–2011. However, there has been some deterioration in the ability of ecosystems to filter and detoxify water, apparently due to land management practices that both reduce vegetation cover and result in higher levels of chemicals than the ecosystems can cope with. Consequently, some aspects of water quality (turbidity and total nitrogen) were assessed as poor.

Water's role in supporting local biodiversity, regulating the microclimate and contributing to urban aesthetic values are other important ecosystem services to consider in the ACT.^{133,134} The assessments in Chapter 6 indicate that the overall ecological condition of the ACT's waterways is poor, implying a decline in ecosystem processes that support biodiversity (although most sampling was in areas affected by development of some kind, and waterways in more remote areas appear to be in good condition).

As discussed in Section 9.4, the interrelationships between water, land, biodiversity, built infrastructure and human decision-making will determine the ability of the ACT to maintain ecosystems and human quality of life in the face of pressures and risks such as:

- climate variability (particularly droughts and floods)
- activities that affect water quantity or quality in water catchments
- population growth
- climate change.

Biodiversity

The diversity of life in natural systems, interacting with the nonliving components of the environment, underpins and produces ecosystem services. Therefore, any changes in the state of biodiversity are likely to affect a range of interconnected ecosystem services.

Provisioning services are affected mostly by the ecosystem processes that influence soil fertility, protection from extreme weather, stabilisation of riverbanks, erosion control and pest control. Therefore, the ongoing pressure from pest species

is a concern, as is the poorly documented influence of land management on the state of waterways.

Regulating services are strongly influenced by vegetation cover and the associated ecological processes happening above and below ground that keep vegetation communities healthy and resilient. The high proportion of land in conservation tenure in the ACT suggests that regulating services are at high levels, but the 2003 bushfires illustrated how fire in particular can change the state of these services if it is extensive and intense, or not managed well. It appears that there is good cooperation between conservation, land, water and emergency management agencies in the ACT to manage fires and other pressures that might influence regulatory ecosystem services (see Chapter 10).

There is a strong focus on threatened and endangered species in the ACT, including those that have a declining geographic distribution, declining population size and numbers of mature individuals, or are possibly becoming extinct. These species are considered important because of their cultural significance, and because of the ethical and moral obligation to other species we accept as humans. To an extent, the state of threatened and endangered species reflects provision of cultural services and the possibility that this state is declining is of concern. Cultural services are also strongly influenced by the visual condition of landscapes, which appears to be good in the ACT since a high proportion of land is under conservation tenure.

Chapter 7: Biodiversity reveals that the pressures on biodiversity from pest species are high. Pressures from land clearing or modification are unclear as a result of limited information in the ACT, but urban development is likely to be an increasing pressure that has major impacts on ecosystem services where it occurs. It is important that there is strategic consideration of the cumulative impacts of small modifications to habitat, because these can lead to thresholds being crossed unknowingly and unintentionally for at least some ecosystem services. Pressures from fire are likely to be moderate to high, and to increase with climate change, but there is a high level of risk planning and management aimed at containing this risk.

Heritage

The links between heritage and ecosystem services are complex. The values of natural and Aboriginal heritage places are often derived from elements of the ecological systems in which those places are situated. When this is the case, degradation in the state of land, water or biodiversity will affect heritage value. Historical heritage places often also have links with the natural environment. For example, Canberra was designed to fit into the surrounding landscape, and to take advantage of views and availability of water and recreational opportunities.

There are insufficient data available to assess specifically if and how trends in the state of land, water or biodiversity have affected heritage places in general. Concerns have been raised about the impacts of urban expansion on Aboriginal heritage

sites, including the impacts of removing artefacts from their original location for their protection. Fires have temporarily had major impacts on the visual amenity of the ACT and some long-term effects on heritage structures. Decisions about how burnt areas have been managed also have impacts that were not able to be considered in this report. It was noted previously that there is a need to better consider the cumulative impacts of urban development and other land modification on biodiversity and ecosystem functions. The same applies to the cumulative impacts of land modification on heritage values.

Assessment summary

Table 9.30 summarises the assessments of the effects of the state of the environment in the ACT on ecosystem services.

Table 9.30 How the ACT state of the environment is affecting ecosystem services, by theme

Theme	Description of effect on ecosystem services	Effect
Air	Poor-quality air can affect ecosystems and the services they might provide to humans, but the ACT generally has good air quality and so ecosystems are unlikely to be affected	Positive
	The abundance of natural ecosystems surrounding Canberra help to absorb air pollutants and minimise the impacts of wind-blown particulate matter	Positive
Land	The high proportion of land under conservation tenure means that a wide range of regulating and cultural ecosystem services are maintained at high levels	Positive
	Increasing urban development may increase run-off, increase localised temperatures, reduce ability for local food production, and cause the loss and fragmentation of flora and fauna	Potentially negative

continued

Table 9.30 *continued*

Theme	Description of effect on ecosystem services	Effect
Water	The high proportion of land under conservation tenure means that a wide range of regulating and cultural ecosystem services are maintained at high levels	Positive
	Overall surface water quality is in a good state and improving	Positive
	ACT residents have access to high-quality drinking water and overall were satisfied with the quality of drinking water	Positive
	There has been some deterioration in the ability of ecosystems to filter and detoxify water, because of reduced vegetation cover and increased chemical levels	Negative
	Canberra's lakes, ponds and constructed wetlands improve biodiversity, aesthetics, heat mitigation and recreational opportunities – thereby supporting human wellbeing	Positive
	The overall ecological condition of the ACT's waterways (particularly in built areas) is poor, indicating a decline in ecosystem processes that support biodiversity; however, measurements were mostly made in disturbed areas and protected areas were healthier	Potentially negative
Biodiversity	The high proportion of land under conservation tenure supports healthy and resilient ecosystems, and provides protection from extreme weather, stabilises riverbanks and controls erosion	Positive
	Some threatened and endangered species in the ACT are declining, but others are increasing	Potentially negative
	Pressures on biodiversity from pest species and fire are high	Potentially negative
	Incremental change (eg in urban development) may lead to thresholds being crossed unknowingly for at least some ecosystem services	Potentially negative
Heritage	The high proportion of land under conservation tenure protects natural and Aboriginal heritage	Positive
	Degradation in the state of land, water or biodiversity, as well as pressure from urban development and fire, may affect heritage value	Potentially negative
	Incremental change (eg in urban development) may lead to thresholds being crossed unknowingly for at least some ecosystem services	Potentially negative

9.4 Resilience

9.4.1 What is resilience?

Resilience is the ability of a 'system' to cope with pressures and shocks while retaining key characteristics of that system.

When many things interact in complex and dynamic ways, the overall set of interactions is often referred to as a system. Systems exhibit properties that would not be possible if the parts do not interact. Resilience is one property that emerges from the complex interactions in systems. Resilience was originally considered in engineering systems, but during the past several decades it has been investigated in relation to ecological systems and human social systems. These systems are made up of interconnected ecological and social components, such as urban ecosystems, nature reserves and agricultural land. They influence, and are influenced by, human behaviours, technologies, economies, institutions and policies (see 100 Resilient Cities,^f Chapin¹³⁵ and Moberg et al¹³⁶).

Most people understand the concept of 'resilience' in relation to the capacity of a person or a community to remain strong in the face of hardship. The same general idea applies to resilience of socioecological systems. The Resilience Alliance, an international program fostering research on this concept, describes resilience:^g

Ecosystem resilience is the capacity of an ecosystem to tolerate disturbance without collapsing into a qualitatively different state that is controlled by a different set of processes. A resilient ecosystem can withstand shocks and rebuild itself when necessary. Resilience in social systems has the added capacity of humans to anticipate and plan for the future. Humans are part of the natural world.

Another way of describing the resilience of a socioecological system like the ACT is its long-term

capacity to adapt to change while maintaining desirable and valued characteristics.

Resilience is not about maintaining a static state; rather, it is the capacity to change within limits while retaining its key characteristics. For the ACT, resilience would mean that Canberra and its surroundings are able to deal with changes such as population growth, urban expansion, climate change and global economic fluctuations, and continue to function and thrive economically, socially and environmentally.

To deal with most major threats we need a combination of both specified and general resilience:

- Specified resilience is resilience to known pressures and shocks. Often, this type of resilience is about having the skills, knowledge, equipment, plans and other resources appropriate for the specific threat.
- General resilience enables a system to absorb disturbances of various kinds, including novel and unforeseen ones.

A system with high levels of general resilience is more likely to be able to detect threats to desired values early, and address them well before those threats cause the system to approach a threshold of potential concern. Characteristics of socioecological systems that have high levels of general resilience include:

- diversity within human and environmental systems
- openness of boundaries, so that people, ideas and species can move freely and be enriched by outside influences
- maintenance of reserves in both human and environmental systems, including things like habitat patches, local knowledge and 'corporate memory' (the combined knowledge and experience of an organisation's employees)
- 'tight feedbacks' in which critical changes in the system are quickly detected, communicated and responded to
- modularity, so that a shock or failure in one part of the system does not disturb the whole system
- strong social capital, including leadership, social networks and trust.

^f www.100resilientcities.org/resilience#

^g www.resalliance.org

By contrast, systems with low general resilience are those where there is little diversity, limited networks of expertise and knowledge, and poor recognition or communication about changes that may threaten desired characteristics of the system.¹³⁷

We usually become aware of a system's resilience after a shock has been experienced (see Case study 9.2).

Case study 9.2: ACT 2003 fires – a test of the resilience of our socioecological system

The 2003 Canberra bushfires are an example in which levels of both specified and general resilience were demonstrated to be high. Specified resilience came from investment in resources such as fire trucks, firefighters, fire plans, fire breaks and escape routes. General resilience came partly from voluntary community support and networks that helped support many of the people directly affected by the fires. These networks were an indication of strong social capital in the ACT (see Winkworth¹³⁸).

Institutions such as the media and government were viewed by many of those affected by the fires as supportive after the fires, an indicator of resilient systems able to support those affected during change.¹³⁹

However, the same institutions were also criticised by some who felt they did not provide adequate support or, in the case of the media, presented stories on the fires in a way that was harmful to survivors.¹³⁹

The ability to have this sort of exchange of different viewpoints and to learn and improve how we respond to this type of event is another aspect of general resilience (ie a resilient system is one in which failures or shortcomings are recognised, learnt from and avoided in the future). Actions such as the inquiry into the operational response to the 2003 fires¹⁴⁰ are critical to building the ACT's resilience, by identifying how future responses can be improved.



Weston Park

Photo: ACT Government

How does resilience relate to the state of the environment reporting framework?

Research during the past few decades suggests that considering ecological systems as separate from human social systems is meaningless in a State of the Environment Report. The reason a society cares about the state of the environment is because the state of the environment affects two things we value highly: the persistence of other species and the wellbeing of humans who depend on the environment for survival

and quality of life. Therefore, a resilience assessment of impacts in the DPSIR framework considers both ecological and human social systems as tightly coupled parts of a larger socioecological system.

Figure 9.15 shows one way to think about where a resilience assessment fits within a DPSIR framework.

Resilience has been assessed for each theme chapter of this report (see Chapters 4–8). This section focuses on how the assessment has been conducted.

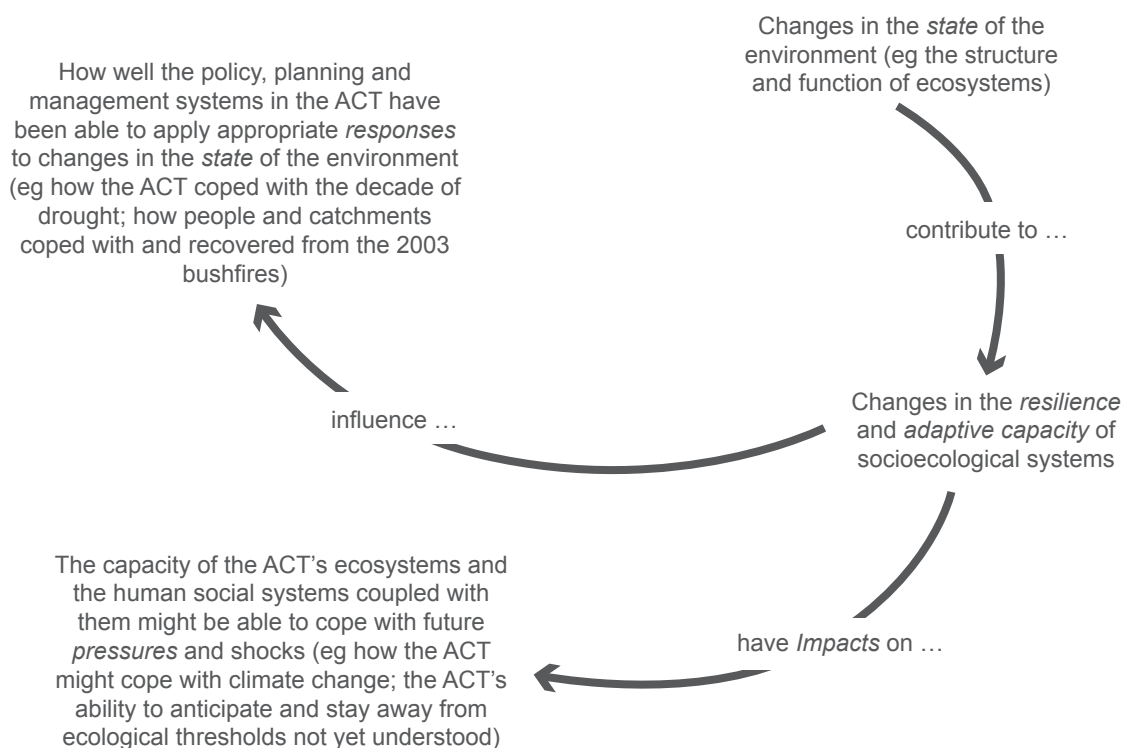


Figure 9.15 How resilience and adaptive capacity relate to the state, impacts and responses components of the Driver–Pressure–State–Impact–Response framework

9.4.2 Assessing resilience

As the understanding of the characteristics required to give socioecological systems resilience has emerged, many decision-makers have asked for a value, number or score for resilience, like the numbers we can use to assess water or air quality. Research during the past few decades shows it is neither possible nor advisable to try and put a number on resilience because of several challenges:

- Resilience draws on a range of attributes of socioecological systems that are assessable in qualitative and sometimes quantitative ways, but, ultimately, whether a system behaves resiliently will depend on complex and largely unpredictable combinations, such as when shocks happen and how people or other organisms in the system respond at the time.
- Even if we could put a number on resilience, we could not interpret that number because we cannot know whether we have too little, enough or even too much resilience until after a shock has been experienced and responded to.
- A key aspect of resilience is maintaining key characteristics of a system (sometimes called its 'identity'), but often we are not clear about what those characteristics are (eg key functions of an ecosystem or key values of a society) or not

everyone agrees on the same characteristics as being 'key'.

- There can be trade-offs between resilience to some shocks versus resilience to others (eg in the United States, New Orleans put a lot of resources into building levee banks to protect itself from one particular threat – floods – but found when hurricane Katrina hit and caused the levee banks to fail that not enough had been invested in the ability of communities to cope with unexpected crises).
- Resilience is not always good (eg a weed-infested ecosystem might be very resilient to a range of shocks, including the shocks humans impose to try and remove the weeds).

However, it is usually possible to identify whether resilience is increasing or decreasing, and whether there is cause for concern (see the example in Case study 9.3). For example, if a community in a fire-prone area has only one road in and out, we might be alerted to the risk that this community has limited resilience if that road is cut during a fire. Similarly, we might not be able to know all the shocks that our socioecological systems might face in the future, but there is great value in thinking about the pressures we currently know about and ones that are possibilities in the future, and what might be required for us to have resilience to those and similar pressures.

Case study 9.3: Canberra's Integrated Waterways Project – an example of resilience and improving benefits from ecosystem services

Canberra's network of constructed urban wetlands, built as part of the Integrated Urban Waterways Project, is an example of an action aimed at increasing resilience of the ACT's socioecological systems.

These constructed wetlands have transformed sections of Canberra's concrete stormwater drains into living systems. The wetlands, replacing concrete storm drains, aim to provide improved landscape aesthetics and livability for residents, increased biodiversity and a means of capturing stormwater to reuse on local sports

fields. The latter function enables use of these fields for longer periods during times of water scarcity.

The constructed wetlands have increased the benefits that Canberrans receive from their local ecosystems while making parts of the system more resilient in times of weather extremes. It is a good example of a project intended to improve resilience of the system as a whole, rather than only focusing on a single aspect (eg recreation, biodiversity or water scarcity).

9.4.3 A resilience assessment for the ACT

The resilience assessment completed as part of the state of the environment reporting process provides a preliminary snapshot of the ACT's position in relation to the socioecological resilience of its air, water, land, biodiversity, heritage, human needs, and climate change values and vulnerabilities. As a first-cut and indicative resilience assessment, it aims to provide the basis for further consultation and development among government and community members.

In assessing resilience in a State of the Environment Report, it is important to consider not only the current state of the ACT's socioecological systems, but also what can be learnt from past instances of shocks and recoveries.^{141,142}

Methodology

A number of methods are designed to assess socioecological resilience. Broadly, these methods are characterised by one or more of the following:

- use of expert judgement
- input of stakeholders
- ranking and mapping; this method produces a qualitative ranking against predetermined criteria and maps, based on quantitative results
- quantification.¹⁴³

The resilience assessment used in this report involved a series of expert workshops. The approach involved:

- summarising the assessments of indicators in sections 'What are the drivers and pressures on our environment?' and 'How is our environment faring?', and the management effectiveness assessment in Chapter 10: What are we doing and what effect is it having?
- establishing the broad values and desired outcomes the community expects from the environment (eg clean air, good quality and sufficient quantities of drinking water)
- summarising the pressures that threaten values
- considering the availability of
 - skills, expertise and ideas to inform and develop further work on socioecological resilience
 - evidence to establish potential thresholds of concern

- establishing the networks and connections that currently exist – these include sociopolitical networks, as well as physical components such as connectivity of ecological communities
- considering the ability of the ACT to adapt to a changing socioecological environment.

These assessments, explained in further detail in the following sections, were then used to make a preliminary and indicative assessment of the vulnerabilities of the ACT's air, land, water, biodiversity, human needs and climate change values (Table 9.33 on pages 425–426).

Resilience of what?

To assess whether the ACT's socioecological systems are resilient first requires identifying what are the values and desired outcomes of the systems that the ACT's people want to maintain in the face of pressures. We also need to know whether these values and outcomes are known about and agreed to, and whether there are processes that allow views about desired values and outcomes to evolve.

The themes examined in the State of the Environment Report (air, land, water, biodiversity, heritage) are themselves an articulation of some of these societal values; they represent key areas in which there is broad societal agreement about what is important for good environmental health. However, these are not the only values considered important in the ACT, and there is ongoing debate about which are most important, what priority they should be given and how to manage different values.

Deciding what we want to be resilient is ultimately a question of human values. Human values are expressed in our society in numerous ways, including through public debate and discussion, artistic and cultural representation, surveys and citizen juries. As societal values shift and change, different issues become prominent and become a focus for new laws and standards, although there is often a time lag between a shift in societal values and formal recognition of these values in political and legal systems.

Table 9.31 provides a list of what the OCSE considers the ACT community is likely to value in relation to socioecological resilience.

Table 9.31 Resilience ‘of what’ in relation to the themes of this report

Theme	Resilience of what – what does society value?
Air	High air quality; the benefits of high air quality for people; governance systems that monitor and maintain good air quality
Land	Maintaining the capacity of land and soil to perform functions such as nutrient cycling and regulating water flow; human systems that encourage, monitor and enforce appropriate land management
Water	Good quality and sufficient quantities of water for drinking, recreation, and the maintenance of attractive and healthy public spaces; water to maintain biodiversity and other ecosystem functions; governance systems that monitor and maintain good water quality
Biodiversity	High levels of diversity (genetic, species, ecosystems) in urban and natural ecosystems; land management practices and governance systems that protect and enhance biodiversity; appropriate fire regimes that strike a balance between risk management and environmental protection
Heritage	Maintenance of natural and cultural heritage sites, and people’s access to these sites; maintaining the community’s sense of identity based on heritage; systems that monitor, maintain and enhance heritage
Climate change	Protecting those aspects of the natural and built environment, human health and social systems that are vulnerable to extreme weather events and higher-than-average temperatures; human systems that can predict and respond to climate extremes
Human needs	Maintaining the ecosystem services that support human life; maintaining high levels of livability (eg human health, safety, economic and social opportunity, recreation opportunities, uncongested roads) in the face of change

Resilience to what?

The next step in a resilience assessment is to understand:

- what the pressures and drivers are that might threaten the values and where surprises might come from
- whether the key drivers and pressures are well understood
- whether we have early warning systems.

These issues have been addressed in the section ‘What are the drivers and pressures on our environment?’ and Chapter 10: What are we doing and what effect is it having?

Table 9.32 provides examples of the types of disturbances that can challenge achieving some of the environmental outcomes desired in the ACT. As well as specific disturbances or threats related to particular outcomes, there are also more general cross-cutting threats. For example, anything that weakens monitoring and regulation standards and practices makes it more difficult to detect and respond to disturbances of all kinds. The assessments in Table 9.32 reflect good identification of current pressures, but little evidence of systematic thinking about future pressures and shocks.

Table 9.32 Resilience ‘to what’ in relation to the themes of this report

Theme	What pressures do the ACT’s socioecological systems need to be resilient to?
Air	Pressures that decrease air quality, such as increased vehicle traffic, wood heaters, urban fires and bushfires
Land	Pressures that degrade land and soil, including inappropriate land management, soil contamination and urban expansion
Water	Pressures that decrease water quality, including increased temperatures, sedimentation, toxic run-off, autumn leaf falls in waterways; land management and extreme events that disrupt the ability of the vegetation and soils in the water catchments from filtering and purifying water before it enters lake, dams and streams
Biodiversity	Pressures that decrease biodiversity, including urban development, inappropriate land management practices and inappropriate fire regimes, including those started by arson; lack of knowledge about what constitutes appropriate fire regimes that strike a balance between the protection of life and property, and the maintenance of biodiversity
Heritage	Environmental and human pressures that degrade or undermine physical and cultural heritage, including vandalism and extreme weather events
Climate change	Changing climate patterns in the ACT, including extreme weather events and increased average temperatures
Human needs	Pressures that have the potential to degrade levels of livability, such as population growth, traffic congestion, social inequality, air pollution, loss of employment opportunities, loss of recreation facilities and green space

Can a sufficient diversity of skills, expertise and ideas be accessed to understand the socioecological system?

This component of the assessment used the management effectiveness assessment in Chapter 10: What are we doing and what effect is it having? The context and planning components of that assessment considered whether policy-makers and land managers in the ACT are able draw on sufficient skills and knowledge to understand how the ecological (and socioecological, where relevant) systems work, what key issues need to be addressed and how to address them. In general, it was found that such skills and knowledge were strong, relevant and accessible.

Are potential thresholds of concern considered, understood and monitored?

Thresholds are a key concept in resilience thinking. A threshold is a point at which a system changes into a different state where its structures, processes and products are different from what they were in the previous state. Once a system passes through a

threshold, the changes are usually either irreversible, or will require a large amount of time, energy or other resources to reverse.

A ‘threshold of potential concern’ is a threshold that, once passed through, means that the system has lost some or all of the characteristics that we valued (see ‘Resilience of what?’). Resilient systems have the ability to stay away from thresholds of concern. The closer a system gets to one of these thresholds, the smaller the shock needed to push the system into a different state. It is often difficult to strictly define where thresholds lie, so it is important to understand the factors that can push a system towards a threshold and the factors that pull the system back from the thresholds.¹⁴⁴

The ACT state of the environment reporting process is a valuable avenue to identify and monitor the key pressures and drivers that undermine the health of our environment over time and that may be pushing our socioecological systems towards thresholds of concern (see Case study 9.4).

Case study 9.4 Crossing a threshold of concern – algal blooms

Algal blooms in Lake Burley Griffin are an example of a system crossing a threshold of concern. The desired state is one in which the water is clean and algae are a small component of the life forms in the lake. When phosphorus levels reach a certain critical level, in combination with particular environmental conditions, the lake system can shift rapidly into a state where toxic blue-green algae flourish. This renders the lake

a significant health hazard to people, and impairs aesthetic and recreational values.

The resilience of the lake is its ability to absorb phosphorus and cope with environmental shocks and still remain clear and clean. That resilience is not just ecological – it also includes the factors that affect the ability of decision-makers to anticipate an algal bloom and take action early to avoid it.

The preliminary assessments in Table 9.33 conclude that some thresholds are understood and taken into account for air (including climate), water and heritage, but that there is low understanding of thresholds in relation to land and biodiversity. This is concerning, because the 2011 national State of the Environment Report and some key recent international publications have suggested that thresholds in relation to soils and biodiversity are already being approached or exceeded in Australia and many other countries.^{145,146} It should be noted that this deficiency is not a reflection on the calibre of staff responsible for managing land and biodiversity, but on the limited resourcing of research and development in relation to ecological thresholds and possible future challenges.

Can indicators and understanding be adapted as experience and information grow?

To be resilient, the ACT's decision-making processes must be able to take account of new information, and adapt what it monitors and how so that it is able to better assess the various factors that contribute to its ability to absorb and adapt to pressures and shocks. This assessment concluded that there is high ability to adapt indicators and monitoring with respect to air, water and heritage, but that there was limited ability with respect to land and biodiversity. This is because data collection is limited in these areas, we use indicators that do not go directly to the key issues, and changing these approaches is expensive.

How might the ways in which things are connected affect resilience?

The nature of connections (ie networks) between parts of socioecological systems (eg between species, habitat patches, people, institutions, projects, programs) has been found to be a vitally important determinant of resilience. For example, if many aspects of the management of the environment were controlled from one central location, one funding source, one policy or program, or one or a few key people, then the management system would be likely to collapse if that central focal point were to fail. Often, management of complex issues within communities, or even governments, is heavily reliant on key individuals who have high levels of skill and understanding and strong support from others. But if that person becomes ill, or moves to another position or place, then that management can become dysfunctional, or at least much less effective.

Undisturbed ecological systems are usually highly resilient because there are many links between species and resources, and key functions are performed by multiple species. If one species declines then another takes its role. This process is often called 'ecological redundancy'.¹⁴⁷ Disturbed ecological systems usually have less redundancy and less resilience because they have been simplified. In a similar way, seeking efficiency in the development and implementation of policies and plans can leave socioecological systems with low redundancy and resilience (ie they have low levels of 'back-up' to call on when critical functions are challenged by shocks).¹⁴⁸

The management effectiveness assessment revealed that there are well-developed and potentially resilient networks within those agencies, other institutions and individuals involved in anticipating and responding to changes in the state of air, land, water, biodiversity and heritage in the ACT. In addition, there are high levels of interaction and cooperation between these groups, especially at an agency level, which is likely to minimise the chances of issues being overlooked. Hence, the assessments against the criterion 'Connectivity of networks' in Table 9.33 are positive across all themes.

It was frequently noted, however, that despite these strong networks, resource allocation can be a problem for dealing with issues, especially in relation to land and biodiversity. In the opinion of the assessment group, these resource constraints are likely to inhibit seeking and acting on feedback of new information and ideas from the literature and informed individuals.

What is the adaptive capacity of the ACT's socioecological systems?

Adaptive capacity is distinct from resilience. Whereas resilience is the property of a system that allows it to absorb shocks while retaining its key characteristics, adaptive capacity is the capacity of humans or other species that take actions in response to change to influence resilience.¹⁴⁹

The adaptive capacity of the ACT's socioecological systems, therefore, is the capacity of humans and other species to respond to change so that the values of the systems that are important to us are maintained.

In practice, the characteristics that give systems high resilience also give them high adaptive capacity, the difference being that adapting requires action. Adaptive capacity in ecological systems is related to genetic diversity, biological diversity and the heterogeneity of landscape mosaics.¹⁵⁰ Social systems, institutions and networks that learn, store and share knowledge and experience provide means by which interest groups can interact productively and problems can be solved flexibly.¹⁵⁰

Four critical factors interact to influence adaptive capacity:¹⁵¹

- learning to live with change and uncertainty
- nurturing diversity for resilience
- combining different types of knowledge for learning
- creating opportunity for self-organisation towards socioecological sustainability.

The assessment group considered these factors in making its assessment of the adaptive capacity of the ACT's socioecological systems in Table 9.33. Adaptive capacity was judged to be high for air, water and heritage. Adaptive capacity was rated as limited for land and biodiversity, largely because of the resource constraints thought to limit adaptation of indicators and take account of new information and viewpoints, which were discussed previously.

Table 9.33 Preliminary assessment of the resilience of socioecological systems that underpin achieving desired outcomes for air, land, water, biodiversity, heritage, human needs and climate change in the ACT

Question or statement about socioecological system resilience		Assessment criteria	Air	Land	Water	Biodiversity	Heritage	Human needs	Climate change
Resilience of what?	Are values and desired outcomes known and agreed to?	Outcomes not known or agreed to							
		Few outcomes known and agreed to							
		Some outcomes known and agreed to, with gaps							
		Outcomes known and agreed to							
	Are there processes that allow views about desired values and outcomes to evolve?	No processes identified							
		Processes exist, not always linked to decision-making							
		Processes exist, linked to decision-making							
		Processes exist that foster debate and discussion, and link to decision-making							
Resilience to what?	Are key drivers and pressures known?	Threat processes not known							
		Few threat processes identified or understood							
		Some threat processes known, with gaps							
		Good understanding of threat processes							
	Is there ongoing identification of drivers, pressures and possible shocks?	No processes for ongoing identification							
		Some processes exist, not always systematic or linked to decision-making							
		Processes linked to decision-making exist, with gaps							
		Regular processes identify and act on threats							
Can a sufficient diversity of skills, expertise and ideas be accessed to understand the socioecological system?		No expertise or capacity							
		Limited expertise and capacity							
		Good expertise, limited capacity							
		Good expertise and capacity							

continued

Table 9.33 continued

Question or statement about socioecological system resilience		Assessment criteria	Air	Land	Water	Biodiversity	Heritage	Human needs	Climate change
Are potential thresholds of concern considered, understood and monitored?		No monitoring							
		Limited monitoring or understanding of thresholds							
		Regular monitoring of outcomes, some thresholds understood							
		Regular monitoring of outcomes and drivers, good understanding of thresholds							
What is the likelihood that indicators and understanding can be adapted as experience and information grow?		No ability to adapt monitoring							
		Limited ability to adapt monitoring (eg at a high expense)							
		Monitoring can be adapted, with some limitations							
		Monitoring can be readily adapted							
Resilience networks	Feedbacks	No feedback processes							
		Limited feedback processes, with large gaps							
		Feedback processes exist, with some gaps							
		Good feedback processes							
	Connectivity of networks	No networks exist to share information							
		Limited networks exist							
		Good networks exist, some limits in connectivity							
		Excellent networks and connectivity							
Adaptive capacity		Adaptive capacity appears to be inadequate							
		Adaptive processes exist but have significant limitations that reduce ability to adapt to change							
		Adaptive processes exist, with gaps							
		Adaptive processes are strong							
Resilience assessment	Overall assessment	Resilience processes are inadequate							
		Resilience processes exist but have significant limitations that reduce ability to adapt to change							
		Resilience processes exist, with gaps							
		Resilience processes are strong							

9.4.4 Summary

A resilience assessment poses questions about whether the ACT's socioecological system has the resources, monitoring, feedback and networks in place to respond rapidly, effectively and successfully to changes that threaten the things that the ACT's people value in their relationships with the environment. Table 9.33 presents a summary of the ACT's resilience for air, land, water, biodiversity, heritage, human needs and climate change.

It is somewhat artificial to judge resilience and adaptive capacity of air, land, water, biodiversity and heritage separately, because they are interconnected parts of the one system bound together by the natural environment and its interactions with humans and their preferences and needs. These themes are, however, dealt with to some extent separately by government and nongovernment institutions, and so it is useful to draw attention to the different perceived strengths and weaknesses of arrangements under these themes. Where there are complex links between drivers and pressures, and their impacts, it is challenging to identify how close the ACT's coupled social and ecological processes might be to thresholds of potential concern. It is also challenging to respond in a timely and effective fashion to stay away from those thresholds.

Overall, the ACT appears to have good socioecological processes in place for maintaining much of what is valued, and has performed very well against targets for reserving comprehensive, adequate and representative samples of ecosystems, which is a significant risk mitigation strategy. However, there are important gaps. The ACT is not alone in facing these challenges – they are issues for all jurisdictions within Australia, and most developed and developing countries around the world.¹⁴⁵

The processes that appear to most need attention to improve the ACT's ability to deal with these challenges are those relating to:

- encouraging access to diverse new information and ideas about land and biodiversity management
- building new information into better indicators of the state of land and biodiversity
- resourcing the collection of relevant information so that improved indicators can be monitored and interpreted, and turned into timely and effective actions.

These deficiencies are not reflections of the calibre or dedication of staff involved in monitoring and managing land and biodiversity in the ACT; rather, they are a reflection on resourcing. The ultimate illustration of this deficiency of resourcing is that there were no rigorous and direct indicators of the state of biodiversity or the quality of ecosystem processes available to those preparing Chapter 5: Land and Chapter 7: Biodiversity.

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