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Social and economic benefits from environmental watering

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Acknowledgement of the Traditional Owners of the Murray–Darling Basin

The Murray–Darling Basin Authority acknowledges and pays respect to the Traditional Owners, and their Nations, of the Murray–Darling Basin, who have a deep cultural, social, environmental, spiritual and economic connection to their lands and waters. The MDBA understands the need for recognition of Traditional Owner knowledge and cultural values in natural resource management associated with the Basin.

The approach of Traditional Owners to caring for the natural landscape, including water, can be expressed in the words of the Northern Basin Aboriginal Nations Board:

> …As the First Nations peoples (Traditional Owners) we are the knowledge holders, connected to Country and with the cultural authority to share our knowledge. We offer perspectives to balance and challenge other voices and viewpoints. We aspire to owning and managing water to protect our totemic obligations, to carry out our way of life, and to teach our younger generations to maintain our connections and heritage through our law and customs. When Country is happy, our spirits are happy.

The use of terms 'Aboriginal' and 'Indigenous' reflects usage in different communities within the Murray–Darling Basin.

Contents

List of tables

Executive summary

The rivers, lakes and wetlands of the Murray–Darling Basin provide important 'ecosystem services' (benefits to people) that contribute to the strength of the Basin economy and to the health and wellbeing of its residents. Water assets provide direct support to industries like tourism and agriculture, and important recreation, amenity and cultural values to Basin residents. For Aboriginal people, healthy rivers and wetlands are essential to spiritual, cultural and physical wellbeing, while also supplementing incomes by providing bush foods. Returning more water to the environment under the Basin Plan was expected to increase the capacity of the environmental to deliver services to people. This would lead to improved social and economic outcomes for Basin residents and the broader Australian community (MDBA 2012).

This report assesses whether implementation of the Basin Plan is 'on track' in relation to the expected benefits to people of returning water to the environment. In this regard it is important to note that Basin Plan implementation is only part way through – not all environmental water has been recovered, and there are lags between the use of environmental water, changes to ecological conditions, and measurable changes to social and economic outcomes. Not unexpectedly, data and evidence is somewhat limited, and what is available at this stage is often anecdotal, qualitative, or indirect. The report does, however, provide useful insights into the links between the environment and important social and economic outcomes. It also provides a platform for future assessments of the benefits from environmental watering.

The range of ecosystem services considered in this report are those that directly or indirectly affect social and economic outcomes in four areas: amenity; recreation; tourism; and services to agriculture. These areas have been chosen on the basis that the links between environmental conditions and associated social and economic outcomes for businesses or people are relatively direct and observable. They are important in terms of the overall benefits expected to result from implementing the Basin Plan, and there is generally more data and evidence available to assess changes in the size and extent of benefits over time.

There are other types of ecosystem services benefits (and a potentially broader group of beneficiaries) that environmental water recovered under the Basin Plan could contribute to. For example, maintaining and improving the condition of key Basin rivers and wetlands (particularly in relation to outcomes for rare and endangered plants and animals) is important to a broader group of people than just Basin residents and visitors. This reflects international recognition of the Basin's unique ecosystems, and national and international support for their conservation. These broader benefits are not considered in this report, but will contribute to future reviews of the Basin Plan.[1]

[1] Appendixes A & B provide more detail on the ecosystem services concept, and the full range of 'ecosystem services' benefits and beneficiaries identified in the literature. Also included is background material, an outline of the way assessments of ecosystem services have been made in this report, and a short discussion of future work planned in this space by the MDBA.

Approach to assessing ecosystem services benefits

The four areas of social and economic benefit identified above are assessed by:

- Identifying the scale and scope of the benefits and beneficiaries
- Describing the relationship between the condition of the environment and the social and economic outcomes provided (e.g. improved amenity and lifestyle benefits to Basin residents, improved opportunities to fish recreationally)
- Describing how the relevant services and related social and economic outcomes have changed since the Basin Plan began
- Assessing the contribution of the Basin Plan to the observed changes.

Benefits and beneficiaries

Of the ecosystem services covered in this assessment, some are large in both scale and scope. Tourism, for example, is an important industry in the Basin with much activity centred on major rivers, lakes and wetlands. In 2016–17 there were just under 18 million overnight visits to the Basin, accounting for expenditure of around $7.5 billion. (The value of irrigated agriculture in the Basin was almost $7 billion in 2015–16, which, in real terms, is similar to the level of production seen back in 2001.)

More than 2 million people now live in the Basin. For most, water resources are considered the lifeblood of their communities – they make towns more liveable, and provide places to relax, unwind and reconnect with nature. A further 1.2 million people living outside the Basin also depend on the Murray River for potable water supplies.

Apart from their consumptive needs, an estimated 400,000 to 500,000 Basin residents regularly fish in the Basin for pleasure. Total expenditure on recreational fishing is estimated to be worth around $1 billion each year, generating more than 10,000 jobs. Around 40,000 non-irrigated farms in the Basin also depend critically on rivers and creeks for stock and domestic water.

The link between environmental conditions and benefits to people

The condition of the Basin's rivers and wetlands directly affects social and economic outcomes for businesses, residents and visitors alike. When environmental conditions deteriorate, as they did during the millennium drought, outcomes for people deteriorate. Recreation and tourism-based industries suffer as visitor numbers drop, while amenity and other social and cultural values derived from water ecosystems decline.

Changes in water quality and reliability (whether man-made or natural) also affect business costs. More than 40,000 non-irrigated farms in the Basin rely on the Basin's water resources for stock and domestic needs. The quality and reliability of this water directly impacts their profitability, and the quality of life of farm families. Many grazing farms also rely to one degree or another on periodic flooding events. These events boost productivity on their floodplains, improving profitability.

Changes in environmental conditions in the Basin Plan era

The ecological condition of many Basin rivers and wetlands has improved over the last five or so years in response to a general improvement in Basin rainfall and an increase in flows associated with environment watering. The improvement in environmental conditions has contributed to improved social and economic outcomes, with benefits in the form of improved amenity and recreation opportunities, job and income growth in the tourism sector, and benefits to farming and other consumptive water users from improved water quality. Tourism statistics show visitor numbers and expenditure in the Basin have increased substantially in the last five years. As noted above, expenditure by overnight visitors to the Basin is now worth around $7.5 billion per annum – an increase of $1.8 billion compared with five years ago.

The importance of amenity and recreation benefits can be seen in property values, which have been increasing in much of the Basin but increasing most in those towns and regions with greater proximity to rivers and wetlands and which have significant and/or growing tourism industries. The Basin's population also grew by more than 90,000 in the last five years, with many new residents attracted by the amenity and lifestyle benefits on offer.

Ecological conditions have not improved in all regions however, and there is some evidence that social and economic outcomes have stagnated or worsened as a result. Also, much of the population and economic growth in the Basin is confined to medium to larger centres, with many smaller towns exhibiting constant or declining populations.

In relation to social outcomes, results from the Regional Wellbeing Survey show that Basin residents are no different (on average) to other rural and regional Australians when it comes to life satisfaction and their perceptions of community wellbeing. While a significant proportion of people (particularly among irrigators) in the Basin report negative outcomes from environmental watering, this does not show up in the wellbeing and life satisfaction scores for Basin residents. The survey results show, however, that the majority of Basin residents support the use of environmental water to improve outcomes for birds, fish and native vegetation (University of Canberra 2016).

Overall, the evidence on recent changes in the Basin supports the view - outlined in a range of reports and assessments undertaken prior to the introduction of the Basin Plan - that there are a broad range of positive social and economic outcomes from improving the condition of the Basin's water ecosystems.

Contribution of the Basin Plan

This assessment has not attempted to put an aggregate value on the ecosystem services provided by Basin water resources, or to measure the extent to which additional environmental water provided under the Basin Plan (to date) may have contributed to that value. Previous research commissioned by the MDBA has established that Basin water resources do provide substantial ecosystem services benefits, and that recovering water is needed to support their capacity to continue doing so (MDBA 2012).

Early evidence has been found, however, suggesting that site-specific environmental watering events are making a positive contribution to social and economic outcomes. Residents in Victoria report that specific environmental watering activities have contributed to, “bumper recreational fishing catches, increased numbers of bird watchers, improved canoeing and rowing regatta conditions, influxes of campers and bush-walkers and a general improvement in the 'greening' of scenery encouraging picnickers and day-trippers.” There are also anecdotal reports from site managers and operators of tourism businesses that environmental flows have directly supported a recovery in visitor numbers to specific sites.

Modelling undertaken by the MDBA shows that environmental flows provided by the Basin Plan to-date have generated additional salinity dilution benefits of approximately 36 EC units at Morgan, South Australia. This dilution is estimated to have provided a net benefit of approximately $5 million per year to river water users, including irrigation farmers.

On balance, there are multiple lines of evidence supporting the view that water recovery to date under the Basin Plan is contributing to improved environmental outcomes, with positive flow-on effects to Basin residents and visitors and to key industries like tourism and recreational fishing. While benefits are likely to be comparatively modest in scale and scope at this point, this is consistent with expectations at the time the Basin Plan was developed. Importantly, the early evidence confirms the link between increased flows and improved social and economic outcomes for many Basin businesses, residents and visitors.

Cooperation and learning

Underpinning many of the positive social or economic outcomes generated by environmental flows to date is complementary investments (monetary and in kind) by governments, local councils, community action groups and landholders. Whilst the benefits generated to date are likely to be both modest and site-specific, in relation to the longer time outcomes expected, many people in the Basin recognise the value of these longer-term changes based on what they are already observing.

Over time, and as more water is recovered and used for environmental purposes, it is expected that the flow-on benefits to people will accumulate. As noted earlier, not all environmental water has been recovered yet, and it will take time for the environment to respond. Further research and analysis to better understand and quantify ecosystem services benefits is planned, with results expected to contribute to future reviews of the Basin Plan.

A key finding from this assessment is that local governments, land holders, and community and natural resource management groups are increasingly working together in the design and delivery of environmental watering programs. This cooperative approach integrates local knowledge and expertise into the management of environmental flows, increasing the potential for environmental watering events to achieve multiple outcomes while minimising the chance of unintended or adverse outcomes. There is a strong sense of learning by doing.

Amenity benefits from healthy rivers, lakes and wetlands

> *Amenity is broadly defined as the qualities of a region that make it an attractive place in which to live, work and recreate (Argent et al. 2007)*

More than 2 million Basin residents derive important amenity and lifestyle benefits from their proximity to Basin Rivers and wetlands. Apart from visual amenity, healthy water resources provide Basin residents with a sense of place, psychological wellbeing and local identity. Water resources are considered the lifeblood of many Basin communities – they make towns more liveable, and provide places to relax, unwind and reconnect with nature. For Aboriginal people, healthy rivers are essential to spiritual, cultural and physical wellbeing, and provide important bush foods.

The Basin's population has grown by more than 90,000 in the last five years, with many new residents attracted by the amenity and lifestyle benefits on offer. The population is estimated to be close to 2.4 million before the Basin plan is fully implemented – an increase in permanent residents of around 180,000 in 10 years. Apart from their consumptive water needs, an expanding Basin population will provide an ongoing demand for the amenity and lifestyle benefits associated with healthy and sustainable rivers, lakes and wetlands.

In this section the amenity benefits we consider are largely those associated with lifestyle and aesthetics. They include visual amenity, as well as social, cultural and lifestyle benefits that come from living and working in a region with an attractive and healthy natural environment. Tourism and recreation benefits associated with Basin water resources are considered in separate sections of this report, while cultural benefits to Aboriginal people are discussed in a separate report.

How amenity is linked to water ecosystems

Amenity is an easily recognisable benefit provided by a healthy natural environment. People pay more to live in places that have aesthetic, lifestyle and cultural appeal, particularly those with views of attractive natural assets like rivers, lakes, forests and wetlands. A study of residential property prices along the River Murray in South Australia found that, among properties within 1 km of the river, being 500 metres closer to the river increased the average property value by around $250 000 (Tapsuwan 2012). This increase in value is attributed to the 'recreational attractiveness' of the river. More generally, the research indicates that social and economic values are positively associated with the River, and reflected in residential property values.

Many local governments go to considerable trouble and expense to make their communities more visually attractive as places to live. Building and maintaining community parks and gardens is a common strategy, with many such facilities in the Basin located adjacent to creeks, rivers, lakes and weir pools. These facilities build on the natural amenity that local water resources intrinsically provide.

There is also a growing emphasis on developing public spaces and facilities that are better integrated with environmental assets to allow easier and safer access for residents and visitors. For example, raised walkways, viewing platforms and cycling and walking paths are frequently used around water assets to enhance their accessibility and functionality. Many such developments target health and exercise benefits, as well as allowing more people to connect with nature via direct participation.

> *The (Wagirra) trail is sealed and accessible to users of all fitness levels, making it perfect for walking, running or cycling. (It) is a long-term project to link Albury's central riverside areas to Lake Hume along a 70 kilometre trail. The current priority is to construct the Wagirra Trail around the perimeter of Wonga Wetlands ... This will provide an additional 12 kms of trail which will take in the wonderful scenery of the Murray River around Wonga Wetlands.*

Another way to illustrate the link between healthy and attractive water ecosystems and individual and community wellbeing is to consider what happened in many Basin communities when water availability was limited, such as during the millennium drought.

> *They'll all tell you – anyone who experienced this in the millennium drought, white, black, green, blue – that if you have unhealthy environment you have unhealthy communities (Fisherman Coroong SA)*

At the time, the devastation of water ecosystems and the decline in lifestyle and amenity values had significant social impacts, particularly for people living closer to rivers and wetlands. The reduction in water flow, the loss of vegetation, and the decline in bird, fish and animals adversely affected many Basin residents. The strength of concern in local communities over the state of the natural environment arguably contributed to the decision to rebalance water use in the Basin.

The millennium drought also had unprecedented impacts on the availability of water for critical human water needs, and led to severe restrictions on urban water use in many Basin towns and cities. These impacts resulted in revised water sharing arrangements to ensure that human water needs were better protected in future.

> *By the beginning of July 2007, a total of 457 Victorian towns were subject to water restrictions. Coupled with the extended dry conditions since 1997, some towns were on severe levels of restriction for long periods, with considerable impacts on communities. (DELWP Millennium Drought report)*

> *For the 700 residents of Lake Boga, in Victoria's northwest, the five-year big dry changed everything about their small town - the look, the smell, the mood. The parched lake bed, the stench of rotting fish and the desperate expressions on the faces of the locals were constant reminders that the once-thriving town on the Murray was on its knees. ('Life on the lake again rich with promise,' The Australian, 2010 http://www.theaustralian.com.au/news/nation/life-on-the-lake-again-rich-with-promise/news-story/abb91093594aea2ceb7315e500d4e1af)*

Ultimately, healthy rivers, lakes and wetlands provide important lifestyle and amenity benefits to Basin residents. These benefits are directly related to the condition of water ecosystems, and will likely grow in importance over time in line with further increases in the Basin's population.

Evidence of change (outcomes and indicators)

Indicators of ecological health and condition – including bird and fish numbers, riparian vegetation estimates, and water quality indexes – show that the condition of Basin rivers, lakes and wetlands has generally improved in the last five years. According to the Commonwealth Environmental Water Holder (CEWH), "Following the breaking of the millennium drought and record floods in 2010 and 2012, natural flooding and environmental watering actions have resulted in improvements in the condition of many Victorian Rivers in the Murray–Darling Basin and associated wetlands" (Department of the Environment and Energy 2017). In principle, these improvements in environmental conditions contribute to better amenity, lifestyle and cultural outcomes for Basin residents.

Measuring or quantifying these benefits can be difficult however, as there are few indicators of amenity or wellbeing that are directly related to the condition of water ecosystems, or adequately measure how these values change over time. There is anecdotal and indirect evidence, however, that amenity and lifestyle values for many Basin residents have increased in line with the general improvement in environmental conditions since the drought broke. For example, residential property values in the Basin have continued to increase, with faster rates of growth in those towns and regions with proximity to water and associated built amenity - parks, gardens, bike paths, walkways etc. (Valuer General of New South Wales 2016).

Natural and built amenity attracts people and investment

Recent research by the Bureau of Infrastructure, Transport and Regional Economics and the Productivity Commission highlights the increasingly important role played by amenity (man-made as well as natural) as a driver of location decisions. In essence, more and more people are comparing towns and regions on factors other than employment and industry when deciding where to live (Bureau of Infrastructure, Transport and Regional Economics 2014).

> *People are more likely to move to a large regional centre that has green playing fields and houses with nice lawns and gardens … Dubbo's playing fields are renowned throughout the state and we get lots of sporting tournaments here that generate tourism income. We believe it's important to people's wellbeing to live in a green environment. ('Delivering a healthy working Basin for Australia: Dubbo, New South Wales,' Stewart McLeod, Dubbo City Council, http://155.187.2.69/water/publications/action/local-stories/dubbo.html*

> *The town (Moama) has recently seen a great resurgence with people moving to the region seeking a 'tree change' from Melbourne which is located 2.5 hours' drive away to the south and is a popular destination for tourists. (Valuer General of New South Wales 2016)*

Growth in the Basin's population is partly a reflection of the attractiveness of many Basin towns as a place to live. New property developments in the Basin often focus on the lifestyle and amenity benefits of the region, with proximity to rivers, lakes and wetlands a frequent theme in promotional material, particularly in the southern Basin. (Examples of 'lifestyle' property developments on or near major rivers and lakes in the southern Basin are outlined in Appendix 3).

The Gardens (in Shepparton) are close to schools, shops, transport and nature, while the residential estate has been carefully planned to enhance your lifestyle, with more than half the development made up of parkland, lakes and wetlands. (Development Victoria)

Choose to build at Riverwood Park, and you'll find nature quite literally on your doorstep. Direct connection to Greater Shepparton City Council's shared bike path network provides access for you to explore 10's of kilometres of river bushland and pathways - whether walking, running or riding. Magnificent landscaped parkland, set amongst the beautiful Goulburn River bushland offers playground facilities, quiet places to relax, or wide open grassed areas for a game of cricket or a kick of the footy. Breathtaking views, wide open space, all set to the soundtrack of native birdsong - nature awaits at Riverwood Park.

During recent years many new homes have been erected (in Paringa) and some sites offer magnificent views over the Murray River. ('History in the Renmark Paringa District,' Renmark Paringa Council https://www.renmarkparinga.sa.gov.au/history)

While there is strong interest in attracting young families to the Basin, attracting the retired and semi-retired is also an important objective of many local governments. Over the next 20 years the number of people in Australia aged over 60 is set to double, and this is driving a rapidly expanding retirement village industry. Many Basin towns are capitalising on this trend, using the twin lures of lifestyle and competitively priced land.

The Murray Region provides a rich lifestyle for its residents, with affordable housing, picturesque landscapes, and close proximity to major cities. (MurrayNow Group 2014)

Swan Hill Village is under construction and will feature 155 independent living homes catering to the over 55 community. … Resort-style facilities will include a Country Club with lounge & dining area and a sports bar, gymnasium, computer room, activities centre and expansive gardens and nature walks.

Not all regions within the Basin, however, have experienced improved environmental conditions since the Basin Plan began. In these cases, amenity benefits to Basin residents from riverine ecosystems may have declined rather than improved. Some water ecosystems have not improved substantially since the breaking of the millennium drought, despite generally improved rainfall conditions in much of the Basin. In south-western New South Wales, residents claim that the lower Darling River has suffered an extended period of little or no flow, with particularly devastating impacts on the region's Aboriginal people.

> *When the water is low the spirit is low. It affects everyone's wellbeing. People are out and about when there is water. They go to the river or lake every weekend. (Broken Hill resident, 2017)*

> *In 2012 there was water and bird life the people were out there and happy and living off the land fishing and hunting gathering yabbies. It's really disheartening to see now the water is dying there is no fish and animals for the people (Broken Hill resident, 2017)*

Basin Plan contribution

There is early evidence – mostly qualitative and anecdotal at this stage, and site-specific rather than Basin scale – that Basin plan environmental water is contributing to the health and wellbeing of Basin residents (and visitors) through the positive impact it is having on the condition of rivers and wetlands. The VEWH, for example, regularly receives feedback from communities regarding specific outcomes from environmental watering. This feedback points to a broad range of community benefits experienced after environmental water is delivered to sites, including "bumper recreational fishing catches, increased numbers of bird watchers, improved canoeing and rowing regatta conditions, influxes of campers and bush-walkers and a general improvement in the 'greening' of scenery encouraging picnickers and day-trippers" (VEWH website). Healthier and more attractive rivers and wetlands – partly supported by environmental watering – are providing improved amenity and recreation benefits for Basin residents and visitors.

> *Down at the Loxton River front the floodplain was in pretty bad shape when we started watering that project it was one of our first sites and we were using sprinklers to water seedlings that had popped up in the 2010–12 floods. The response now by those trees is quite dramatic and we have started to put water into the riverfront lagoon, this area is just below Loxton Township, next to a caravan park. … Now any time of day I have been down there you have people walking their dogs, people cycling, you have got the usual fisher people down there as well. And the local rotary club in the last 12 months have built a board walk out over the Lagoon where we are pulling in some environmental water so they are really taking hold of that now and can really benefit from having a healthy floodplain right at their doorstep and get out an enjoy it. (Manager of the Water for Nature program, SA.) [MDBA interview quote]*

Land owners also report positive social outcomes from environmental watering:

> *I guess there has been a few occasions when the water has been sent down with environmental watering,…it's come on to our land and caused some benefits, primarily for the environment, but also some benefit to us… it's good for the fish and the tadpoles and good for the birds. … I like being able to take my son to go fishing on the weekend… I can chuck [fishing gear] in the car and go fishing and then they [my children] can see bird life around and they can catch a fish and relax. I think that's important. (Local insights interview 2014–15.)*

> *This (privately owned) wetland feeds the billabongs in the national park so when this floods (using environmental water), the water will flow into those lagoons and the whole of Australia can benefit from that park and the resource it presents. … You've got more birds, more wildlife and those sorts of things around the edge of the farm … They (freshwater turtles) were walking across the mudflats which was terrific to see. The kids thought that was marvellous. ('Yambuna beef producer finds watering private wetlands does not have to cost the farm,' ABC website, http://www.abc.net.au/news/rural/2017-09-26/watering-private-wetlands-does-not-have-to-cost-the-farm/8986494)*

Notwithstanding the early positive signs, the full range of amenity benefits associated with returning water to the environment are likely to take longer to manifest. Some badly degraded environmental systems were expected to recover only slowly from the millennium drought, even with the return of water recovered under the Basin Plan. In these cases, flow-on benefits to communities – such as improved amenity benefits – are not expected to be large or easy to observe, particularly at this stage of Basin Plan implementation. Nevertheless, the amenity benefits to Basin residents flowing from improved condition of water resources are ultimately expected to be significant, and will grow further as the Basin population continues to increase. Given the size of the Basin population, small improvements in the condition of the environment can generate large changes in the aggregate amenity and lifestyle benefits that residents enjoy.

This evaluation has not attempted to estimate the size or scale of the amenity benefits to date arising from changes being implemented as part of the Basin Plan. Further research and analysis is being done in this space, and the results of this work will contribute to the first full review of the Basin Plan scheduled for 2020.

What is already clear however, is that healthy rivers and wetlands are important to the health and wellbeing of Basin residents. Moreover, there is strong community support for ongoing improvements to the environmental condition of rivers and wetlands with most residents viewing the need for sufficient environmental water as critical to achieving this goal (UC 2016). There is particularly strong community support for the use of water recovered under the Basin Plan to support native fish populations, vegetation growth and bird breeding events. For example, an estimated 70% of Basin residents (close to 1.5 million people) support the use of environmental water to improve native fish populations, and there is a similar level of support for other environmental and cultural outcomes (UC 2016). This partly reflects self-interest – many Basin residents like to go fishing – but there is broad community support for using environmental water to help maintain the health of rivers and wetlands.

Community engagement helps to achieve multiple benefits from environmental watering

Community involvement in managing environmental water is fostering inclusiveness and contributing to a better understanding of how water can deliver multiple benefits to a diverse (and sometimes diffuse) group of stakeholders. Government agencies responsible for delivering environmental water are actively using local knowledge and expertise to maximise the benefits from delivered water (and, in some cases, to minimise any potential adverse impacts). In Victoria, the VEWH works with waterway managers and managers of water storages (who deliver water to homes, farms and businesses) to maximise the release of environmental water to deliver broader community benefits, such as for improved recreation, so long as the environmental reasons for watering are not compromised (VEWH).

Community involvement and assistance (including access to landholder and irrigation system infrastructure) is also helping water managers deliver environmental water to important ecosystems that were no longer receiving regular flows prior to the Basin Plan:

> *… local irrigation infrastructure and teamwork have delivered environmental water to sections of the Murray Valley for the first time in 40 years with great results for plants and animals. (NSW OEH)*

The Commonwealth Environmental Water Holder is using a system of local engagement officers to help create opportunities for interested local people to participate in decision-making around environmental water use. The local engagement officers work with water, environment and community organisations in their region to build an understanding of local knowledge and perspectives. This information is helping to inform the management of Commonwealth environmental water (Department of the Environment and Energy 2017b).

Amenity-based industries and residential development opportunities are helping some communities adjust to declining farm numbers

A long-term decline in farm numbers has been an ongoing challenge for many communities in the Basin, particularly those that are more dependent on irrigation. However, population and job growth driven by other sectors can sometimes have a positive offsetting effect. Subdivisions of farming land close to regional towns and centres is invigorating some local communities, with strong social as well as economic benefits:

> *Being so close to Mildura, we've got the river, and what we're finding on a, yeah I guess, full socio-economic aspect is that (property) lots of this size are highly sought after now. … There's a lot of young couples (buying in to this area), so … a football club develops, and then it's got to go have juniors, junior netball and junior football and a basketball stadium, which we've got, and all those sorts of things. Tennis, they play night tennis down here at Gol Gol, they have junior lessons. It is a very, very strong community, overall. [Local farmer]*

Not all towns have as many adjustment options however, and continued declines in farm numbers (influenced by water recovery programs in some cases) have not been offset by growth in other

sectors. Also, as noted above in relation to parts of western New South Wales, it is likely that many smaller communities are yet to see major flow-on economic and social benefits from environmental water, either because there hasn't been enough or because the early benefits arising from specific environmental watering events are not spread evenly across the Basin. Other communities may be in regions where there are few significant water assets, limiting the potential gains from improved environmental conditions. While residents in these districts can benefit from general improvements in amenity elsewhere, they are less likely to see many of the direct economic benefits observed in regions with important water assets close by, and which are already popular with visitors and potential new residents.

Contribution of tourism to the Basin economy

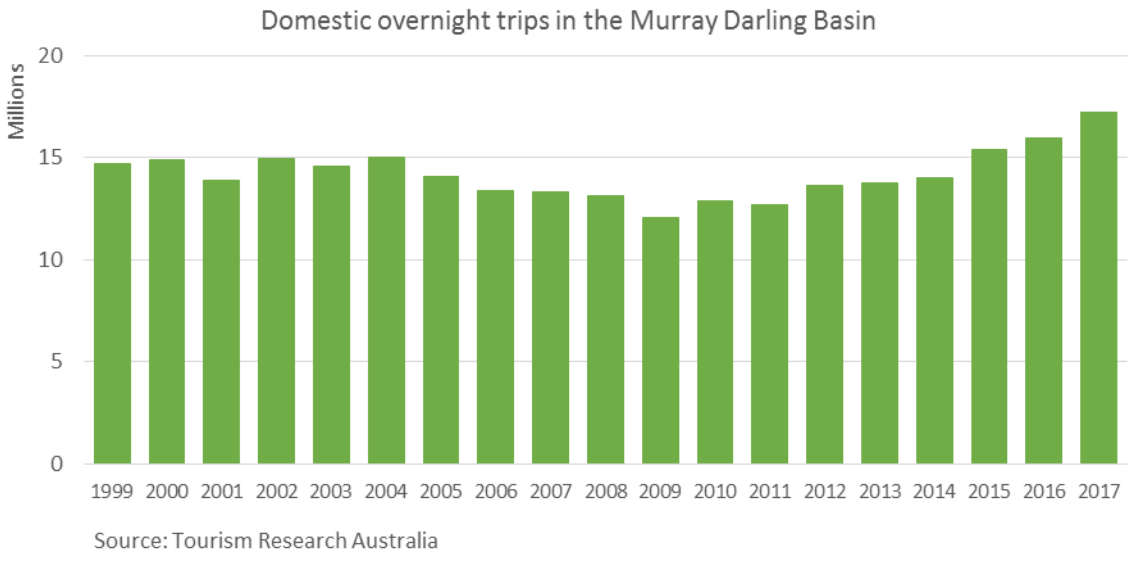
The diverse geography and history of the Basin offers many opportunities for tourism, ranging from skiing in the Australian Alps, enjoying food and wine in fertile valleys, visiting historic townships, and fishing and camping along thousands of kilometres of waterways. Boating, water skiing, canoeing and kayaking, bird-watching and golfing are other common activities for domestic and international visitors to the Basin. Experiential tourism is increasingly popular, with strong ties to local food and wine producers.

Visitor numbers to the Basin have grown strongly over the last five years, and are now above levels recorded prior to the millennium drought (Figure 1). In 2016–17 domestic tourists made more than 17 million visits to the Basin, stayed for more than 50 million nights and spent more than $6.5 billion (Tourism Research Australia). The number of international visitors to the Basin also grew strongly over the last five years. Total expenditure by international visitors added a further $900 million to the Basin economy during 2016–17, and contributed to the turnover of an estimated 31,000 tourism-related businesses in the region.

Tourism is a strong source of future growth in the Basin, with a key focus being the Murray River itself (Murray Regional Tourism Strategic Plan 2015 - 2020). Industry organisations are targeting a doubling of overnight visitor expenditure in the Murray region between 2015 and 2020.

> *Strong tourism growth is predicted with the many waterways providing great potential for nature-based tourism developments, especially along the Murray River and Gunbower Forest. (Murray Now Association, 2014 Regional Profile).*

Figure 1 Visitor numbers have improved following the breaking of the millennium drought



How tourism is linked to water ecosystems

A thriving tourism industry in the Basin is critically dependent on the health and attractiveness of its rivers, lakes and wetlands. Many visitors are attracted to the region largely because of the Murray River and the recreational opportunities it supports (Tourism Research Australia 2010). Tourism operators, local governments and managers of water systems have identified water clarity, quality and accessibility as important factors that influence the enjoyment visitors derive from water-based activities (Hadwen et al. 2012). Local plants and animals were also identified as 'extremely important' to visitor experiences (ibid, p. 329).

The direct link between environmental conditions and tourism in the Basin was most noticeable during the millennium drought, when visitor numbers fell substantially, and many tourism-related businesses suffered. Regular visitors to the Basin came less often, stayed fewer days and spent less money. Impacts were particularly severe on key tourist sites such as the Coorong and the Barmah-Millewa forest. Tourism Research Australia estimated that, over the entire period (1999–2008), the drought caused a reduction in regional output (Gross Regional Product) of $461 million, resulting in approximately 596 fewer full time equivalent jobs in the region (Murray–Darling Basin Authority 2012).

> *Suffering is visible in a drought - cracked lake beds, empty caravan parks, silent camp grounds, rotting fish. (Lake Eppalock splashes back into life, ABC website 2012, http://www.abc.net.au/local/audio/2012/02/01/3420479.htm)*

Water is also a known driver of visitor numbers to many remote communities, and can be the difference between business success and failure. Some businesses in remote regions generate a substantial proportion of their annual income from a small number of trading days when the rivers are flowing and the fish are biting. While natural flow events are likely to remain the most important determinant of business outcomes in these cases, the use of environmental water could play an important role in the future.

Local residents also benefit from tourism

Tourism also benefits Basin residents through its impact on the supply of man-made amenity and facilities, developing lifestyle options and expanding community services. Growing visitor numbers drive improvements in retail, restaurant and entertainment options, transport services, education and sporting facilities (Victoria Tourism Excellence 2014). These changes benefit Basin residents and communities in general, which may not otherwise warrant the improvements based on the residential population alone. Improvements in amenity and services through tourism can also lead to an increase in the number of people permanently relocating to a region, bringing additional economic and social benefits.

Evidence of change (outcomes and indicators)

As noted earlier, visitor numbers to the Basin have increased substantially in the last five years in response to a general improvement in seasonal conditions. The contribution of additional environmental water as part of the Basin Plan may also have played a part.

State and local governments are taking advantage of a growing interest in ecotourism and experiential tourism by investing in the Basin's natural assets. In northern Victoria a $1.2 million Nature-Based Tourism Hub is connecting iconic natural assets around Koondrook, Cohuna and Kerang, including the Gunbower State Forest, Murray River and Kerang Lakes. Hub projects include cycling tracks, walking tracks, canoe trails, and the Kerang–Koondrook Rail Trail. Over time, the Hub is expected to attract an additional 6,000 visitors to the region annually and increase visitor nights by 1,800 annually. Broader benefits because of the hub and the future Murray River Adventure Trail include an estimated output of $12.8 million and more than 70 additional jobs.

> *The combination of a tracks, trails and on-water activities present a wonderful opportunity to showcase the spectacular natural assets of the region and boost its visitor economy as a result. (Victorian Minister for Regional Development Jaala Pulford, Nature-Based Tourism Hub Connects Gannawarra Towns, https://www.premier.vic.gov.au/nature-based-tourism-hub-connects-gannawarra-towns/*

Tourism in the Coorong has also rebounded from the drought. The natural assets of the region provide exceptional experiences for tourists. It has a unique geology that includes a magnificent coastal sand dune system and complex wetland habitat which supports an abundance of fish, birds and animals.

As the water starts coming back in, then of course the birds start coming back and it then begins again to start to draw people back in. People come down to see birds, particularly people who visit from overseas, and the cities where you don't see lots of flocks of birds. A flock of pelicans going over head are impressive. (Interview with SA Lakes Tour boat operator July 2017)

Improvements in environmental conditions have also supported local agribusinesses along the River Murray in South Australia who are keen to promote the provenance of their products as part of their marketing efforts. As noted by one business operator, 'Customers are interested in where food is produced, and they want to come and have a look'. Many of these tourists are interested in a direct and meaningful engagement with the environment, the farmers and farming systems and the linkages between the three.

> *… wine and food tourism is what we do, businesses like ours, cellar doors, wineries farm gate, we do pretty well, we have between a thousand and four thousand visitors a week (MDBA interview with olive farmer July 2017)*

According to a spokesperson from the Coorong Council, tourism has become the backbone of the local economy. Employment in the region is almost back to pre-drought levels but growth has primarily been in the service based industries supporting tourism.

Visitor numbers to the Harrah Lakes – part of the Ramsar listed Hattah–Kulkyne wetland system in north-western Victoria – have also increased over the last 5 years. The park attracts more than 70,000 visitors who enjoy camping, walking, canoeing and other activities. Visitor numbers are linked to flooding, with tourists attracted when water is present. The direct economic benefit to park visitors is estimated to be around $1.5 million per year (BPAR 2014–15).

Basin Plan contribution

Tourism is one industry that can respond relatively quickly to improvements in the condition of the natural environment, including those associated with site specific environmental watering events. As noted elsewhere in this evaluation, some water ecosystems have responded relatively quickly to changes in water availability (natural and/or environmental water), and this is contributing to the general increase in visitor numbers.

> *… the presence of environmental water has brought an increase in visitor numbers, including the number of school groups that use the area for paddling and hiking. Every school holidays, more people are travelling from Melbourne, South Australia and beyond to see Hattah lakes. (Victoria State Government: The Murray River Guardian 2015-16)*

> *Since the millennium drought things have moved in a positive direction. The most significant breakthrough for the Coorong has been a specific environmental allocation of water. In the last five years since that water management plan has been in place we have seen a significant turnaround. (Coorong tourism business operator)*

Evidence from environmental water managers outlining positive ecological outcomes from environmental watering events also points to actual and potential increases in visitor numbers as a flow on consequence. For example:

> *The opening (of the Gwydir Wetlands State Conservation Area) coincides with a season of environmental water releases managed by the NSW Office of Environment and Heritage. Senior Wetlands Conservation Officer Daryl Albertson said it was an opportunity for people to see first-hand the remarkable response of these wetlands to water flows. "The Gwydir wetlands are becoming a major regional attraction as the opening periods for sites become more widely known," Mr Albertson said. (Gwydir wetlands opens to the public, NSW OEH website 2017, http://www.environment.nsw.gov.au/news/gwydir-wetlands-open-to-the-public)*

In the Gunbower forest, environmental watering in the region is contributing to improved outcomes for native fish, aquatic plants and river red gums, enhancing the attractiveness of the region to visitors (see Box 1).

People running eco-tourism businesses are keenly aware of the value of environmental flows to their businesses. In the words of a local tourism operator:

> *We need the environmental flows, when we've got low flows coming down, we need to make sure that we get something for the environment. Just to keep it all nice and healthy and keep all the industries working. Farming, fish and tourism industries, we all rely on that money….As far as life in the Coorong goes, with that little bit of fresh water coming down it's spectacular, like the fish will start spawning and all the birds are feeding on the little benthic zone animals, worms and crustaceans. During the drought Fairy Terns in the*

> *Coorong were very close to becoming locally extinct. Now they have bred around the Murray Mouth and back down the southern end of the Coorong. As long as we have got that fresh water coming down which allows all the food to come in, then they have got enough food for their offspring, so that has been really significant (Canoe the Coorong interview May 2017).*

In the Coorong, Lower Lakes and Murray Mouth (CLLMM) region, environmental flows are believed to be critical for supporting the local economy:

> *You know our greatest concern here as a community is that we are going to lose the water again, so the guarantee of extra water flows secures livelihood for myself and my employees, but also other businesses in Goolwa and around the lower lakes (Spirit of Coorong Operator - business June 2017)*

On the other hand, it was always anticipated that it would take considerable time for some parts of the environment to recover from the impact of increased water diversions to irrigation during the last 30 years. In these cases, the flow-on benefits to tourism were not expected to be significant or even observable at this stage of Basin Plan implementation.

Box 1: Environmental watering outcomes in the Gunbower Forest

Environmental water was provided to 2,840 hectares of Gunbower Forest in 2015–16, including to 95% of the forest's impermanent wetlands. Environmental watering also benefited 14% of the forest's river red gum trees. Vegetation surveys in watered wetlands and under river red gums demonstrate strong aquatic plant growth, especially in areas where plants were protected from carp. Healthy growth and improved condition of river red gums were observed in parts of the forest that received environmental water. In contrast, the condition of river red gum trees in parts of the forest not watered was reported as comparatively poor. Fish surveys also identify mass recruitment of small-bodied fish in floodplain wetlands that received environmental water. (Water to 2,840 hectares of Gunbower Forest, http://www.vewh.vic.gov.au/news-and-publications/stories/water-to-2,840-hectares-of-gunbower-forest)

On balance it is too early to measure the aggregate impact of Basin Plan Environmental watering on Basin tourism. As noted above however, there is early evidence that site specific environmental watering (along with new investments in tourism infrastructure in some cases) is associated with positive outcomes for visitor numbers.

There is also evidence that the commitment to the environment embodied in the Basin Plan is contributing to new investment in tourism-related businesses through its effect on business confidence. In the Lower Murray region, for example, it was expected that implementation of the Basin Plan would lead to more reliable flows, giving tourism and fishing businesses in the region greater confidence to invest and grow.

> *Better environmental flows for the lower lakes makes a huge impact to the local community because it reduces that negative perspective that we are going to lose water*

here again, so if we have environmental flows coming into this area, hopefully we won't go through what happened in 2007 through to 2010, you know our greatest concern here as a community is that we are going to lose the water again., so the guarantee of extra water flows secures livelihood for myself and my employees, but also other businesses in Goolwa and around the lower lakes (Spirit of the Coorong Operator – business was est. 1957)

… because of the Basin Plan, you know I had the confidence to basically set up a business like this, which depends on having water in the river and having water delivered to wetlands. (Murray River Walk operator, 2017)

Box 2 contains an example of how an integrated approach to water management can generate multiple benefits, including new recreational and business opportunities.

Box 2: Newspaper report on kayaking opportunities

A Berri paddling group has praised improvements to local wetlands after the construction of a new inlet regulator and fishway at the entrance of Eckert Creek. The works were park of the $155 million SA Riverland Floodplains Integrated Infrastructure Program (SARFIIP) which is funded by the Australian Government through the Murray-Darling Basin Authority. The structure is located where Eckert Creek leaves the river 3 km downstream of Berri - on the Katarapko floodplain in the Murray River National Park. Kym Werner, of Canoe Adventure in Berri, said the inlet regulator allows more water to flow through Eckert Creek and South Eckert Creek (also called Jarrett Creek), which can be controlled to mimic the rover's natural raising and lowering that would have occurred before the locks were built. "Before the new regulator, South Eckert Creek had little to now flow for maybe 60 or 80 years," he said. "Now it's flowing freely, making for a fascinating kayaking train - narrow and winding, with something different around every corner. The flow is faster than in the river, with some obstacles, so we would recommend it for kayakers who are confident in their ability to steer a kayak accurately. If travelling downstream, the flow gives plenty of assistance, so it's not a strenuous trip." The new inlet regulator also allows native fish, such as golden perch, silver perch and freshwater catfish, to enter the system of side creeks to breed, improving its overall health. Mr Werner said a local kayaking group enjoyed its first outing along South Eckert Creek earlier this month. "Everyone agreed the creek is a great addition to the collection of local paddling routes," he said. The Berri kayaking Group meets every Tuesday after work during daylight saving, and can be contacted on 0421 167 645 (kayaks for hire for those without their own).

Source: Murray Pioneer, Renmark South Australia, 22 September 2017

Some communities have fewer tourism opportunities

While tourism is an important component of employment in many parts of the Basin, it is not a solution for all communities looking to diversify their local economy. Opportunities for tourism

depend on a complex set of factors, including proximity, natural assets, and historical and cultural features (MDBA 2012). These features are not distributed evenly in the Basin.

Some Basin communities – both dryland and irrigation-dependent – are experiencing long-term declines in population and services. Shifting attention and resources towards tourism could generate net benefits, but the gains might be limited or take some time to achieve. Tourism development in these communities could be part of a balanced and integrated regional growth strategy that considers local needs, resources and opportunities.

Other issues affecting the links between tourism and environmental objectives

Potential conflicts between environmental objectives and existing and future tourism objectives have also been identified. For example, some stakeholders have alleged that environmental watering events can have negative outcomes on campers and other visitors if they affect access to campgrounds or river heights. Similarly, Howard (2008) points to the opposition of residents and businesses around Yarrawonga Weir to the idea that the lake height might be varied more frequently in future to meet downstream environmental objectives, potentially compromising boating and other tourism businesses in the region during peak holiday season.

It is important to distinguish, however, between problems that are ultimately associated with river management (the timing and volume of controlled releases of water from storages), as opposed to the potential for unintended or unexpected adverse outcomes due to increasing the overall amount of water that is not diverted to irrigated agriculture.

Concerns have also been raised regarding the potential for continued growth in visitor numbers to have negative impacts on the condition of key water ecosystems. According to Hadwen and others (2012), increases in visitor numbers to waterbodies can threaten the ecological condition of these sites, and hence their conservation values. The authors argue for a better understanding of the linkages between human demands for water (including tourism and recreation demands) and the ecology of inland waterbodies. This is a critical element in ensuring that these systems are sustainably managed (ibid, p. 338).

Recreation depends on healthy rivers and wetlands

> *Recreational use along the Murray River tends to be related to the use of water and the immediate river environs. Fishing, bird watching, boating, bushwalking and enjoyment of the outdoors generally revolve around the Murray River. (Dyack et al. 2007)*

Freshwater based recreation is particularly important to Basin residents. The Basin's rivers, creeks and wetlands provide a backdrop for popular land-based recreational activities like bushwalking and birdwatching, as well as direct water-based activities like recreational fishing, swimming, canoeing and kayaking.

Recreational fishing is particularly important to social and economic outcomes in the Basin. It is estimated that between 400,000 and 500,000 Basin residents – up to one quarter of all Basin residents – regularly fish for pleasure. Expenditure on recreational fishing in the Basin is estimated to be worth around $1 billion each year, and generates over 10,000 jobs (Copeland and Baker 2016, Deloitte Access Economics 2012, and Ernst & Young 2011). Fishers come from all sectors within the MDB community and represent a diverse range of socio-economic, education, employment and age demographics. With a large and growing population, small changes in environmental conditions could potentially lead to large changes in the aggregate benefits Basin residents derive from recreational fishing and other water-based activities.

How recreation is linked to water ecosystems

Environmental and recreational goals typically go hand in hand, and maintaining and improving environmental conditions in the Basin is essential to the quantity and quality of recreational opportunities for residents. For example, healthy environmental conditions support recreational fishing, whether the end goal is largely social or strictly catching fish. They also contribute to the enjoyment derived from swimming and boating. In other cases, activities to improve environmental conditions, such as periodic or site-specific flooding, could restrict recreational opportunities (Dyack et al. 2007, Howard 2008). On balance however, aggregate recreational benefits in the Basin are positively related to the condition of water ecosystems.

Evidence of change (outcomes and indicators)

Aggregate recreation benefits to Basin residents are likely to have increased over the last five years. There are two reasons for this. First, the general improvement in environmental conditions following the breaking of the millennium drought have intrinsically supported the recreational benefits that individual residents derive from participating in water-based recreation. In essence, per capita benefits are likely to be higher in line with improvements in the condition of rivers, lakes and wetlands. Second, there has been strong growth in the Basin population, increasing the number of individuals benefiting from water-based recreation.

In relation to recreational fishing, the number of Basin residents participating in this activity is estimated to have grown by around 18,000 over the last five years. Annual expenditure on fishing related activity is likely to be around $43 million higher than it was at the time the Basin Plan was implemented.

There is some evidence that the quality of fishing experience has improved over recent years. For example, following a series of environmental watering events in the Goulburn River between 2013 and 2015, fishing was reported as "the best in years". A survey of recreational fishers in New South Wales also found evidence that native fish numbers in the Basin had improved in recent years (Copeland and Baker 2016). The Victorian Environmental Water Holder has also reported positive feedback from Basin communities regarding fishing outcomes following environmental watering events.

On the other hand, environmental water has been associated with recent blackwater events, which contributed to the death of many fish. Some anglers complained that environmental water releases disrupted the opening of the Murray cod fishing season at the start of December 2016.

Improvements in fishing conditions are unlikely to be Basin-wide, and there are likely to be regions where fishing outcomes in terms of the number of fish caught have not improved. Nevertheless, some of the main benefits associated with recreational fishing are more intrinsic values like relaxation, being outdoors, and spending time with friends and family (Deloitte Access Economics 2012). These values are almost certainly positively related to the ecological condition of rivers and wetlands, and as important as fish populations for some anglers.

> *The predominance of relaxing and being outdoors as the motivations for fishing point to the value fishers place on the natural environment. Fishers are primary recreational users of waterways and their environs, and the 'naturalness' of these areas is an important contribution to fishing satisfaction. (Baker 2017)*

Basin Plan contribution

It is not possible at this stage to quantify the contribution that environmental watering may have made to improved recreation outcomes in recent years. As with other potential benefits to the broader community from environmental watering events, not all environmental water has been recovered yet, and there are lags between the use of environmental water, ecological outcomes, and flow-on benefits to Basin residents and recreation industries.

Regarding recreational fishing, the full benefits from implementing the Basin Plan are not expected to be realised until water recovery is complete, and there has been sufficient time for fish numbers and fishing conditions to respond to the additional water. Nevertheless, specific environmental water activities have been associated with better fishing outcomes in many cases (see, for example, reports by the Victorian Environmental Water Holder). Of the top 50 Victorian recreational fishing reaches, 28 can receive environmental water. Twenty-four of these reaches (86%) received environmental water in 2015–16, and 27 (98%) have received water since 2011 (Victorian Environmental Water Holder 2016:2017). More generally, there have been over 300 specific environmental watering events in the Basin aimed at improving native fish outcomes. Targeted monitoring programs have

found that more than half of the native fish species listed in the Basin-wide Environmental Watering Strategy have responded positively to the provision of water for the environment (MDBA Native fish 2017 evaluation).

Perhaps more importantly, Government agencies responsible for using environmental water to achieve fish outcomes are working closely with recreational fishers and their associations to ensure the best possible outcomes from the use of environmental water. Ultimately, efforts to work cooperatively and integrate local knowledge and interests should lead to better overall outcomes for recreational fishing from the use of environmental water.

Looking ahead

Updated estimates of the social and economic importance of recreational fishing in the Basin would be a valuable input to the first formal evaluation of the Basin Plan due by 2020. Previous work in this space was used in developing the Basin Plan, and is summarised in the MDBA report, Socioeconomic Analysis and the Draft Basin Plan. This work could be updated or expanded in time for the 2020 review.

Also, around the time the Basin Plan was being developed the MDBA commissioned a series of detailed regional histories of recreational fishing in 12 reaches of the Basin. The project, 'Talking Fish', was managed by the Conservation Action Unit (CAU) within the NSW Department of Primary Industries. The reports, which are available from the New South Wales Department of Primary Industries website, were published in 2012. Revisiting this work to assess any changes since then could provide valuable insights into the effects of the Basin Plan (and other projects) on fish numbers and recreational fishing in general.

Farming and industry also benefit from healthy ecosystems

Terrestrial and aquatic ecosystems are strongly interdependent and farming enterprises of all types rely on a range of ecological processes. Many of these processes are partially or directly connected to the functioning of the rivers and wetlands in the Basin. They include water provision and purification, healthy and productive soils, pollination services and protection from pests. One of the central reasons for introducing the Basin plan was to address the impacts of the water crisis on the capacity of the environment to sustain the agriculture sector (dryland and irrigated) over time.

Agriculture is one of the major land use activities in the Basin. Farming in the Basin is 69% grazing, and farms in many floodplain regions traditionally benefitted from periodic inundation from floodwaters that boosted grazing productivity and profitability.

Industries such as almonds, avocados, apples, and stone fruit depend almost totally on commercial pollination services for their production. The availability and cost of these services is partially dependent on the condition of native vegetation in the Basin, in particular river red gum forests along the Murray.

Industry, town water suppliers and agriculture also benefit from access to reliable high quality water. For example, an estimated 3.6 million urban or town residents depend on the Basin's rivers for drinking water supplies, while around 40,000 non-irrigated farms in the Basin depend critically on rivers and creeks for stock and domestic water. Changes in the condition of Basin water resources therefore have significant consequences for water treatment costs, and ultimately the health and wellbeing of a great many people and livestock.

How industry and agriculture benefit from healthy water ecosystems

Improved water quality

Water used for industry, irrigation and livestock must have sufficiently low salt content or salinity to be usable. Salinity is a measure of the content of salts in soil or water. Salt accumulation occurs naturally in the Basin but human activities such as land clearing and irrigation development often exacerbate salt mobilisation. Historically increased salinity levels have had adverse impacts on the agricultural sector, such as lower crop yields. These impacts vary according to climate conditions, with risks being most pronounced during extremes, such as when surface-water storage levels are low, providing little opportunity for dilution of saline groundwater inflows; and in wet periods when increased salt is mobilised from tributary valleys, irrigation areas and floodplains (MDBA Guide to the Basin Plan: 2010, Volume 2, p. 45). Water flowing through the river system and out to the sea through the Murray mouth is the only natural way that salt can leave the Basin.

Commercial pollination services

Commercial pollination services are essential for almond production in the Basin. This industry has grown very quickly over the last decade, and further expansion is anticipated. At $464 million, almonds were Australia's most valuable horticultural export in 2016–17.

The almond industry is mainly located along the Murray River in the NSW Riverina, north-west Victoria and neighbouring South Australian Riverland. Almond orchards currently use approximately 180,000 hives during the pollination season, which are mainly supplied by bee keepers based in NSW and Victoria. The demand for pollination services is expected to grow in line with further expansions in plantings.

According to industry sources, close to half of the beekeepers in Victoria and southern NSW depend on the floral resources of river red gums to maintain honey production and to keep their bees healthy following pollination services.

> *Red gums are important, we are trying to have more beehives and Victoria is just about exhausted of places to put bees (Vic Beekeeper)*

The pollen that comes from red gums is also of exceptionally high quality, and contributes to honey production and the overall profitability of apiarists.

Higher productivity on Flood Plains

Agricultural production on the flood plain is a function of the response of vegetation on the floodplain to a range of flood inundation events. There is a relationship between flows in rivers, inundation of the floodplain, pasture response, and floodplain grazing production and profitability. Research documenting the benefits of inundation of the floodplains in the northern Basin includes estimates of both financial benefits for land holders and social and environmental benefits (GHD 2012). A recent MDBA assessment undertaken for the Northern Basin review found that in the Lower Balonne, the water recovery under the Basin Plan could return up to one third of lost stock productivity (31.9%) and earnings (34%).

In the Southern Basin, the situation is more complex because overbank flows can also have negative impacts, such as damaging improved pasture and/or infrastructure and interrupting access.

Evidence of Change

Improvements in the health of rivers and wetlands in recent years are contributing to improved outcomes for agriculture and industry through a range of different ecosystem services.

Water quality

For example, water quality in the Southern Basin has generally improved over the last five years, with salinity levels continuing to improve in most reaches/regions. The commissioning of strategically located salt interception schemes since the late 1980s has helped to divert hyper-saline water away

from the River Murray system. Partnership arrangements under the Basin Plan have built on the efforts that were made for the previous 29 years to continue this work. Salinity management generated estimated benefits of around $27 million in 2015–16, based on the 2005 level of agricultural and industrial use of water and commodity prices (MDBA 2017).

Pollination services

Apiarists report more frequent flowering of river red gums in recent years which has boosted honey production and assisted with maintaining the health of their bees. In turn this is supporting the capacity of local apiarists to provide commercial pollination services.

> *My dad started in bees from the early 50's and was regularly going to redgum forests in Hattah lakes and Ned's Corner. Red gum generally has a mass flowering every second year and Dad was at Ned's corner every second year and as weirs and dams came in it became unreliable. Since the environmental flows it has really changed. Over the last five years in Hattah lakes we saw some small flows at first then 3 years ago there was a major watering event and we saw the big response, there has been a few small flows since and we are seeing budding more regularly. With these flows we are really excited that we will go from seeing production every 5-7 years back to every 2-3 years. The flows take it from a below average year to an excellent year in terms of honey and economics. It's also the hive health. In our game hive health is the next thing, so keeping bees in peak condition all the time that's critical, because when their condition deteriorates, (they have to recover and honey production is low). That's what red gum gives you, because it is such a good source of pollen. Personal Communication Central Victorian Beekeeper 28/09/17*

The anecdotal reports from apiarists are supported by MDBA assessments of the condition of river red gum forests in the lower Murray region.

Floodplain grazing

There is comparatively little data or evidence (qualitative or quantitative) regarding outcomes for floodplain grazing in the Basin since the breaking of the millennium drought. In principle, generally higher rainfall and inflows should have improved outcomes for floodplain graziers in the period, other factors notwithstanding.

Under the current management of water resources in the Basin, small and medium floods reaching grazing areas are still comparatively few, either because the water is not available, or because there are constraints limiting the extent of managed overbank flows. Constraint relaxation projects associated with the Sustainable Diversion Limit Adjustment Mechanism are expected to help alleviate this limitation however, with eventual benefits in the form of higher productivity and profitability.

Basin Plan contribution

Understanding how water recovered to date under the Basin Plan has impacted salinity levels and their associated costs requires an understanding of the complex intersections between groundwater and surface-water hydrology. The greater volumes of water in-stream due to the Basin Plan have provided greater dilution of salt loads in the rivers, benefiting consumptive water users.

Modelling undertaken by the MDBA shows that environmental flows provided by the Basin Plan to-date have generated additional salinity dilution benefits of approximately 36 EC units at Morgan, South Australia. This dilution is conservatively estimated to have provided a net benefit of approximately $5 million per year to river water users, including irrigation farmers (General Review of Salinity Management, https://www.mdba.gov.au/publications/mdba-reports/general-review-salinity-management).

> *If we can keep flowing the river, the water quality over the last couple of years as far as our business has been concerned has been good. Anything that keeps that flow coming through and keeps it going out through the locks would be good. Otherwise the salinity will build up. [MDBA Interview]*

In relation to pollination services, there is evidence that environmental water to date is contributing to improved pollination services and honey production in the lower Murray region. As noted above, apiarists are reporting improved conditions for bee health and their ability to deliver pollination services linked to specific environmental watering events.

Further research is needed however, to quantify the contribution of environmental water to commercial pollination services. This work should be done in conjunction with apiarists to understand the effect of both the volume and timing of environmental flows to support the flowering ecology on which both honey bees and other pollinators depend.

At this point there is not a systematic framework to track the contribution of environmental water to floodplain inundation events across the Basin. As a result, it is difficult to assess the contribution of environmental watering events to outcomes for floodplain graziers. There is, however, some site specific evidence that environmental watering is contributing to improved outcomes for floodplain graziers. For NSW Office and the Environment and Heritage provide the following example:

> *Between July 2009 and June 2017 OEH have delivered over 486,000 ML (including Commonwealth and planned environmental water) to the Nimmie-Caira and North Redbank systems located in the Lowbidgee. These deliveries have resulted in the inundation of approximately 200,000 ha over the last 7 years. These systems are predominantly privately owned and managed for livestock grazing. While the water is delivered via regulators, the nature of the delivery system allows for overbank inundation across many of these private properties – with landholder agreement. While little research is available on how stocking rates are improved through floodplain inundation it is assumed that the carrying capacity of these areas are greatly improved*

following an environmental watering event, as graziers have access to these wetlands following the establishment of wetland vegetation. (NSW OEH pers. comm. 2017)

Appendix A: Background, framework and key evaluation question

River regulation has changed the size, frequency and timing of natural flows in the Murray–Darling Basin. This has contributed to a decline in the health of the Basin's water-dependent ecosystems – its rivers, floodplains and wetlands. Flow regulation began in the Murray–Darling Basin in the late 19th century, with intensive development of regulators occurring along the Murray River between 1920 and 1940 (Maheshwari et al. 1995). As more water has been diverted for people, agriculture and other economic activities, flow through the system to the sea has reduced by 75% on average (BWS 2014).

The Sustainable Rivers Audits 1 (2004- 2007) and 2 (2007 - 2010) found key ecological components of the Murray–Darling Basin (fish, macroinvertebrates, vegetation, physical form and hydrology) to be in poor condition across most river valleys (Davies et al. 2008, Davies et al. 2010).

The Basin Plan was legislated in 2012 with the aim of returning the Basin to a healthy working system. The focus of the plan is to improve the Basin's environment, while balancing social and economic needs, in a sustainable way. The plan sets an environmentally sustainable level of water take for consumptive use (sustainable diversion limit) and secures a share of available water for the environment. This 'environmental water' allows managers to restore some of the critical elements of the flow regime so that plant and animal species can complete their lifecycles and help build population resilience in healthy habitats.

The Basin Plan sets out three overall environmental objectives for water-dependent ecosystems. These are to:

a. protect and restore water-dependent ecosystems of the Murray–Darling Basin
b. protect and restore the ecosystem functions of water-dependent ecosystems
c. ensure that water-dependent ecosystems are resilient to climate change and other risks and threats.

These are long-term objectives; and implementation of the plan and environmental recovery will take time. Therefore the plan aims to achieve 'no net loss or degradation in the recruitment and populations of native water-dependent species including vegetation, birds, fish and macroinvertebrates' (Schedule 7, BP) up to 2019, and looks for improvement beyond 2019.

2017 Evaluation

The Murray–Darling Basin Authority's 2017 Evaluation represents the first evaluation of the Basin Plan since the policy was implemented in 2012. It forms part of an ongoing monitoring and reporting process that supports an adaptive approach to program implementation and management. The 2017 Evaluation will examine progress towards full implementation of the Plan, and consider early social, economic and environmental outcomes.

A series of technical reports have been prepared by the MDBA as inputs to the 2017 evaluation. They cover a range of themes and issues, including impacts on birds, fish, vegetation, and social and economic outcomes. Results from these reports contribute to the overarching 2017 Evaluation report, which is available on the MDBA website (www.mdba.gov.au).

Key evaluation question in this report

The key evaluation question addressed in this technical report is:

> *What have been the social and economic benefits (including ecosystem services) associated with improved environmental outcomes? (Basin-Plan Evaluation Framework 2014: p. 7)*

Ecosystem services is the term used to describe the environmental processes that directly or indirectly benefit human wellbeing (see Appendix B and Table 1). The concept provides a basis on which to value environmental services, and hence a way to assess the benefits to people from improving the condition of environmental assets (MDBA 2012a).

An ecosystem services framework was used by the MDBA when developing the Basin Plan, and is outlined in the Regulatory Impact Statement (RIS) prepared by the Authority to explain the benefits expected from implementing the Basin Plan (MDBA 2012b).

Some ecosystem services benefits are easier to observe and value in monetary terms, while others are scientifically complex and more difficult to value. Adopting an ecosystem services approach typically involves applying a range of different disciplinary methods to suite the policy being evaluated.

In the assessments outlined in this report, a range of different methods from ecology, psychology and economics were used to provide an integrated assessment of the transformations in aquatic ecosystem services. Multiple lines of evidence were used, including anecdotal, qualitative and quantitative data. This included interviews with Basin residents to determine what is happening and what is being achieved with environmental water, alongside survey results and ABS reports.

Assessing ecosystem services impacts

Evaluating the contribution of the Basin Plan

A four-step approach was used to assess the contribution that environmental flows are making to selected ecosystem services, and the associated benefits to people:

- Identification of the beneficiaries
- Description of the relationship between the environment and the social and economic outcomes (e.g. improved amenity and lifestyle benefits to Basin residents, improved opportunities to fish recreationally)

- Description of how the relevant environmental functions and associated outcomes are changing over time (using quantitative data, where possible, to measure the extent of any changes in observed outcomes)
- Assessment of the impact or contribution of the Basin Plan to observed social and economic outcomes, by reviewing which aspects of change could or would have happened anyway, or were caused by other factors.

Extent to which Ecosystem Services Benefits can be evaluated in 2017

At this stage in the implementation of the Basin Plan we are limited in our ability to answer the evaluation question. While there is good evidence that environmental watering is starting to contribute to improved social and economic outcomes in the Basin, it is not possible at this stage to quantify the contribution. What evidence there is tends to be at selected locations, and is often based upon anecdotal information or feedback. However, there is a relatively consistent message that supports the view - outlined in a range of reports and assessments undertaken prior to the introduction of the Basin Plan - that there can be a broad range of positive social and economic outcomes from improving the condition of the Basin's water ecosystems.

Looking ahead

The assessment of ecosystem services outlined in this report helps to establish the scale and scope of ecosystem services benefits provided by the Basin's water resources. It also provides a useful starting point for a more detailed and comprehensive empirical assessment of ecosystem services benefits being developed by the MDBA, in anticipation of the first formal evaluation of the Basin Plan due in 2020.

In the first instance, preparation of a research program to contribute to the 2020 evaluation will involve consultation with key stakeholder groups. This reflects that MDBA's commitment to the principle that beneficiaries should inform what gets measured, and how different benefits are measured and valued. A preliminary framework explaining the links between ecosystem services, potential beneficiaries and outcomes is being developed (see Appendix B). In 2018 this framework will be further developed in consultation with key stakeholder groups, including experts in the field of ecosystem services valuation.

It is expected that a range of different research methodologies will be needed to gather information on the key indicators identified in the framework. This may include approaches from economics such as contingent valuation (a survey-based methodology commonly used to measure the value of non-market environmental assets) and travel cost studies. The collection and analysis of ABS and other survey data related to tourism, recreational fishing activity, and property markets, will also be key inputs to any future assessments of Basin Plan impacts.

Social science research to collect information about people' s observations, experiences and values from environmental watering to measure impact will also be undertaken. It will be important to engage delivery partners – agencies responsible for delivering environmental water, local

governments, the business sector and community groups – in these data collection exercises to ensure that data collection is well targeted.

There are still many gaps in our understanding of the ecosystem services provided by rivers, wetlands, lakes and estuaries in the Basin, and in our ability to value them. While work to address these gaps and limitations is already underway, a multidisciplinary response is required to achieve successful outcomes.

Table 1: Examples of ecosystem services, adapted from Maynard, James and Davidson (2010)

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
- Managing Pests and diseases
- Productive soils

Support for human culture and social values by provision of:

- Iconic species
- Support for spiritual and cultural beliefs
- Systems from which humans can increase their knowledge
- Inspiration
- Aesthetically satisfying experiences
- Mediation of social interactions
- Recreational opportunities
- Therapeutic landscapes
  Iconic landscapes

Appendix B: Ecosystem services

The ecosystem services concept has become a popular way of describing and characterising the linkages between the condition of the natural environment and human well-being. The Millennium Ecosystem Assessment conducted by the United Nations (MA 2005) popularised the concept, and much work has been conducted globally since, including by the World Bank and the World Resources Institute (Maynard, James and Davidson 2009).

The following suite of tables outline a framework for assessing or evaluating ecosystem services in practice. They identify: the range of potential services provided by aquatic and terrestrial ecosystems; the benefits and beneficiaries of some specific ecosystem services of importance to the Murray–Darling Basin; and indicators or metrics that could be used to quantify some of the identified benefits.

Table 1 lists the range of services that ecosystems provide to people. While not necessarily exhaustive, the services identified likely represent a significant proportion of the aggregate benefits that land and water ecosystems provide.

Table 2 explains the broad linkages between changes in ecosystem function or condition, and changes in social and economic outcomes. (The 'linkages' in the table should be read from right to left.) The focus is on the subset of benefits and beneficiaries related to amenity,

recreation, tourism, and services to agriculture considered in this report. For example, healthy riverine ecosystems provide plants, birds, fish and habitat that allow people to enjoy a range of recreation activities. Participation in these activities contributes to human wellbeing, and provides economic opportunities for businesses engaged in providing or supporting these activities.

Table 1 Links between water regimes, ecosystem services, and social and economic outcomes

Improved watering regimes	Changes in ecosystem functions	Changes in environmental outcomes (ecosystem services)	Changes in social and economic outcomes (Benefits)	Beneficiaries
	Broad range of processes that support the listed services, including: Water supply and regulation; Provision of shade and shelter; Landscape opportunity; Pollination; Climate regulation; Nutrient regulation; Supporting habitats; Waste treatment and assimilation; Genetic resources	Healthier floodplains and riverside plants; healthier populations of birds, fish; turtles, frogs, butterflies, moths, mammals and marsupials; cleaner water ways.	Enhanced opportunities and experiences in relation to: Bicycling Camping Walking for relaxation and fitness Exploration and discovery Orienteering Shooting (feral animals and ducks) Photography Birdwatching Water sports (boating & kayaking)	Basin residents, visitors & tourists
		Improved spawning, recruitment and numbers of native fish.	Improved opportunities & experiences to catch native fish; Greater wellbeing and improved connections to people and place.	Fishers
		Healthy floodplains and riverside plants; Mitigation of algal blooms; Water quality	More attractive places to live and work - Population growth - Investment	Basin residents and amenity-based businesses
		Environmental assets (wetlands and adjoining forests)	Increased - Visitation - Expenditure	Tourism and hospitality businesses &

				other parts of the services sector
		Improved water quality	Lower water treatment costs due to reduced salinity and fewer or less severe algal blooms	Farmers
		Improved condition of flowering Red gums, supporting the health and viability of commercial pollination service	Increased crop yields; Increased revenue from pollination services and honey sales	Farmers (Horticulture and cropping) and apiarists
		Increased numbers and health of terrestrial foraging birds, aiding pest management	Lower farm costs associated with pest regulation	Farmers (Cropping and grazing)
		Increased productivity on flood plains	Higher flood plain productivity and profitability; Enterprise resilience	Graziers

Table 3 lists possible indicators (and potential data sources) for conducting more detailed empirical research into the scale and scope of ecosystem services provided by riverine ecosystems in the Basin. Again, the focus is on a subset of benefits and beneficiaries, rather than attempting to cover all possible ecosystem services. Some of the indicators have been used in the interim assessments of ecosystem services benefits described in this report. Future work in this space is expected to utilise the broader range of indicators identified in this table.

Table 2 Indicator framework for assessing ecosystem services benefits

	Beneficiaries	Changes in social and economic outcomes (Benefit)	Indicators and potential sources
Recreation			
	Retail equipment suppliers, tourism operators	Increased economic activity and employment growth	Fishing activity • Expenditure data (Ernest and Young and Deloitte studies) No. of recreational fishing competitions
	Fishers	Increased fishing opportunity Improved experience of fishing	• Numbers participating in recreational fishing • Enjoyment and satisfaction Recreational fishing surveys (e.g. Forthcoming national

			survey conducted by ABARES, State surveys, Regional Wellbeing survey)
	Birdwatchers	Increased opportunity to observe birds Improved experience of birdwatching	• No. of online posts of water bird observations in the Basin • Number of tourism companies providing birdwatching tours in the Basin Birdwatching associations and membership within the Basin
	Campers and bushwalkers sub-section of Australian residents	Increased enjoyment of the natural environment Increased opportunity to walk and camp in and around Basin rivers wetlands and lakes	• Enjoyment and satisfaction Participation in bushwalking and camping. TRA survey data on activities.
Amenity			•
	Basin residents and businesses	Increased enjoyment of the natural environment Maintenance of sense of place and identity Maintain or increase number of people choosing to reside in the Basin	• Population growth • Residential developments • Perception of local liveability and quality of rivers, lakes and wetlands (Regional Wellbeing Survey) • Local and regional events that incorporate and celebrate rivers lakes or wetlands Area of wetlands/forests with outstanding cultural and or historical significance
Tourism			
	Tourism and hospitality businesses and other parts of the services sector. Basin residents (expansion in jobs and available services)	Increased employment and diversification of tourism, hospitality and other service industries. Improvements to 'built' amenity linked to tourism	• Visitor stays (Tourism Research Australia (TRA)) • Expenditure data (TRA) • Employment estimates (TRA) • Visitor experience surveys (TRA) Private and public investment in promotion and management of nature

			tourism (Desktop research and interviews with tourism boards and local government)
Agriculture/industry			
	Farmers and industry	Avoided or reduced costs of water treatment	Salinity levels Water treatment costs
	Farmers (Horticulture and cropping)	Improvements and maintenance of crop yields Use of red gums by commercial Pollination services	No. of beekeepers/hives utilising flowing red gum forests
	Farmers (Cropping and grazing)	Reduction in damage to crops from pests	Terrestrial foraging birds
	Graziers	Productivity Enterprise resilience	Flood plain vegetation
	Farmers	New investment in agricultural sector	Knowledge systems (and regulatory frameworks) for water management and confidence in water markets and water reliability and the social license for irrigation

It is important to note that tables 1, 2 and 3 are not meant to be definitive, but provide practical information regarding the linkages between (the condition of) ecosystems and social and economic outcomes for people. The tables identify possible indicators that could be used to assess changes in the magnitude of ecosystem services over time. As such they provide a guide or starting point for future empirical work examining the contribution of environmental water recovered under the Basin Plan to ecological, social and economic outcomes.

Appendix C: Examples of lifestyle and marina developments in the southern Murray–Darling Basin

Table 4 Examples of lifestyle and marina developments in the southern Murray–Darling Basin

Name	Location	Web address
River Estate	NSW (Barham)	http://www.riverestate.com.au/
River Gum on the Murray	NSW (Barham)	http://www.rivergumonthemurray.com.au/land-and-pricing/
Waterfront	NSW (Moama)	https://www.waterfrontmoama.com.au/
Murray Banks Estate	NSW (Moama)	http://murraybanks.com.au/
Shoreline Estate	NSW (Mulwala)	
Riverside Estate	Victoria (Wodonga)	http://www.riversideestate.com.au/
Riverwood Park	Victoria (Shepparton)	https://www.riverwoodpark.com.au/
The Gardens	Victoria (Shepparton)	http://www.development.vic.gov.au/residential-projects/gardens-at-shepparton
Kialla Lakes Estate	Victoria (Shepparton)	http://www.kiallalakes.com/
Silverwoods	Victoria (Yarrawonga)	http://www.silverwoodsyarrawonga.com.au/
Tower Hill	Victoria (Swan Hill)	http://www.places.vic.gov.au/land-and-housing/tower-hill/the-lifestyle
Elloura	Victoria (Lake Nagambie)	http://www.elloura.com.au/lifestyle/
Riverside Estate	SA (Renmark)	http://riversidelife.com.au/riverside-estate-location/
Mannum Waters	SA (Mannum)	http://mannumwaters.com.au/about/
Jane Eliza Estate	SA (Renmark)	https://www.murraypioneer.com.au/not-so-plain-jane/

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