5. Identified risks and considerations for governments

5.1 Risk assessment

In this section the current and emerging pressures and threats identified in section 4 are examined in a risk assessment framework in order to identify the most important gaps in management of riverine ecosystems in the Lake Eyre Basin. Each major pressure or threat is shown in Table 20, together with analysis of the consequent stressors and likely ecological responses. Determining the level of risk to water resources and riverine ecosystems of the Basin is assessed in a process of six steps. Firstly, timing of the risk is assessed, rated as currently expressed, or emerging more through time, or both. Second, its spatial extent is ranked, depending on whether impacts of the pressure are mainly local or cumulative across the Basin, or both. Third, the likelihood of each pressure is assessed in relation to its probability of occurrence, in the categories low, medium and high. Fourth, the consequence in terms of the probable severity of impacts if the threat did in fact materialise is ranked either low, medium or high. Finally, the presence of existing legislation, policy and management activities is ranked as present or absent. Every identified pressure and threat in the Lake Eyre Basin has a management response either through legislation or other policy documents. There are some examples where the current management response is not directly addressing the problem or effectively reducing risk.

The risk assessment was undertaken initially by the consultant authors using their expert knowledge of the Basin. Subsequently, the ratings were examined by members of the Community Advisory Committee to the Lake Eyre Basin Ministerial Forum. Then the Steering Committee overseeing preparation of the report considered both the community input and the consultants' ratings, and arrived through some modifications at the results shown in Table 20.

Table 20. Major threats, stressors and ecological responses in riverine ecosystems of the Lake Eyre Basin. Risks are assessed in relation to the timing[1], spatial extent[2], likelihood[3] and potential consequences[4] of each pressure (see footnote for details). Residual risk is ranked as: low - has a management response in place; medium - limited management response in place; high - no effective management response or legislative mechanism to address the threat.

Pressure / threat	Stressors	Responses	References	Risk				Residual risk		
				Timing[1]	Spatial extent [2]	Likelihood[3]	Consequence[4]	Covered by legislation	Residual management risk	Comment
Hydrological alteration										
Water resource development	Alteration of natural wetting and drying cycles	Shifts in composition & structure of riverine communities	Bunn et al 2006; Reich et al 2010; Arthington & Balcombe 2011	emerging	cumulative	Low	Major	All jurisdictions	Low	
Surface water storages	Changes to natural flow regime	Increased abundance of exotic & translocated aquatic species	Bond et al. 2010; Box et al 2010; Balcombe et al. 2011	current, emerging	local (cumulative if act as source populations)	Low	Moderate	All jurisdictions	Low	
Surface water extraction	Reduced water quantity	Decreased waterhole persistence; loss of larger-bodied and less resistant aquatic species	Arthington et al. 2005; Bond et al. 2010; Wakelin-King 2010, 2013	current, emerging	local (cumulative if act as source populations)	Low	Moderate	All jurisdictions	Low	

Pressure / threat	Stressors	Responses	References	Risk				Residual risk		
				Timing[1]	Spatial extent [2]	Likelihood[3]	Consequence[4]	Covered by legislation	Residual management risk	Comment
Hydrological alteration										
Surface water diversion	Reduced hydrological connectivity	Altered pathways for migratory species; loss of recruitment opportunities for species that breed in backwaters/off-channel habitats	King et al. 2003 Balcombe et al. 2011	current, emerging	cumulative	Low	Moderate	All jurisdictions	Low	
Surface water diversion	Reduced flow variability	Altered fish community dynamics favouring generalists including exotic species	Bunn et al. 2006; Arthington & Balcombe 2011	current, emerging	cumulative	Low	High	All jurisdictions	Low	

Pressure / threat	Stressors	Responses	References	Risk				Residual risk		
				Timing[1]	Spatial extent [2]	Likelihood[3]	Consequence[4]	Covered by legislation	Residual management risk	Comment
Hydrological alteration										
Infrastructure	Reduced hydrological connectivity	Altered pathways for migratory species; loss of recruitment opportunities for species that breed in backwaters/off-channel habitats	Fullerton et al. 2010; Kerezsy et al. 2013	current, emerging	local	Low*	Moderate	All jurisdictions	Low	
	Altered inundation patterns	Altered extent of floodplain productivity and habitat available to aquatic species		current, emerging	local	Low*	Low*	All jurisdictions	Med	Covered for large infrastructure, but guidelines need to be improved to address floodplain inundation.
Groundwater extraction	Altered groundwater contribution to waterhole hydrology	Reduced persistence and water quality of groundwater fed waterholes; declines in health of riparian trees	Costelloe et al. 2008; Cendón et al. 2010	current, emerging	local	Low*	Moderate	All jurisdictions	Low	Alluvial groundwater

Pressure / threat	Stressors	Responses	References	Risk				Residual risk		
				Timing[1]	Spatial extent [2]	Likelihood[3]	Consequence[4]	Covered by legislation	Residual management risk	Comment
Hydrological alteration										
Groundwater extraction	Uncontrolled outflow from artesian bores	Raised groundwater tables; drowning of riparian trees; sustenance of source populations of exotics such as gambusia (e.g. to springs)		current, emerging	local	Moderate*	Major	All jurisdictions	Med	Limited management for Great Artesian Basin water
Land and Water degredation										
Vegetation clearing	Altered catchment processes and runoff patterns	Altered riverine habitat characteristics, e.g. water quality	Arthington et al. 2005; Bastin et al. 2010	current, emerging	local, cumulative	Low	Moderate	All jurisdictions	Low	
Land use development	Increased runoff, erosion, salinisation	Reduced water quality; infilling of waterholes; reductions of sensitive species; increased spread & abundance of exotic species	Morgan et al. 2003; Arthington et al. 2005; Cockayne et al. 2009	current, emerging	local, cumulative	Low	Moderate	All jurisdictions	Low	

Pressure / threat	Stressors	Responses	References	Risk				Residual risk		
				Timing[1]	Spatial extent [2]	Likelihood[3]	Consequence[4]	Covered by legislation	Residual management risk	Comment
Land and Water degredation										
Land use intensification	Local waterhole degredation reduced waterhole connectivity	Homogenisation of aquatic communities with increased dominance by exotics and loss of more sensitive species	Bond et al. 2010; Arthington & Balcombe 2011; Davis et al. 2015	emerging	cumulative	Low	Major	All jurisdictions	Low	
Overgrazing	Local waterhole degredation (e.g. vegetation trampling, bank erosion); increased nutrients	Increased potential for algal blooms and fish kills; disruption of algal "bathtub" ring) leading to food web impacts and loss of higher trophic species	Petit 2002; Bunn et al. 2003; Arthington and Balcombe 2011; King et al. 2012	current	local	Low	Minor	All jurisdictions	Med	Limited management response regarding impacts on waterholes
Urban development	Local waterhole degredation; reduced water quality	Homogenisation of aquatic communities with increased dominance by exotics and loss of more sensitive species	Morgan et al. 2003	emerging	local	Low	Moderate	All jurisdictions	Low	

Pressure / threat	Stressors	Responses	References	Risk				Residual risk		
				Timing[1]	Spatial extent [2]	Likelihood[3]	Consequence[4]	Covered by legislation	Residual management risk	Comment
Mining and petroleum activities										
Release of co-produced coal seam gas water	Alteration of natural wetting and drying cycles	Shifts in composition & structure of riverine communities; homogenisation of aquatic communities with increased dominance by exotics and loss of more sensitive species	Davis et al 2010; Reich et al. 2010; Arthington & Balcombe 2011	emerging	cumulative	Low	Major	All jurisdictions	Low	
Release of 'ultra pure' water	Altered water chemistry	Impacts on carapace and shell development of crustaceans & molluscs – leading to food web impacts	King 2004; Davis et al. 2010; Farag et al. 2010	emerging	local	Low	Moderate	All jurisdictions	Low	

Pressure / threat	Stressors	Responses	References	Risk				Residual risk		
				Timing[1]	Spatial extent [2]	Likelihood[3]	Consequence[4]	Covered by legislation	Residual management risk	Comment
Mining and petroleum activities										
Water diversions	Altered surface water and groundwater interactions	Altered pathways for migratory species; loss of recruitment opportunities for species that breed in backwaters/off-channel habitats	King et al. 2003; Fullerton et al 2010 Gibson et al 2008; Farag et al. 2010; Balcombe et al. 2011; Kerezsy et al. 2013;	current, emerging	local, cumulative	Low	Moderate	All jurisdictions	Low	
Water body removal	Loss of waterholes, potential loss of some channel networks loss in connectivity	Altered pathways for migratory species; loss of recruitment opportunities for species that breed in backwaters/off-channel habitats; population reductions of aquatic species, e.g. fish	King et al. 2003; Fullerton et al. 2010 Bunn et al. 2006; Balcombe et al 2011; Kerezsy et al. 2013;	emerging	cumulative	Low	Major	All jurisdictions	Low	

Pressure / threat	Stressors	Responses	References	Risk				Residual risk		
				Timing[1]	Spatial extent [2]	Likelihood[3]	Consequence[4]	Covered by legislation	Residual management risk	Comment
Mining and petroleum activities										
Pollution	Reduced water quality	Population reductions of aquatic species, e.g. fish	Davis et al. 2010; Farag et al. 2010; Arthington & Balcombe 2011	emerging	cumulative	Low	Moderate	All jurisdictions	Low	
Tourism and Recreation										
Recreational use	Local waterhole degredation; reduced water quality	Altered quality of waterhole & riparian habitat	Schmiechen. J, 2004; Arthington et al. 2005; Farag et al. 2010; Adelaide.ECE & Department of the Environment, Water, Heritage and the Arts, 2010, Canberra; Arthington & Balcombe 2011; Lee. G, 2011, Port Augusta.Lee. G, 2013, Port Augusta.	current, emerging	local	Moderate*	Moderate	All jurisdictions	Low	Localised and low level of impact

Pressure / threat	Stressors	Responses	References	Risk				Residual risk		
				Timing[1]	Spatial extent [2]	Likelihood[3]	Consequence[4]	Covered by legislation	Residual management risk	Comment
Tourism and Recreation										
Pollution	Reduced water quality	Population reductions of aquatic species and fish	DEH & SAALNRMB 2009; King et al. 2012;	current	cumulative	Low	Moderate	All jurisdictions	Low	
Recreational fishing	Increased mortality of selected native fish species	Reduced population sizes of native fish species; homogenisation of fish communities	Arthington et al. 2005; Close et al. 2014	current, emerging	local	Moderate	Minor	All jurisdictions	Low	
Invasive species										
Aquatic animals	Displacement of native species	Predation and competition impacts on natives – food web impacts	Bond et al. 2010; Clifford et al. 2010; Balcombe et al 2011;	current, emerging	local, cumulative	High	Major	All jurisdictions	Med	Limited management response
Stocking fish for harvesting	Increased abundance and extent of exotic & translocated fish	Homogenisation of aquatic communities with increased dominance by exotics and loss of more sensitive species	Lintermans 2004	current, emerging	local, cumulative	Moderate	Major	All jurisdictions	Med	Limited management response

Pressure / threat	Stressors	Responses	References	Risk				Residual risk		
				Timing[1]	Spatial extent [2]	Likelihood[3]	Consequence[4]	Covered by legislation	Residual management risk	Comment
Invasive Species										
Terrestrial animals	Altered habitat quality; displacement of native species	Degredation of riparian & wetland habitats (e.g. waterbird breeding areas); altered vegetation composition & structure; reductions of native animal populations	Bunn et al. 2003; Arthington et al 2005; DEH & SAALNRMB 2009; Arthington & Balcombe 2011	current, emerging	local, cumulative	High	Moderate	All jurisdictions	Med	Limited management response
Terrestrial plants	Altered vegetation composition & structure	Reductions of native plant diversity; altered fire regimes (e.g. buffel grass)	Arthington et al. 2005	current, emerging	local, cumulative	High	Moderate	All jurisdictions	Med	Limited management response
Social										
Declining and aging human population. Dislocation of Aboriginal community and loss of knowledge	Loss of local knowledge & management capacity, therefore reducing ability to detect unacceptable ecological change	Decreased exploitation of water resources and surrounding habitats leading to impacts on riverine ecosystems & biodiversity	King et al. 2003; Arthington et al. 2005; Bond et al. 2010; Arthington & Balcombe 2011; Close et al. 2014; Davis et al.	emerging	local, cumulative	Moderate	Moderate	No relevant legislation Australia wide	Low	Programmes in place for maintaining local Aboriginal knowledge i.e. Aboriginal people working on the country

			2015							
Pressure / threat	**Stressors**	**Responses**	**References**	**Risk**				**Residual risk**		
				Timing[1]	**Spatial extent [2]**	**Likelihood[3]**	**Consequence[4]**	**Covered by legislation**	**Residual management risk**	**Comment**
Social										
Impacts on Aboriginal cultural and historical sites	Loss of local knowledge and management capacity due to disconnection from country and reduced ability to detect unacceptable ecological change	Loss of ecological integrity	Nursey-Bray 2015	emerging	local, cumulative	moderate	moderate	Covered by Native Title legislation, Aboriginal Heritage Act 1988 (SA) and by government programs	Low	
Climate change										
Warming	Altered habitat quality & resource availability	Reductions & loss of sensitive species; altered species distributions	James et al. 2013	emerging	local, cumulative	High	Major	South Australia only	Med	Far North and Outback SouthAustralia Climate Change Adaptation Plan 2016
Altered rainfall, runoff & flow regimes	Altered habitat quality & resource availability	Reductions & loss of sensitive species; altered species distributions	King et al. 2003; Fullerton et al 2010; Balcombe et al 2011; James et al.	emerging	local, cumulative	Moderate*	Major	No relevant legislation Australia wide	Low	Appropriate management responses can be developed when we are certain about the future climate

			2013; Kerezsy et al. 2013							
Pressure / threat	**Stressors**	**Responses**	**References**	**Risk**				**Residual risk**		
				Timing[1]	**Spatial extent [2]**	**Likelihood[3]**	**Consequence[4]**	**Covered by legislation**	**Residual management risk**	**Comment**
Climate change										
More frequent & intense droughts	Altered habitat quality & resource availability	Longer & more severe bust phases; loss of 'bridging' flows; reductions & loss of sensitive species; altered species distributions	Watterson et al. 2015	emerging	local, cumulative	Moderate*	Major	No relevant legislation Australia wide	Low	
Altered fire regimes	Enhanced habitat for invasive species	Homogenisation of aquatic communities with increased dominance by exotics and loss of more sensitive species	Bond et al. 2010; Balcombe et al. 2011	emerging	cumulative	Moderate*	Moderate	No relevant legislation Australia wide	Med	

1 – Timing: risk is either current or emerging or both; 2 – spatial extent: impacts of pressure are mainly local or cumulative across larger scales or both; 3 – likelihood: probability of occurrence of this pressure; 4 – consequence: probable severity of impacts of pressure did occur; * - indicates high levels of uncertainty. N.B. Likelihood and consequence scores are based on the expert opinion of the report authors in relation to the range of sources considered in the preparation of this report.

5.2 Pressures and threats of the highest risk

While there are management responses to all of the pressures and threats, for certain matters the current response has been assessed as not delivering a direct response. In these examples the existing legislation and policy approach leaves a 'residual risk', which is a measure of the as-yet-unresolved challenge in dealing effectively with the matter. The following issues have management responses that don't fully address the pressure or threat and which therefore pose the greatest risk to the physical condition of the Basin.

This report takes the view that the main priority is to address those issues for which adequate controls are yet to be determined: the effects of climate change, and the management of invasive species on riverine and floodplain environments. The matters of mining and petroleum activities and water and altered inundation patterns have also been included as they are of significant concern to the Lake Eyre Basin community.

The most concerning emerging threats in the Basin are those associated with climate change (Table 20). Risks to riverine ecosystems and biodiversity posed by increasing temperatures and heat waves may be considerable, with the potential for reductions in native species populations, species losses and shifts in distributions throughout the Basin. Rainfall and hydrological changes are comparatively uncertain. There is considerable potential of a significantly drier future in the Basin by the end of this century, especially in the south (Watterson et al. 2015). A South Australian assessment of the vulnerability of water-dependent ecosystems to projected climate change identified the Far North Prescribed Wells Area, which encompasses the South Australian portion of the Basin, as an area with significant risks, especially with respect to the presence of high value water-dependent ecosystems in the region, such as the Coongie Lakes Ramsar site (Harding 2012).

Managing risks to the water resources and river ecosystems in the Basin is about determining the consequence of an activity (or an impact) with the likelihood of that event occurring. The aim of planning, policy and management activities is to reduce the consequence of and or the likelihood of that occurrence. Some consequences we can prevent – such as determining water allocations – and others we will have to learn to manage – such as climate change. The community's perception of risk generally highlights issues with the biggest impact on community values, combined with the concern that the controls in place are inadequate to manage the potential impact.

Risks associated with the majority of current threats to water resources and riverine ecosystems in the Basin are typically considered to be low under current water resource management plans, pastoral legislation and inter-state cooperation in assessing the effects of cross-border issues on streamflow (Negus et al. 2013; Table 20). Additionally, the spatial extent of and probable responses to many current threats are likely to be localised, often concentrated around particular waterholes (Table 20). There is a potential for the intensity and extent of such localised pressures to increase into the future, which could lead to cumulative impacts across the Basin if their effects disrupt aquatic refuges during bust phases or the hydrological connectivity between these during boom phases.

Invasive species are a high priority risk to riverine ecosystems in the Lake Eyre Basin,

including aquatic and terrestrial animals and terrestrial plants (Table 20). There is evidence, including data from the Lake Eyre Basin Rivers Assessment programme, that invasive goldfish, sleepy cod, redclaw and cane toads are becoming more abundant and widespread. Climate change may also facilitate further growth and spread of many invasive species and aggravate their effects on native species and ecosystem function. Illegal stocking of fish in waterholes of the Basin for fishing also poses a risk to aquatic communities (Table 20).

Other current threats with moderately high levels of risk include the uncontrolled outflow of groundwater from artesian bores, mainly because of the potential for populations of gambusia to invade spring habitats and imperil their endemic fish species. The effects of mining infrastructure and roads on surface water hydrology of floodplains may also be of moderate concern in areas with a greater intensity of development. Effects on hydrology of floodplain infrastructure have the potential to alter the quality and connectedness of aquatic and riparian habitats, although these effects remain uncertain (Table 20).

Land and water degradation

Several activities associated with land and water degradation, including vegetation clearance, overgrazing and inappropriate cropping practices, were listed as potential threats in the State of the Basin 2008 (Lake Eyre Basin Scientific Advisory Panel 2009a). Levels of vegetation clearing and landscape modification are very low throughout the Basin, especially in comparison with catchments in south-eastern and south-western Australia. In the Queensland portion of the Basin, for example, vegetation clearing within the Mitchell Grass Downs and Channel Country bioregions has retained 94% and 99.8% of their original vegetation, respectively (QLD State of the Environment 2015).

Hydrological alteration

Hydrological alteration through water resource development (activation of, or creation of new water licences for irrigation), surface water storages (dams and weirs and off-stream storages), surface water extraction (waterhole take and water harvesting) and surface water diversion was identified as being at low risk. Water resources and riverine ecosystems of the Basin are managed by State and Territory legislation under a wide range of existing legislation, policy and non-statutory plans (Table 17).

Despite assessment of the risk of water use for irrigation as low, it remains one of the greatest concerns amongst the Community Advisory Committee in relation to the upper Basin catchments in Queensland; the Committee rated the risk as medium. Ongoing concerns about activation of currently unused water harvesting licences along with legislative amendments remains the Committee's main concern.

Infrastructure development for roads, levees and pipelines along floodplains was identified as a medium risk. Infrastructure on floodplains can isolate portions from flooding or interfere with natural patterns of movement of plants, animals and nutrients between floodplains and the river. Such fragmentation reduces the effective floodplain area available to support grazing and natural ecological processes. Whilst current legislation can deal with larger infrastructure, it was evident through the risk assessment and consultation processes that specific protection of floodplains from infrastructure development is lacking and therefore remains as a medium risk.

Groundwater extraction from sub-artesian aquifers (i.e. not from the Great Artesian

Basin) was considered low risk as current extraction remains low and is therefore not perceived as a major threat.

Uncontrolled Great Artesian Basin bores

The Lake Eyre Basin Intergovernmental Agreement area covers a large portion of the Great Artesian Basin, which is Australia's largest underground water resource covering 22% of the continent. The water resources of the Great Artesian Basin sustain a wide range of communities, tourism enterprises and water-dependent industries throughout Australia's remote inland. The Great Artesian Basin supports more than 6,000 natural spring complexes which are home to a diverse range of animals and plants that are found nowhere else in Australia and are dependent upon discharge of artesian water.

Drilling into the Great Artesian Basin commenced in 1878 and by 1918 more than 2,600 bores had been constructed to supply cattle stations, railways and towns. Most of these bores were not capped and water was allowed to flow freely into open bore drains, leading to reductions in artesian pressure and flow. Management arrangements for Great Artesian Basin bores did not change significantly until the late 1990s.

Using Great Artesian Basin groundwater in this way has led to the following impacts, requiring management intervention:

- reduced groundwater base flows to Great Artesian Basin spring and wetland complexes;
- increased invasive weeds and animals in open bore drains;
- reduced access for industries and towns that are reliant upon Great Artesian Basin water.

Since 1999, the New South Wales, South Australia, Queensland, Northern Territory and Australian governments have been working together to address these impacts by capping free-flowing bores and piping to replace open bore-drains . This joint government approach has been implemented through the Great Artesian Basin Sustainability Initiative and other state-based capping and piping programmes. As a result, nearly 700 bores have been capped or controlled and nearly 21,000km of bore drains replaced with piped networks. It is estimated that there are now 38,000 bores drilled into the Great Artesian Basin, of which around 600 are still free-flowing into open bore-drains, even after implementation of the various joint capping and piping programmes.

Whilst there has been substantial efforts made by governments over the past 20 years to manage free-flowing bores, the impacts associated with remaining uncapped and unpiped bores continue. Stakeholders within the Lake Eyre Basin consider ongoing management of free-flowing bores to be important. Resolution of the matter requires groundwater users to continue to cap and pipe until the residual impacts are at an acceptable level. The condition of the Lake Eyre Basin would improve as a result of reducing free-flowing groundwater bores through reduction of the spread and occurrence of invasive weeds and animals, improvement in the base flows to Great Artesian Basin springs, and improved accessibility to groundwater for water users.

Mining and petroleum

Mining and petroleum associated risks to catchment condition are considered to be low. Mining currently covers a very small proportion of the Basin area, with pressures from mining such as release of mining water, water diversions, pollution and water extraction

currently not having a significant impact at the scale of the Basin. Each jurisdiction has comprehensive mining legislation, which covers a range of issues affecting water disposal, land clearing, water use and pest control. Notwithstanding these legislative controls, the impacts of mining can be catastrophic, particularly at the local-scale, as occurred recently in the 2009 spill at the Lady Annie Copper Mine. Similarly cumulative impacts of smaller but frequent contaminant releases remain one of the greatest longer-term threats from mining. Mining within the Basin is likely to expand in the short to medium term, particularly the existing petroleum and gas industry in the Cooper basin sub-region, and despite the considerable work which has been undertaken as a part of the Bioregional Assessments more specific research is required to fully understand and manage potential impacts. The need for more research and data has been recognised by the Community Advisory Committee, which took a precautionary opinion and rated mining risks as medium.

Overgrazing

Overgrazing is a minor risk in South Australia because there are few pastoral leases and regular interaction between them and government agencies through rangeland monitoring. In the Northern Territory only a small number of pastoral leases is included within the Basin. In Queensland, there are many more leases and lesser efforts in monitoring and communication with lessees. For these reasons, the risk is rated as medium.

Invasive species

Management of pest animals and weeds was identified as a medium risk. This pressure is expressed through a multitude of species with widespread effects on aquatic and riverine ecosystems. The effects are mitigated by extensive efforts in weed control and management of pest animals by landowners, natural resource management bodies and governments throughout the Basin, backed up by legislation. Despite this widespread effort, it is evident that the risk of damage due to them remains significant. In the opinion of the Community Advisory Committee the risk is high, rather than the rating of medium shown in Table 20. This 'on-ground' view suggests either that current policies are inadequate to mitigate the risk, or that resources dedicated to the task are too small to achieve locally-desired outcomes.

Social change

The risk of ongoing social change to effective management of the Basin's water resources and related ecosystems has been regularly raised by community members over the past decade. The declining and ageing population, principally among members of the pastoral community, is frequently identified as a threat to natural resource management because of loss of knowledge and community commitment, especially following drought. Similarly, the Aboriginal community is concerned that without full and meaningful engagement in water planning processes that incorporates Aboriginal knowledge and values there will be an ongoing risk to the sustainability of 'country' from an Aboriginal perspective. Overall, therefore, the Community Advisory Committee ranked this risk as medium. Although these considerations certainly need to be taken account of, in Table 20 the risk is ranked as low. This rating reflects the difficulty of identifying means by which government might mitigate the risk through legislation or policy.

Climate change

Climate change was identified as a medium risk. Climate change will strongly influence this already variable system, requiring adaptation by land managers and native plants and animals. Local temperatures are projected to increase along with evapotranspiration, while rainfall which is harder to predict than temperature, is likely to be increasingly variable, with longer periods of below average rainfall punctuated by above average, intense rainfall events. The consequences of climate change could significantly alter the Basin, however until we have more information and certainty about the future climate it is not possible to establish effective management responses to climate change. This risk rating reflects the difficulty in identifying at this time the impacts that require mitigation.

Fires and warming

Climate change is likely to create more bushfire weather because hotter conditions will become more frequent. Among the earliest of responses to climate change around the globe is increased fire risk. There is little reason to doubt that the same influence will be felt in the Lake Eyre Basin. Wildfire is currently a major management challenge, and so the risk is presently not well mitigated. Therefore, fire is ranked as a medium risk.

Tourism

Tourism and recreation pressures in the Basin are managed by jurisdiction-wide legislation, for example for water pollution, and also by local governments and shire councils. Otherwise, land-holders such as national park agencies and private land owners manage the pressures. Tourist businesses have an indirect role in the management of the pressures through their role as guides. The environmental impacts of tourism and recreation are localised, but nevertheless significant because these sites are highly valued by the community. There is a widespread local view that not enough resources are directed to preventing and ameliorating the impacts. At a catchment scale, the residual risk of tourism and recreation pressures on the aquatic environment is considered low, though the movement of invasive species by tourists and recreationalists contributes to the medium pressure rating for invasive species.

5.3 Strategic knowledge needs

To assist governments in identifying, understanding and responding to emerging pressures and threats within the Lake Eyre Basin it will be essential that a strategic framework for collecting, analysing, and reporting on information is established. A knowledge framework would provide an opportunity for governments to understand and respond actively to current and emerging impacts in an efficient, effective and timely manner through development and implementation of well informed policy responses.

The following high-level knowledge needs have been identified:

- Knowledge to inform improved management responses to the residual risks' identified in section 5.2.
- Knowledge to give confidence to water managers that the responses being implemented are effective and should continue.
- Access to knowledge to allow managers to understand new issues as they arise and to develop effective management responses.

The identification of knowledge needs and development of information must be strategic. Knowledge will only contribute to positive outcomes if it is useful for resource managers and policy developers, and assists them to understand issues and develop effective management responses. Effective information collection and analysis must deliver outputs fit for purpose and also be flexible enough to adapt as issues, environmental conditions and technology evolve.

To enable information relevant to key policy and management issues to be identified and developed, policy developers and technical experts need to work together to identify key questions and priorities and plan arrangements to develop the required knowledge. This could be done through the revitalisation of the existing Lake Eyre Basin Knowledge Strategy.

The Lake Eyre Basin Knowledge Strategy, developed by the Scientific Advisory Panel in 2009, sets out critical questions to guide investment in research in the Basin (Lake Eyre Basin Scientific Advisory Panel 2009b). Progress has since been make on addressing many of the knowledge questions. For example, questions regarding the health of the Basin's rivers are being informed by the Lake Eyre Basin Rivers Assessment and are reflected in the outcomes of this Report.

A revitalised KnowledgeStrategy would not only consider the currency of the knowledge questions posed in the 2009, but also identify any new questions, information needed to answer those questions and plan work over appropriate time periods to gather this information

To ensure that tasks being carried out under the Knowledge Strategy continue to be useful and necessary, and to allow flexibility to respond to shifting management needs, experts from jurisdictions and the Lake Eyre Basin Scientific Advisory Panel and Community Advisory Committee would meet annually to review the Strategy and plan knowledge-gathering work for the coming year.

Image 16 Lake Lady Blanche, Coongie Lakes area. Photo: M Good