

5 | ACT Rivers and Riparian Zones: Planning and Management for Conservation

The importance of ACT rivers in the development of the national capital has been long recognised. Their place in the rural economy before and after the establishment of the Territory and attractiveness for recreation is discussed in s. 2.3.1. The ornamental Lake Burley Griffin on the Molonglo River floodplain is the centrepiece of Walter Burley Griffin's plan for the capital. Subsequent town centre development has included ornamental lakes, also serving a water quality control purpose (urban stormwater and protection of the rivers). The potential for water supply from the forested mountain catchment of the Cotter River was recognised in choosing the site for the capital. Protection of this catchment was initiated in 1914 with a 'restricted use' policy under the *Cotter River Ordinance 1914–1959*, providing the legal means to restrict camping and picnicking in the catchment area (NCDC 1986). In summary, rural production, recreation, urban ornamental and symbolic national capital purposes, retention of run-off and pollution control, and water supply have dominated the use, planning and management of ACT rivers and streams. Only more recently have nature conservation and healthy ecosystem function become explicit goals for planning and management of aquatic and riparian areas.

5.1

Planning, Protection and Management of Rivers and Riparian Zones in the ACT

This *Strategy* builds upon a substantial existing reservation, planning and management framework for catchments and river corridors in the ACT. For the ACT as a whole, the key issue for the rivers and riparian areas is not the need for reservation or recognition in statutory planning, but the need to strengthen and coordinate management (e.g. Molonglo below Scrivener Dam), prepare management plans for some areas (e.g. Molonglo Gorge), and undertake work on particular management issues (e.g. weeds including

willows) based on effective implementation plans. The development of a strategic management plan for the Lower Cotter Catchment is a good example of a strategic approach to land management where multiple agencies are managing for diverse outcomes (water supply, water quality, biodiversity and recreation) (ACT Government 2006b).

5.1.1 Planning

In a national capital context, ACT rivers and riparian zones are a key element in the concept of the National Capital Open Space System (NCOSS) in the *National Capital Plan* (NCA 2005). A *Principle and Policies*, that include environmental protection, are prescribed for NCOSS. Under the provisions of the *Australian Capital Territory (Planning and Land Management) Act 1988* (Cwlth), the *National Capital Plan* also sets out 'special requirements' for the Lanyon Bowl area, the Murrumbidgee and Molonglo River Corridors, and the Namadgi National Park Area (being the Park and adjacent areas in the Gudgenby and Cotter catchments). In effect, all the areas covered by this *Strategy*, except for Paddy's River, are included in the 'special requirements' provisions. The *National Capital Plan* includes Policy Plans for the 'Murrumbidgee River Corridor' and 'Namadgi National Park and Adjacent Areas', which together with *Territory Plan* policies provide the context for the preparation of management plans.

In a Territory planning context, *The Canberra Spatial Plan* (ACT Government 2004b) contains policies for the protection of the river corridors (biodiversity conservation) and policies for the management of water quality to improve the quality of stormwater runoff to streams. Detailed land use policies in the *Territory Plan* (ACTPLA 2005) that are of particular relevance to this *Strategy* are those for river corridors and water use and catchments (see also s. 1.5.1). In addition, all proposals for buildings within areas covered by the River Corridors Land Use Policies are subject to mandatory environmental impact assessment (Preliminary Assessment) under Appendix II of the *Plan*.

River Corridors Land Use Policies (*Territory Plan* Part B13) give primacy to the protection of natural and cultural values and recognise recreation as the key use. A number of land uses consistent with the *National Capital Plan* (NCA 2005) may be permitted and these may be subject to mandatory preliminary assessment under Part IV of the *Land (Planning and Environment) Act 1991*. Objectives of the River Corridors Land Use Policies are:

- (a) to conserve the ecological and cultural values of the ACT's major river corridors;
- (b) to protect streamflow, water quality and floodplains from adverse impacts;
- (c) to ensure that the type and intensity of development is sustainable;
- (d) to provide opportunities for a range of water and land based recreational activities;
- (e) to ensure compatibility between land uses, water uses and the general character of the rivers; and
- (f) to provide opportunities for appropriate environmental education and scientific research activities.

A range of controls applies, including restrictions on livestock grazing, protection from urban development, and protection of streamflow and water quality. Special conditions may apply including controls on use of fertilisers, pesticides and weedkillers. Sand and gravel removal, and channel stabilisation works, may be undertaken as required to rehabilitate and stabilise aquatic habitats and flood channels.

Water Use and Catchment Policies (*Territory Plan* Appendix 1) allocate waters of the ACT in terms of their permitted water uses and environmental values to be protected. Three Water Use Catchments have been defined:

- (a) Conservation (includes Molonglo River Corridor, Murrumbidgee River Corridor and some of the Murrumbidgee River catchment in the ACT; catchment of the Gudgenby and Naas rivers);
- (b) Water Supply (Cotter River catchment); and
- (c) Drainage and Open Space (includes Paddys and Tidbinbilla rivers, streams in non-urban ACT).

The Conservation Catchments incorporate those lakes, streams and wetlands for which the primary value is conservation of aquatic habitats (natural and modified), migratory routes or landscape qualities. The Water Supply Catchments incorporate those reservoirs and streams for which the primary value is domestic water supply. The Drainage and Open Space Catchments incorporate those lakes and streams for which the primary value is drainage of the catchment and associated provision of open space. Policies for each

of these allow for a range of secondary uses that are compatible with the primary value. The intent of these policies is expressed in a number of ways, an important means being a management plan prepared for a particular area (see s. 5.1.3).

5.1.2 Statutory Protection

The rivers and riparian zones considered in this *Strategy*, except for Paddys River and most of the lower sections of the Naas and Gudgenby rivers, are categorised as Public Land under the *Land (Planning and Environment) Act 1991* (ACT). This land is identified in *The Territory Plan* (Other Policies C1 – Overlay Provisions). Public Land designation requires the preparation of Plans of Management. There are several categories of Public Land, for each of which the Act defines management objectives. Public Land categories assigned to ACT rivers and riparian zones or to areas containing rivers are described in Section 5.4.

The area of Public Land adjacent to the rivers varies widely. In the upper Cotter River, it encompasses the whole of the catchment. Along parts of the Murrumbidgee River, Special Purpose Reserve forms a buffer between riverine Nature Reserve and rural land (e.g. in the Bulgar Creek area and near the northern ACT border). Between Tharwa and Pine Island, land on both sides of the Murrumbidgee River is Special Purpose Reserve, including the Lanyon Landscape Conservation Reserve, which is managed as an historic rural landscape. In the lower Molonglo River valley the Nature Reserve (generally less than a kilometre wide) directly abuts adjacent rural land. The latter highlights a feature of river corridor reserves and a major management consideration—their linearity and high perimeter to area ratios. This exposes them to an extended interface with often contrasting and potentially poorly compatible land uses.

5.1.3 Management

The *Land (Planning and Environment) Act 1991* requires the preparation of a (draft) Plan of Management for an area of Public Land identified in the *Territory Plan*. This process is not complete for the rivers and riparian zones. The following plans are currently in place:

- *Namadgi National Park Draft Management Plan* (ACT Government 2005c). An approved Namadgi National Park Management Plan will supersede the 1986 *Namadgi National Park Management Plan* that was prepared under Commonwealth legislation (ACTP&CS 1986). The upper and middle sections of the Cotter, Gudgenby and Naas rivers and most of the Orroral River are in the Park.

Figure 5.1: Territory Plan Land Use Policies and Areas of Public Land in the Murrumbidgee River Corridor

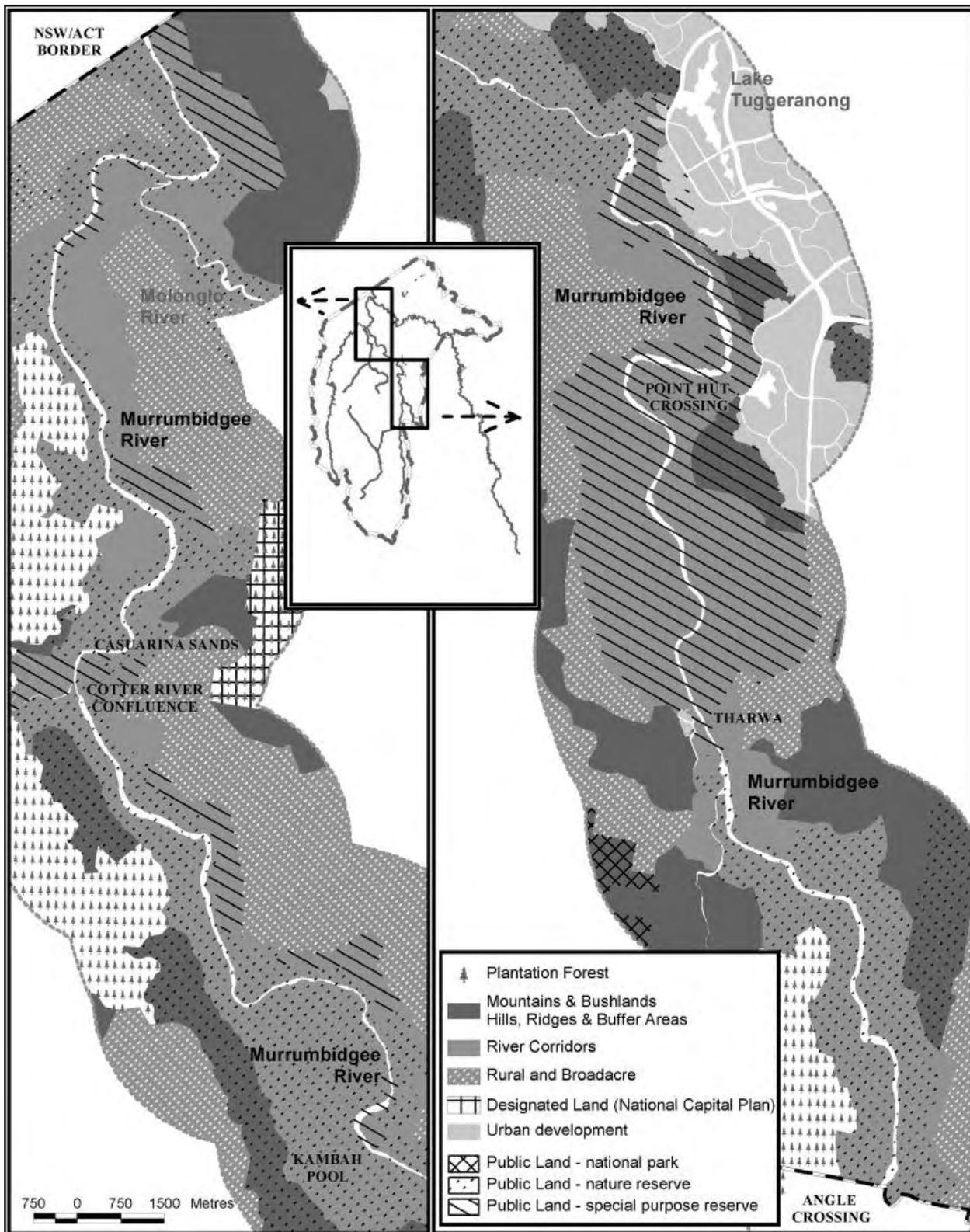


Figure 5.2: Territory Plan Land Use Policies and Areas of Public Land in the Gudgenby, Naas and Orroral River Catchments

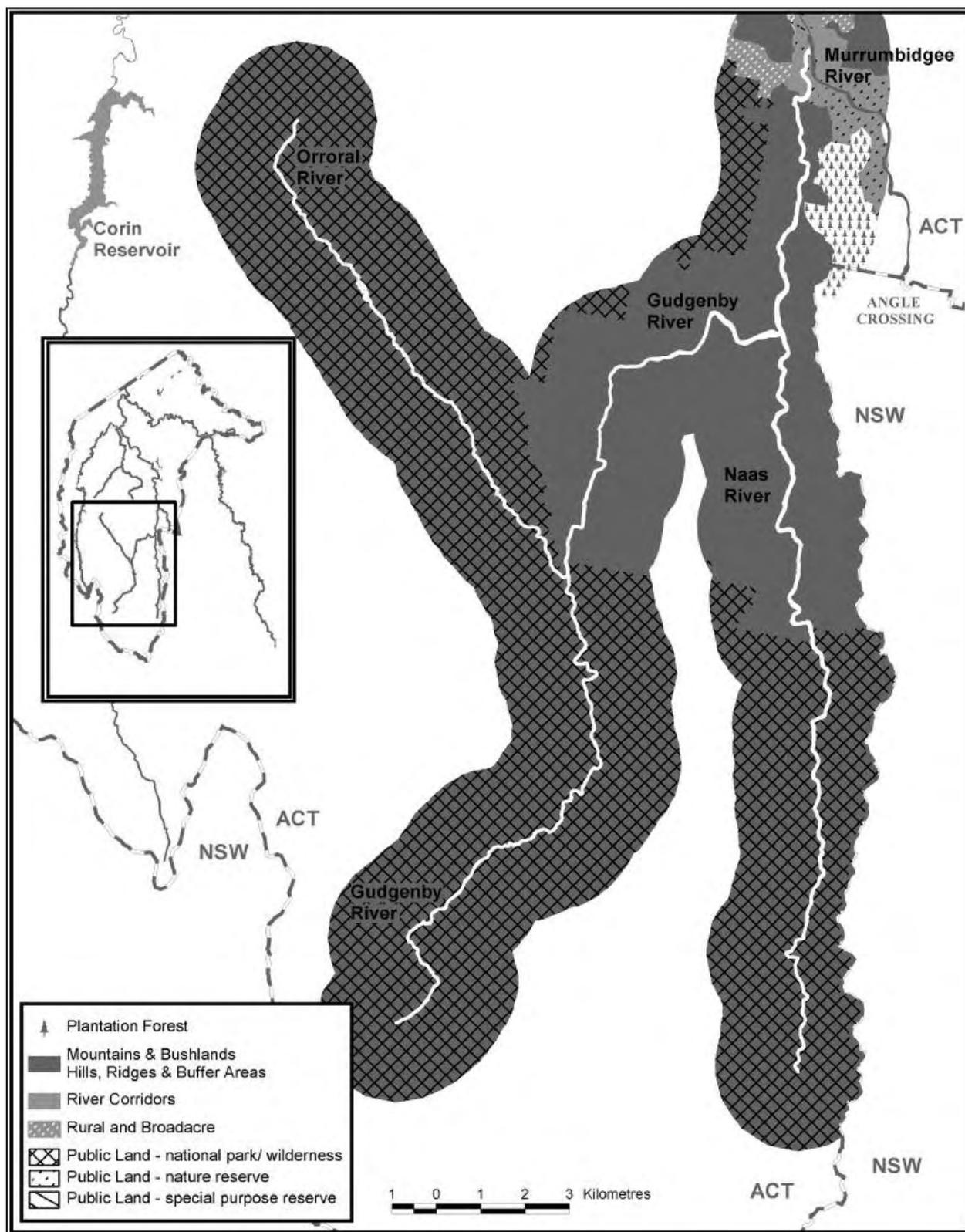


Figure 5.3: Territory Plan Land Use Policies and Areas of Public Land in the Cotter, Paddys and Tidbinbilla River Catchments

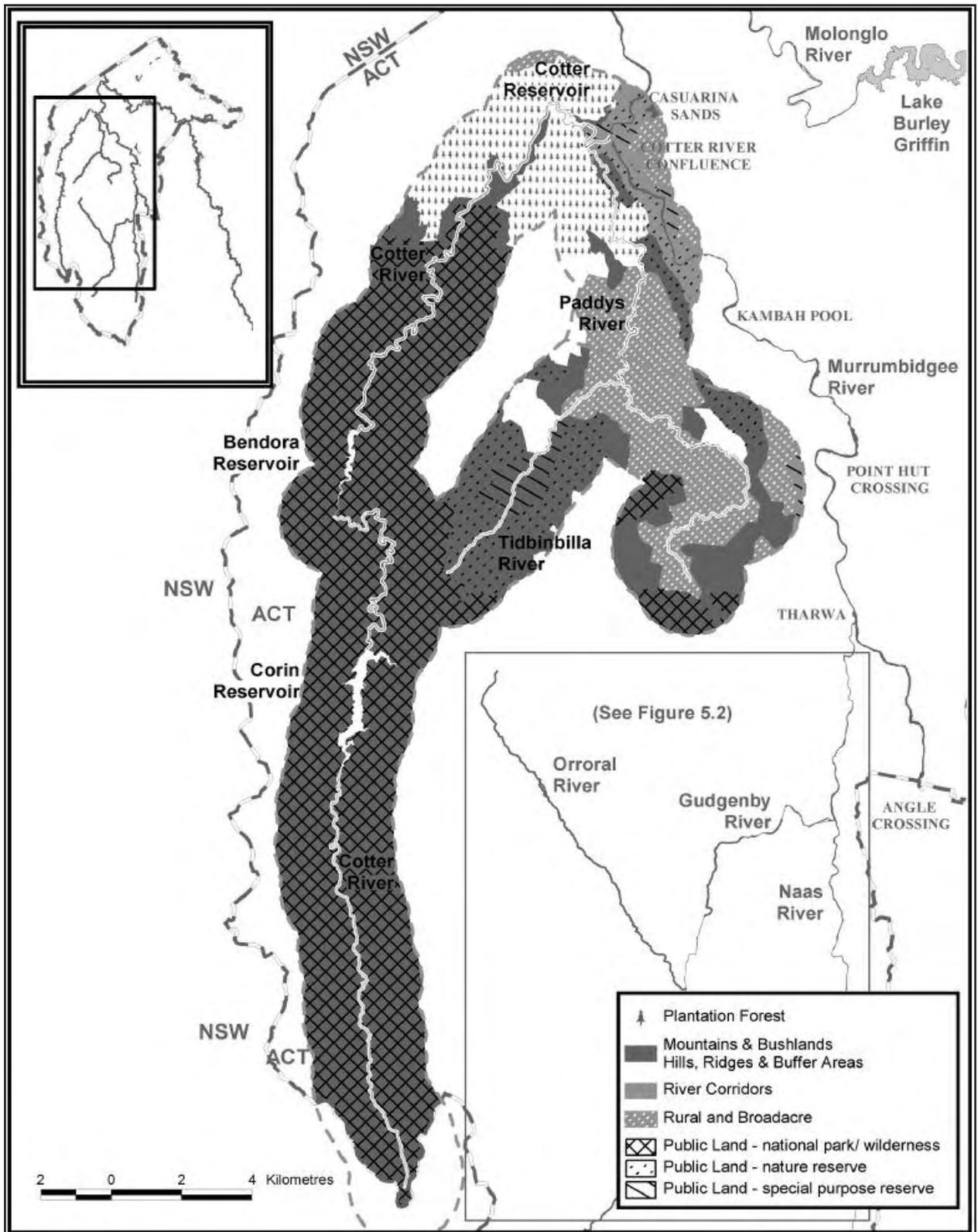
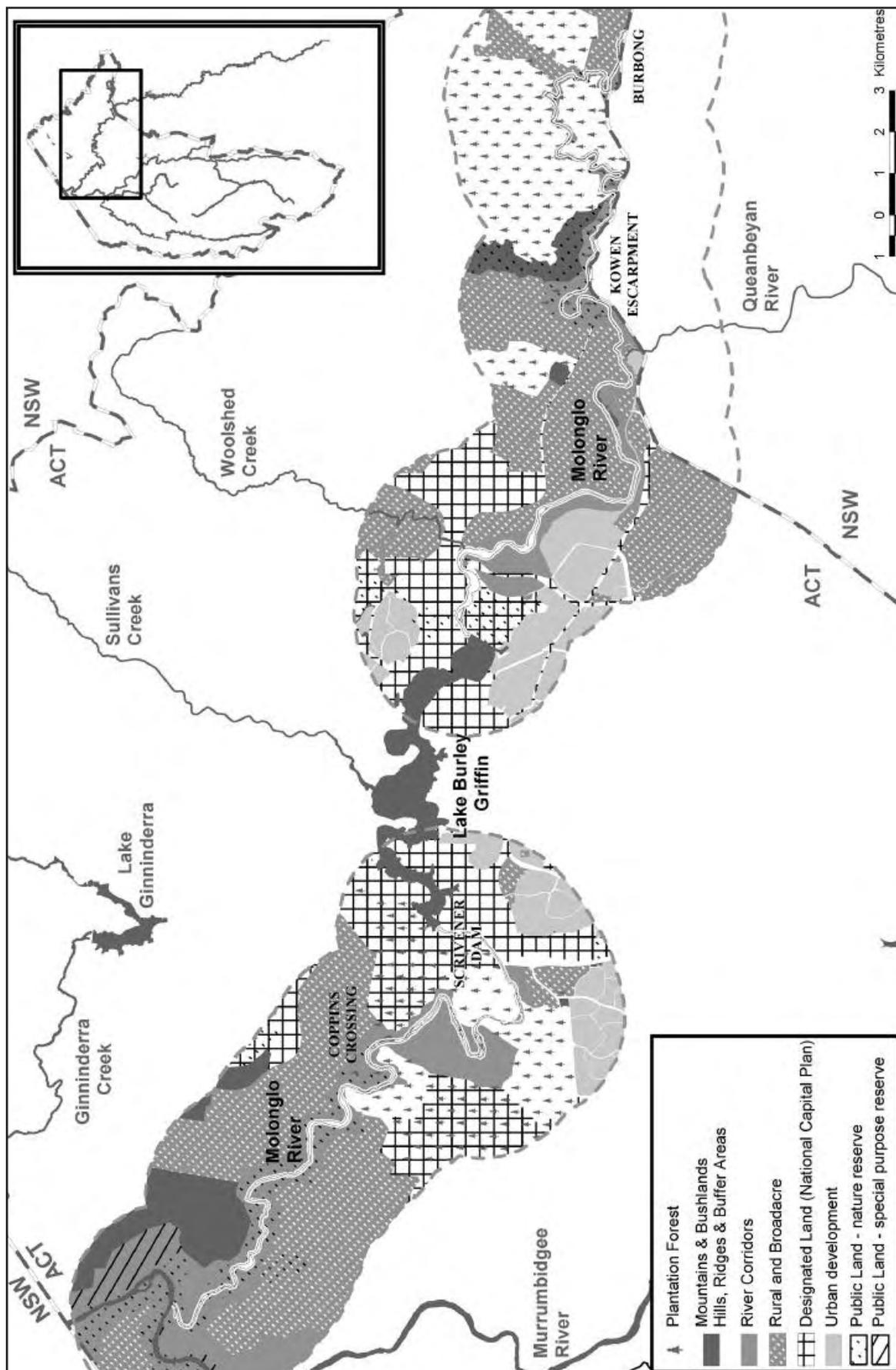


Figure 5.4: Territory Plan Land Use Policies and Areas of Public Land in the Molonglo River Corridor



- *Lower Cotter Catchment: Strategic Management Plan* (ACT Government 2006b).
- *Murrumbidgee River Corridor Management Plan* (Environment ACT 1998).
- *Lower Molonglo River Corridor Management Plan* (Environment ACT 2001b).
- *Tidbinbilla Nature Reserve Management Plan* (Environment ACT 1999). This reserve includes most of the Tidbinbilla River, a tributary of Paddys River.

Management of the National Park, Nature Reserve and River Corridor Special Purpose Reserve areas is the responsibility of Environment and Recreation (Department of Territory and Municipal Services). The activities of other government agencies as well as other organisations also influence the management of these areas (e.g. ACTEW Corporation; Emergency Services Authority).

In relation to the rivers and riparian zones in the ACT, there are three aspects of management that need consideration:

- **Management Responsibility:** This is clearly established for Namadgi National Park and the parts of the Murrumbidgee and Molonglo river valleys that are Nature Reserve and Special Purpose Reserve, which are managed by Environment and Recreation (Department of Territory and Municipal Services). Some other riparian areas have not been actively managed and are very degraded, in particular, along the Molonglo River near Fyshwick, and below Scrivener Dam. More active conservation management is proposed for the Cotter River between Cotter Reservoir and Namadgi National Park with a change in the focus of land use to water supply (ACT Government 2006a).
- **Management Plans:** Management Plans have not been prepared for some Public Land areas, in particular, Molonglo Gorge (Kowen) where there is established recreational use and a nearby land use (pine plantation) with potential to impact on the area.
- **On-ground Management:** Parts of the riparian zone require increased management input e.g. willow control, other weed control, vegetation restoration, and improved management of the sand and gravel stockpile site in the Public Land river corridor near Fyshwick. The former extraction site in this area needs rehabilitation.

5.2

River and Riparian Zone Conservation Areas

As noted in s. 5.1.2 above, most rivers and riparian areas are included in Public Land under the *Land (Planning and Environment) Act 1991*. Outside of Namadgi National Park, Nature Reserve classification has been applied to the more environmentally significant river sections and Special Purpose Reserve to other sections and upslope areas (Table 5.1, Figures 5.1–5.4). In the *Land (Planning and Environment) Act 1991*, management objectives for Special Purpose Reserve are ‘to provide for public and community use of the area for recreation and education’. In practice, in the Murrumbidgee River Corridor, the two reserve types are managed as one, or as complementary. Special Purpose Reserves may provide land suitable for siting of recreational facilities away from areas of greater environmental significance or sensitivity. The Special Purpose Reserve Classification is also used for areas where recreational activities were focused historically (e.g. the river crossings and major pools on the Murrumbidgee River).

As noted previously (s. 5.1, s. 5.1.1 to s. 5.1.3), there is comprehensive reservation of ACT riparian zones as well as planning controls that apply to the river corridors (Figures 5.1 to 5.4). For these reasons, the *Strategy* does not propose new reservations. A priority action for the *Strategy* is to undertake a program of systematic survey of vegetation and habitat in ACT riparian zones (s. 6.5.1, Table 6.1). This will complement the knowledge built up over time of aquatic habitat and ecology (through fish survey and monitoring, macroinvertebrate monitoring and water quality monitoring). Together these will provide an information base to consider the adequacy of reservation and planning controls, however, their greatest value is likely to be in refining the management of already reserved areas.

The following planning and management considerations arise in relation to the differing reserve classifications along the rivers and riparian land uses:

- **Fragmentation and linear connectivity:** River and riparian nature reserves, like their terrestrial counterparts, may be fragmented (i.e. separated by river sections with other land uses). Unlike their terrestrial counterparts, however, there is linear, mainly downstream connectivity provided by flows of water, sediments, organic materials and living organisms. This means that high conservation value areas cannot be isolated from the effects of

activities in the stream lengths that separate them, or from upstream.

This is especially relevant for the Molonglo River, where Molonglo Gorge (Kowen) and the lower gorge (near the Murrumbidgee River confluence), which have significant nature conservation values, are separated by Lake Burley Griffin, sections with major urban stormwater inflows, and lengths of degraded river. In particular, there are substantial willow invasions and other woody and herbaceous weeds, and macroinvertebrate sampling sites on the Molonglo River (Site 242) and nearby Queanbeyan River (Site 235) indicate that these river sections are severely impaired to impoverished in their macroinvertebrate assemblages (ACT Government 2004e). In the Murrumbidgee River, habitat has been seriously affected by upstream erosion and sedimentation with major deposition of sand and gravel in the Tharwa area (see s. 4.1).

Comprehensive conservation management along rivers has proven difficult to achieve, even in a small geographic area such as the ACT. Habitat fragmentation in riparian zones and damage to riverbanks has been caused by grazing (though this is substantially reduced in the ACT), tree clearing and ongoing tree decline, extractive industries, establishment of recreation areas and other facilities.

- **Stream crossings:** Related to the above are the impacts of the number, design and placement of stream crossings. These provide entry points to river and riparian areas for human activity, weeds, dumping of rubbish, illegal fishing and are a source of sediment. The design of crossings can have a severe impact on fish passage. Guidelines are now available for the construction of various types of new crossings and rehabilitation of existing ones that facilitate fish passage e.g. Fairfull and Witheridge (2003). Construction of the rock-ramp fishway at Vanitys Crossing on the Cotter River is an example of such rehabilitation (see s. 4.4.2).
- **Impacts of upslope land uses:** A major management problem for rivers and riparian zones is their linearity and high perimeter to area ratios. They are a very difficult reserve shape for the protection of natural integrity. In the ACT it is evident that the best remnants of low elevation riparian vegetation are in the more rugged gorge areas (Gigerline and Bullen Range adjacent to the Murrumbidgee River and gorges in the lower Molonglo River and at Kowen). These areas have been protected by virtue of their topography and

have not experienced the impacts of grazing, fire and recreation to the same extent as more accessible riparian areas. By contrast, in the lower Paddys River and lower Cotter River areas, extensive pine plantations have reduced native vegetation in the riparian zone to a narrow strip.

5.3

Conservation Planning for Rivers and Riparian Zones

Rivers and their riparian zones possess particular features that require special consideration in their conservation and management (adapted from Williams 1993):

- **Linearity and instability:** They are linear landscape features and inherently unstable because of riverflows. This makes them vulnerable to disturbance and invasion. Conversely, river regulation and reduced flow variability (in particular, reduced high flows) have created conditions suitable for invasion by pest plants and animals.
- **Tenures and land uses:** Their linearity means that rivers pass through differing tenures and land uses. Upstream and upslope uses and management, including the results of activities that occurred a long time ago, influence downstream river sections.
- **Remnant riparian vegetation:** Riparian vegetation is often the sole or major form of remnant vegetation in an area and therefore has increased value for local biodiversity conservation. Riparian areas often provide specialised habitats (e.g. moist areas, rocky gorges, areas protected from climatic extremes, unstable substrates) that support locally uncommon plant and animal species and ecological communities. Riparian vegetation may include relict species (from previous different climatic environments) and species lost from surrounding terrestrial vegetation communities due to grazing pressure from stock.
- **Land uses:** Rivers and riparian areas are the focus of many land uses, activities and demands making them critical zones for land use planning. These include recreation, domestic or urban water supply, rural or agricultural water supply, irrigation, pastoralism, sand and gravel extraction, urban sewage treatment and disposal. Despite this, their small size relative to the total landscape may result in a low public profile. Presence of these uses and demands may result in some reluctance to accept the concept of and need for the maintenance of environmental flows especially in times of drought.

- **Water supply and ecological systems:** Historically, public policy in the ACT has been primarily focused on river systems as a water supply. Major changes to rivers and their catchments occurred before there was the ecological knowledge that could have predicted the effects of these changes. While the importance of maintaining water quality and biological diversity has been increasingly recognised, water supply demands are also growing. At the broader catchment level, this is the major conservation planning issue for rivers and the riparian zone, although quality and quantity of water supply will be linked to the quality and function of the riparian and aquatic ecosystems.

There are some particular conservation planning challenges for the ACT and region with regard to the rivers, aquatic species and the riparian zone. Foremost amongst these are:

- **Urban growth:** The growth of Canberra and Queanbeyan continues to exert significant development pressures on land in and around existing urban areas, including the rivers and riparian areas. Proposed future urban development in the Molonglo Valley and the Kowen Plateau (ACT Government 2004b) will substantially increase the urban population living in close proximity to the Molonglo River.

Particular attention is being given to the relationship between proposed new urban developments in the Molonglo Valley and the adjacent river and riparian areas. This includes protection of habitat (e.g. for raptors and the Pink-tailed Worm Lizard) and the potential to rehabilitate the degraded river section between Scrivener Dam and Coppins Crossing.

As a result of detailed planning processes undertaken by the ACT Planning and Land Authority, there may be a requirements to adjust the boundaries of the areas formally protected under the Territory Plan. This will include reductions and additions as required to River Corridor land use policy areas that reflect the most appropriate balance between planning and the environment, incorporating appropriate protection and mitigation measures as considered necessary.

- **Aquatic habitat:** The recovery of ACT threatened aquatic species is highly dependent upon the maintenance and improvement of aquatic habitat. Key aspects of this are improvements to water quality, maintenance of environmental flows, protection and improvement of riverbanks and riparian condition, removal of willows, sediment

and nutrient management, and in-stream habitat improvement (e.g. through interventions to create scour holes and habitat holes, increase large woody debris, and remove large sand and gravel deposits).

- **Riparian zone management:** (see s. 5.1.3 above).
- **Cross-border issues:** A number of streams span jurisdictional boundaries (Molonglo, Queanbeyan and Murrumbidgee rivers) and so the planning and management of different river sections may not be well integrated.

- **Bushfire Recovery:** In January 2003, bushfires of high intensity burnt 70 per cent of the ACT including all of the Cotter catchment, the riparian zone of the Murrumbidgee River and the lower Molonglo River corridor. The effects of these fires on catchment stability and flora and fauna, and land use planning considerations resulting from the destruction of existing assets (including a substantial area of pine plantation) have long term implications for the rivers and riparian zones. Particular issues are:

- Long-term establishment of stable vegetation cover, which is not predominantly invasive weed species, in former pine plantation areas that are not to be re-planted with pines.
- Planned urban and other development in the lower Molonglo River valley.
- Potential new recreational facilities in river corridor areas (Non-Urban Study Steering Committee 2003).
- Potential intensification of rural use (Non-Urban Study Steering Committee 2003).
- Sediment addition to streams following the fires.
- Longer-term stabilisation of catchments and riparian areas.
- Re-establishment of riparian vegetation along the Cotter River between Cotter Reservoir and Bendora Dam (an area previously surrounded by pine plantation).
- Recovery of the *Casuarina cunninghamiana* Riparian Woodland, which is not a fire-dependent system, following the January 2003 bushfires (England *et al.* 2004). The dominant *Casuarina cunninghamiana* may resprout epicormically after fire, but after a high intensity fire appears not to be able to maintain this growth. Trees along the Murrumbidgee and Cotter rivers that produced epicormic shoots after the fire have subsequently died. Continuing drought may have been a factor in this.
- Recovery of the *Callitris endlicheri* Woodland/ Open Forest. The dominant *Callitris endlicheri*

regenerates by seedling regrowth and is eliminated by frequent intense fire (England *et al.* 2004). Fire severity for this species was high to very high in the Mt Tennent area (Carey *et al.* 2003). River corridor populations were not surveyed immediately following the fires.

5.3.1 Conservation Planning Principles

Some conservation planning principles for rivers and their riparian zones are similar to those applying to the conservation of ecological communities elsewhere and have been discussed in the *ACT Lowland Woodland Conservation Strategy* (ACT Government 2004a, Ch. 5) and the *ACT Lowland Native Grassland Conservation Strategy* (ACT Government 2005a, Ch. 3). Where relevant, these have been integrated into the principles below:

Protection Upstream and Upslope

1. Areas that have the highest conservation values should be protected.
 - This includes protection from the impact of upstream uses.
 - It may necessitate the rehabilitation of upstream river sections.
2. For conservation areas, consideration of size (viability), diversity, representativeness, distinctiveness (rarity) and naturalness is required.
3. Replication of conservation areas in fragmented habitats is necessary to hedge against catastrophic and/or unpredictable local extinction. Integration of smaller systems within broader conservation systems increases their conservation value. River sections should be considered in a catchment context, where appropriate.

(Adapted from ACT Government 2005a; Williams 1993)

Management

Management should be based on a statutory management plan that clearly sets out management objectives, and includes actions, practices and responsibilities to achieve those objectives.

Threats

Management of threats should be a key focus. A scale appropriate to the threat using a catchment framework, and recognising linkages between site values and catchment processes, is required (Kingsford *et al.* 2005).

Riverflows

Riverflows should be protected at a level and regime that sustains all in-stream biota and ecological processes (Kingsford *et al.* 2005).

- The best scientific information available should be used to design water strategies that will sustain the

ecological values of water-dependent ecosystems (Arthington and Pusey 2003).

- An adaptive management approach is preferred for the calculation and refinement of environmental flows.
- Environmental flow calculations should include assessment of the needs of threatened species.

Linear Connectivity

Statutory protection, planning and management need to recognise the linear connectivity along streams and riparian zones and to tributary streams. Highly significant ecologically, it also means that the effects of activities are inextricably linked to downstream sections.

Upslope Connectivity

Statutory protection, planning and management need to recognise the connectivity between the stream, the riparian zone and terrestrial areas (not influenced by the stream), and the importance of this connectivity for ecosystem functioning.

Streamflows and Aquifers

Management should explicitly recognise the interdependence of surface riverflows and subterranean catchments (Kingsford *et al.* 2005). Connected aquifers are part of the river.

Assessment

All proposed activities that affect ecological processes and values of aquatic and riparian systems should be adequately assessed and managed, taking into account catchment scale considerations (Kingsford *et al.* 2005).

5.3.2 Information: Survey, Monitoring and Research

An adequate information base is a necessary precursor to sound conservation planning. Preparation of this *Strategy* has highlighted the unevenness and some deficiencies in the knowledge of species and ecological communities in the rivers and riparian zones of the ACT. In summary there is:

- Good knowledge of the ecological condition of ACT streams based on macroinvertebrate sampling at 200 sites.
- Good knowledge of water quality in ACT lakes and streams based on monitoring since the late 1960s.
- Sound knowledge of many aspects of the biology, distribution, abundance and threats to native fish (including threatened species) and the Murray River Crayfish, Platypus and Eastern Water Rat.
- Less knowledge of other aquatic animal species and aquatic ecological communities.

- Sufficient ecological and distributional information on the Pink-tailed Worm Lizard on which to base conservation action. Research needs for this species are identified in s. 3.3.2.
- A reasonable knowledge of other riparian zone fauna generally. Most species are also found in other ecosystems (see s. 3.2).
- Variable information on riparian vegetation communities, as riparian areas as a whole have not been the subject of a systematic vegetation survey. Existing surveys cover particular rivers or river sections and most are now outdated having been undertaken between 1975 and 1992 (see s. 2.2.1).

SURVEY

The need to undertake surveys of riparian vegetation, giving attention to threatened and uncommon species and ecological communities is identified in s. 2.2.1, s. 2.4.1 and s. 2.4.2. Similar actions for riparian fauna are outlined in s. 3.3. Survey objectives and actions for the *Strategy* as a whole are contained in Table 6.1.1. A follow up to comprehensive survey is the assessment of the conservation status of species and ecological communities to identify those that warrant consideration for nomination as threatened species or ecological communities under the *ACT Nature Conservation Act 1980*.

MONITORING

An objective of the *Strategy* is to keep information on aquatic and riparian communities current by means of an appropriate monitoring program. As noted above, comprehensive monitoring of water quality, fish populations and aquatic macroinvertebrates has been undertaken in the ACT and is ongoing. Monitoring by community organisations may also make an important contribution e.g. Canberra Ornithologists Group's ten year woodland bird monitoring and monitoring of the annual honeyeater migration along the Murrumbidgee, Frogwatch and Waterwatch monitoring. A monitoring program aimed at understanding the long-term ecological effects of the January 2003 bushfires and the recovery of ecological communities and component species is a priority action (Table 6.1.1). This has already commenced (see s. 2.3.1).

RESEARCH

Scientific research, including that undertaken by honours and higher degree students, has made a significant contribution to knowledge about aquatic and riparian species, ecological communities and habitats. The *Strategy* encourages the continuation of such research effort, which might include the effects of, and recovery from, the January 2003 bushfires (Table 6.1.1).

5.3.3 Protection

Statutory protection of areas of high conservation value is a key aspect of conservation planning. As noted previously (s. 5.1.2) a high level of statutory protection currently exists for ACT rivers and riparian areas.

5.3.4 Management

It has been noted in s. 5.1 and s. 5.1.3 that the strengthening of management is the key issue for ACT rivers and riparian areas. Management of rivers and riparian zones has five main objectives (Williams 1993):

- to protect water quality from any damaging effects of pollution;
- to protect the quality of downstream waters;
- to minimise erosion of water courses;
- to maintain the biological diversity of aquatic and riparian biotas; and
- to provide aesthetically and ecologically acceptable recreational facilities.

The effects of past and continuing land and water uses mean that rehabilitation activities are likely to play a central role in management of rivers and riparian areas (see s. 5.5.2). Two particularly intractable problems are (a) the spread and naturalisation of alien fish species and pest plants (Georges and Cottingham 2002), and (b) re-establishing native species and communities in regulated rivers, especially as water needs continue to grow. Table 6.1.5 contains management objectives and actions for the *Strategy* as a whole. More specific actions are in sections 2.4, 3.3, 4.11 to 4.14.

General and detailed management objectives for specified values and for particular reserve areas are outlined in management plans for river corridors, Tidbinbilla Nature Reserve and Namadgi National Park (listed in s. 5.1.3). As noted in s. 1.7, this *Strategy* is not a management plan.

5.4

Planning and Conservation Issues for Rivers and Riparian Zones in the ACT

Table 5.1 contains a summary of planning and conservation issues and priority actions for defined river sections and riparian zones in the ACT. The river sections in Table 5.1 correspond to those in Table 2.2 and Table 4.2.

Table 5.1: River Sections and Riparian Zones: Planning and Conservation Issues and Actions

(Objectives and actions for the Strategy as a whole are outlined in Table 6.1 and provide the context for the identification of issues and actions for individual river sections and adjacent riparian zones in this table)

Current Planning and Management	Description (for more details see Tables 2.2 and 4.2)	Planning and Conservation Issues for Identified River Section and Riparian Zone	Priority Actions
<p>Murrumbidgee River (Murrumbidgee River Corridor (MRC)) (Special Requirements apply to the MRC and Lanyon Bowl Area under the <i>National Capital Plan</i>.)</p>			
<p>MU 1: Angle Crossing to Tharwa</p>			
<p>Territory Plan</p> <ul style="list-style-type: none"> ■ Gigerline Nature Reserve ■ Special Purpose Reserve (Tharwa) ■ Rural leasehold <p>Management MRC Management Plan 1998</p>	<p>Native vegetation cover has been cleared and altered through long history of pastoral use. Gigerline Gorge retains native vegetation. Streambed has been affected by deep sedimentation (sand and gravel). Most of section burnt in January 2003 bushfires.</p>	<p>Information</p> <p>(a) Lack of recent riparian vegetation survey.</p> <p>Threats</p> <p>(a) Illegal fishing for threatened species. (b) Weed invasion including willows. (c) Effects of uncontrolled riparian grazing including riverbank degradation. (d) Loss and continuing decline of in-stream fish/crayfish habitat especially through sedimentation (sand and gravel).</p> <p>Protection</p> <p>(a) Habitat for Pink-tailed Worm Lizard (<i>Aprasia parapulchella</i>).</p> <p>Management (Rehabilitation)</p> <p>(a) Loss and continuing decline of native riparian vegetation (including <i>Eucalyptus viminalis</i> Riparian Woodland). (b) Loss of native fish species.</p>	<p>Information</p> <p>(a) Undertake a survey of this section as part of a systematic vegetation survey of ACT riparian areas.</p> <p>Threats</p> <p>(a) Enforce the ACT fishing regulations. (b) Continue to undertake coordinated weed control based on weed control priorities. (c) Control grazing, including fencing out riparian areas where desirable. (d) Investigate and where feasible undertake in-stream restoration of degraded habitat.</p> <p>Protection</p> <p>(a) As part of management, ensure protection of the habitat of the Pink-tailed Worm Lizard (see s. 3.3.2 for specific actions).</p> <p>Management (Rehabilitation Activities)</p> <p>(a) Undertake actions to regenerate and restore native riparian vegetation (including <i>Eucalyptus viminalis</i> Riparian Woodland). (b) Monitor results of Trout Cod reinstatement in this section as a basis for future stocking.</p>
<p>MU 2: Tharwa to Point Hut Crossing</p>			
<p>Territory Plan</p> <ul style="list-style-type: none"> ■ Special Purpose Reserve (including Lanyon Landscape Conservation reserve) ■ Rural leasehold <p>Management MRC Management Plan 1998</p>	<p>The river passes through broad river flats cleared of their former woodland cover (area is now Lanyon Landscape Conservation Reserve). The river channel is shallow and infilled with sand.</p>	<p>Information</p> <p>(a) Lack of recent riparian vegetation survey.</p> <p>Threats</p> <p>(a) Illegal fishing for threatened species. (b) Weed invasion including willows. (c) Effects of uncontrolled riparian grazing including riverbank degradation. (d) Loss and continuing decline of in-stream fish/crayfish habitat especially through sedimentation (sand and gravel).</p> <p>Protection</p> <p>(a) Uncommon plants including <i>Discaria pubescens</i>.</p> <p>Management (rehabilitation)</p> <p>(a) Loss and continuing decline of native riparian vegetation (including <i>Eucalyptus viminalis</i> Riparian Woodland). (b) Point Hut Crossing barrier to fish movement.</p>	<p>Information</p> <p>(a) Undertake a survey of this section as part of a systematic vegetation survey of ACT riparian areas.</p> <p>Threats</p> <p>(a) Enforce the ACT fishing regulations. (b) Continue to undertake coordinated weed control based on weed control priorities. (c) Control grazing, including fencing out riparian areas where desirable. (d) Investigate and where feasible undertake in-stream restoration of degraded habitat. Investigate means to limit downstream sediment movement including potential for sand extraction</p> <p>Protection</p> <p>(a) As part of management, ensure protection of uncommon plants and habitat (see s. 2.4.2 for specific actions).</p> <p>Management (Rehabilitation Activities)</p> <p>(a) Undertake actions to regenerate and restore native riparian vegetation (including <i>Eucalyptus viminalis</i> Riparian Woodland). (b) Investigate, design and construct fish passage past Point Hut Crossing.</p>

Table 5.1: (Continued)

Current Planning and Management	Description (for more details see Tables 2.2 and 4.2)	Planning and Conservation Issues for Identified River Section and Riparian Zone	Priority Actions
MU 3: Point Hut Crossing to Kambah Pool			
<p>Territory Plan</p> <ul style="list-style-type: none"> ■ Special Purpose Reserve (Point Hut Crossing to Pine Island, Pine Island, Kambah Pool) ■ Bullen Range Nature Reserve (Pine Island to Kambah Pool) ■ Rural leasehold <p>Management MRC Management Plan 1998</p>	<p>There is a diversity of vegetation related to topography and past land use. <i>Callitris endlicheri</i> is common on rocky slopes. Section contains southern limit of <i>Casuarina cunninghamiana</i> in ACT. The open river valley changes to steep slopes and terraces and includes Red Rocks Gorge. Most of section burnt in January 2003 bushfires.</p> <p>Habitat of threatened <i>Muehlenbeckia tuggeranong</i>.</p>	<p>Information</p> <p>(a) Lack of recent riparian vegetation survey.</p> <p>Threats</p> <p>(a) Illegal fishing for threatened species. (b) Weed invasion including willows. (c) Urban impacts and recreational use. (d) Loss and continuing decline of in-stream fish/crayfish habitat especially through sedimentation (sand and gravel).</p> <p>Protection</p> <p>(a) Scenic values. (b) Raptor habitat (including nesting sites). (c) Threatened and uncommon plants (<i>Muehlenbeckia tuggeranong</i>, <i>Thesium australe</i>, <i>Discaria pubescens</i>, <i>Bossiaea bracteosa</i>). Snow Gum (<i>Eucalyptus pauciflora</i>) occurs near Red Rocks Gorge. (d) Habitat for Pink-tailed Worm Lizard (<i>Aprasia parapulchella</i>).</p> <p>Management (Rehabilitation)</p> <p>(a) Loss and continuing decline of native riparian vegetation.</p> <p>Planning</p> <p>(a) Potential impacts of any future urban development or provision of recreational facilities.</p>	<p>Information</p> <p>(a) Undertake a survey of this section as part of a systematic vegetation survey of ACT riparian areas.</p> <p>Threats</p> <p>(a) Enforce the ACT fishing regulations. (b) Continue to undertake coordinated weed control based on weed control priorities. (c) Manage recreational impacts in accordance with the <i>Murrumbidgee River Corridor Management Plan</i>. Maintain recreation at nodes with appropriately sited, low key linear walking trails along the river corridors. (d) Investigate and where feasible undertake in-stream restoration of degraded habitat. Investigate means to limit downstream sediment movement.</p> <p>Protection</p> <p>(a) Ensure protection of scenic values in accordance with the MRC Management Plan. (b) Ensure protection of raptor habitat through management of recreational use and other potentially harmful activities. (c) As part of management, ensure protection of threatened and uncommon plants and their habitat (see s. 2.4.1 and s.2.4.2 for specific actions). (d) As part of management, ensure protection of the habitat of the Pink-tailed Worm Lizard (see s. 3.3.2 for specific actions).</p> <p>Management (Rehabilitation Activities)</p> <p>(a) Undertake actions to regenerate and restore native riparian vegetation.</p> <p>Planning</p> <p>(a) Assess development proposals under relevant legislation, planning and management frameworks. Ensure that planning of recreational infrastructure recognises and protects river corridor values.</p>

Table 5.1: (Continued)

Current Planning and Management	Description (for more details see Tables 2.2 and 4.2)	Planning and Conservation Issues for Identified River Section and Riparian Zone	Priority Actions
MU 4: Kambah Pool to Cotter River Confluence/Casuarina Sands			
<p>Territory Plan</p> <ul style="list-style-type: none"> ■ Bullen Range Nature Reserve ■ Special Purpose Reserve (upslope areas on eastern side of Murrumbidgee R. above nature reserve) ■ Special Purpose Reserve (Cotter Reserve/Casuarina Sands) <p>Management MRC Management Plan 1998</p>	<p>The Bullen Range and steep valley slopes in this section have retained their vegetation cover, mainly dry forests, Callitris Pine woodland and shrublands. River Oaks and shrub vegetation dominate the riverbanks.</p> <p>This section was severely burnt in the January 2003 bushfires.</p>	<p>Information</p> <p>(a) Lack of recent riparian vegetation survey.</p> <p>Threats</p> <p>(a) Illegal fishing for threatened species. (b) Weed invasion including willows. (c) Loss and continuing decline of in-stream fish/crayfish habitat especially through sedimentation (sand and gravel).</p> <p>Protection</p> <p>(a) Uncommon plants including <i>Discaria pubescens</i>, <i>Desmodium brachypodium</i>, <i>Pomaderris pallida</i>. (b) Habitat for Pink-tailed Worm Lizard (<i>Aprasia parapulchella</i>).</p> <p>Management (Rehabilitation, Connectivity)</p> <p>(a) Post-fire recovery (January 2003 bushfires) of <i>Casuarina cunninghamiana</i> Riparian Woodland and <i>Callitris endlicheri</i> Woodland. (b) Maintaining and improving ecological connectivity through Cotter/Casuarina Sands recreation area.</p> <p>Planning</p> <p>(a) Potential impacts of provision of recreational facilities associated with recovery following January 2003 bushfires (see s. 5.3).</p>	<p>Information</p> <p>(a) Undertake a survey of this section as part of a systematic vegetation survey of ACT riparian areas.</p> <p>Threats</p> <p>(a) Enforce the ACT fishing regulations. (b) Continue to undertake coordinated weed control based on weed control priorities. (c) Investigate means to limit downstream sediment movement.</p> <p>Protection</p> <p>(a) As part of management, ensure protection of uncommon plants and their habitat (see s. 2.4.2 for specific actions). (b) As part of management, ensure protection of the habitat of the Pink-tailed Worm Lizard (see s. 3.3.2 for specific actions).</p> <p>Management (Rehabilitation Activities, Maintaining Connectivity)</p> <p>(a) Monitor post-fire recovery of <i>Casuarina cunninghamiana</i> Riparian Woodland and <i>Callitris endlicheri</i> Woodland. Evaluate means to assist recovery of the <i>Casuarina cunninghamiana</i> and <i>Callitris endlicheri</i> woodlands, if necessary. (b) Maintain and improve ecological connectivity through Cotter/Casuarina Sands recreation area in management of the area (see also Planning below).</p> <p>Planning</p> <p>(a) Assess development proposals under relevant legislation, planning and management frameworks. Ensure that planning of recreational infrastructure recognises and protects river corridor values. Give attention to maintaining and improving ecological connectivity through Cotter/Casuarina Sands recreation area in provision of recreational facilities associated with recovery following January 2003 bushfires.</p>

Table 5.1: (Continued)

Current Planning and Management	Description (for more details see Tables 2.2 and 4.2)	Planning and Conservation Issues for Identified River Section and Riparian Zone	Priority Actions
MU 5: Cotter River Confluence/Casuarina Sands to ACT/NSW border			
<p>Territory Plan</p> <ul style="list-style-type: none"> ■ Stony Creek Nature Reserve ■ Swamp Creek Nature Reserve ■ Woodstock Nature Reserve ■ Special Purpose Reserve (upslope areas above nature reserves) ■ Special Purpose Reserve (Uriarra Crossing) <p>Management MRC Management Plan 1998</p>	<p>The river passes through deeply dissected slopes cut from undulating terrain. Riverbanks and valley slopes are in parts densely vegetated with Tableland Shrubland (dominated by <i>Kunzea ericoides</i>) and emergent <i>Callitris endlicheri</i>. Dry forest is also common in this section. Riverine vegetation consists of <i>Casuarina cunninghamiana</i> with shrubs in rocky areas. This section was severely burnt in the January 2003 bushfires.</p>	<p>Information</p> <p>(a) Lack of recent riparian vegetation survey.</p> <p>Threats</p> <p>(a) Illegal fishing for threatened species. (b) Weed invasion including willows. (c) Loss and continuing decline of in-stream fish/crayfish habitat especially through sedimentation (sand and gravel).</p> <p>Protection</p> <p>(a) Uncommon plants including <i>Bossiaea bracteosa</i>. (b) Habitat for Pink-tailed Worm Lizard (<i>Aprasia parapulchella</i>). (c) Raptor habitat (including nesting sites).</p> <p>Management (Rehabilitation)</p> <p>(a) Post-fire recovery (January 2003 bushfires) of <i>Casuarina cunninghamiana</i> Riparian Woodland and <i>Callitris endlicheri</i> Woodland.</p>	<p>Information</p> <p>(a) Undertake a survey of this section as part of a systematic vegetation survey of ACT riparian areas.</p> <p>Threats</p> <p>(a) Enforce the ACT fishing regulations. (b) Continue to undertake coordinated weed control based on weed control priorities. (c) Investigate means to limit downstream sediment movement.</p> <p>Protection</p> <p>(a) As part of management, ensure protection of uncommon plants and their habitat (see s. 2.4.2 for specific actions). (b) As part of management, ensure protection of the habitat of the Pink-tailed Worm Lizard (see s. 3.3.2 for specific actions). (c) Ensure protection of raptor habitat through management of recreational use and other potentially harmful activities.</p> <p>Management</p> <p>(a) Monitor post-fire recovery of <i>Casuarina cunninghamiana</i> Riparian Woodland and <i>Callitris endlicheri</i> Woodland. Evaluate means to assist recovery of the <i>Casuarina cunninghamiana</i> Woodland, if necessary.</p>

Gudgenby River
(Tributaries: Naas and Orroral rivers)

(Special Requirements apply to the Namadgi National Park Area under the National Capital Plan. This 'Area' is the Park and adjacent areas in the Gudgenby and Cotter catchments.)

GU 1: In Namadgi NP			
<p>Territory Plan</p> <ul style="list-style-type: none"> ■ Namadgi National Park <p>Management Namadgi National Park Draft Management Plan 2005, Namadgi National Park Management Plan 1986</p>	<p>Open valley floors in the Naas–Gudgenby catchment contain grassy vegetation communities and limited areas of shrubland and wetland complexes. There is variable tree cover, from open forest to open woodland.</p>	<p>Information</p> <p>(a) Lack of recent riparian vegetation survey.</p> <p>Threats</p> <p>(a) Reestablishment of willows following major willow removal program.</p> <p>Protection</p> <p>(a) Uncommon plants including <i>Viola calejana</i>, <i>Discaria pubescens</i>.</p> <p>Management (Rehabilitation)</p> <p>(a) Post fire recovery (January 2003 bushfires) of riparian vegetation and habitat. (b) Restoration of native riparian vegetation and rehabilitation of habitat following willow removal.</p>	<p>Information</p> <p>(a) Undertake a survey of this section as part of a systematic vegetation survey of ACT riparian areas.</p> <p>Threats</p> <p>(a) As follow-up to willow removal programs, monitor willow regeneration and undertake removal if necessary.</p> <p>Protection</p> <p>(a) As part of management, ensure protection of uncommon plants and their habitat (see s. 2.4.2 for specific actions).</p> <p>Management (Rehabilitation Activities)</p> <p>(a) Monitor post-fire recovery of riparian vegetation and habitat, and evaluate means to assist recovery if necessary. (b) Undertake vegetation restoration and habitat rehabilitation following willow removal.</p>

Table 5.1: (Continued)

Current Planning and Management	Description (for more details see Tables 2.2 and 4.2)	Planning and Conservation Issues for Identified River Section and Riparian Zone	Priority Actions
GU 2: Namadgi NP to Murrumbidgee River			
<p>Territory Plan</p> <ul style="list-style-type: none"> ■ Special Purpose Reserve (possible Tennent Dam site) ■ Rural leasehold 	<p>Vegetation has been extensively modified by pastoral use. Native vegetation present in the steep, rocky valley of the Gudgenby River near Mt Tennent.</p>	<p>Information</p> <p>(a) Lack of recent riparian vegetation survey.</p> <p>Threats</p> <p>(a) Re-establishment of willows following major willow removal program.</p> <p>(b) Effects of uncontrolled riparian grazing including riverbank degradation.</p> <p>(c) Loss and continuing decline of instream fish/crayfish habitat especially through sedimentation (sand and gravel).</p> <p>Management (Rehabilitation)</p> <p>(a) Restoration of native riparian vegetation and rehabilitation of habitat following willow removal.</p>	<p>Information</p> <p>(a) Undertake a survey of this section as part of a systematic vegetation survey of ACT riparian areas.</p> <p>Threats</p> <p>(a) As follow-up to willow removal programs, monitor willow regeneration and undertake removal if necessary.</p> <p>(b) Control grazing, including fencing out riparian areas where desirable.</p> <p>(c) Investigate means to limit downstream movement of sediment including removal of sediment from this section.</p> <p>Management (Rehabilitation Activities)</p> <p>(a) Undertake vegetation restoration and habitat rehabilitation following willow removal.</p>
<p>Cotter River (Tributary: Paddys River)</p> <p>(Special Requirements apply to the Namadgi National Park Area under the <i>National Capital Plan</i>. This 'Area' is the Park and adjacent areas in the Gudgenby and Cotter catchments.)</p>			
CO 1: Paddys River (Tributary: Tidbinbilla River)			
<p>Territory Plan</p> <ul style="list-style-type: none"> ■ Tidbinbilla Nature Reserve ■ Rural leasehold ■ Plantation forestry <p>Management</p> <p>Tidbinbilla Nature Reserve Management Plan 1999</p>	<p>Vegetation has been substantially altered by pastoral use. Extensive pine plantation in lower reaches (destroyed in January 2003 bushfires). <i>Kunzea ericoides</i> has colonised valley slopes and there is a wide variety of weed species.</p>	<p>Information</p> <p>(a) Lack of recent riparian vegetation survey.</p> <p>Threats</p> <p>(a) Illegal fishing for threatened species.</p> <p>(b) Weed invasion (wide variety of weed species including willows).</p> <p>(c) Effects of uncontrolled riparian grazing including riverbank degradation.</p> <p>Protection</p> <p>(a) Uncommon plants including <i>Drabastrum alpestre</i>, <i>Pomaderris pallida</i>, <i>Bossiaea bracteosa</i>, <i>Thesium australe</i>.</p> <p>Management (Rehabilitation)</p> <p>(a) Loss and continuing decline of in-stream fish/crayfish habitat especially through sedimentation (effects of January 2003 bushfires, roads, forestry activities).</p> <p>(b) Degradation of riparian habitat (grazing, weeds, recreational use, forestry activities, erosion).</p> <p>(c) Potential for re-establishing threatened fish populations.</p> <p>Planning</p> <p>(a) Potential impacts of provision of recreational facilities associated with recovery following the January 2003 bushfires (see s. 5.3).</p>	<p>Information</p> <p>(a) Undertake a survey of this section as part of a systematic vegetation survey of ACT riparian areas.</p> <p>Threats</p> <p>(a) Enforce the ACT fishing regulations.</p> <p>(b) Continue to undertake coordinated weed control based on weed control priorities.</p> <p>(c) Control grazing, including fencing out riparian areas where desirable.</p> <p>Protection</p> <p>(a) As part of management, ensure protection of uncommon plants and their habitat (see s. 2.4.2 for specific actions).</p> <p>Management (Rehabilitation Activities)</p> <p>(a) Ensure all management activities incorporate measures to ensure erosion control and manage sedimentation into drainage lines and the river.</p> <p>(b) Investigate appropriate means to restore riparian habitat and incorporate into management activities.</p> <p>(c) Investigate appropriate techniques for re-establishing a viable Macquarie Perch population.</p> <p>Planning</p> <p>(a) Assess development proposals (including those associated with recovery following the January 2003 bushfires) under relevant legislation, planning and management frameworks. Ensure that planning of recreational infrastructure recognises and protects riverine and riparian values.</p>

Table 5.1: (Continued)

Current Planning and Management	Description (for more details see Tables 2.2 and 4.2)	Planning and Conservation Issues for Identified River Section and Riparian Zone	Priority Actions
CO 2: Cotter River (Headwaters to Corin Dam)			
<p>Territory Plan</p> <ul style="list-style-type: none"> ■ Namadgi National Park <p>Management</p> <p>Namadgi National Park Draft Management Plan 2005, Namadgi National Park Management Plan 1986</p>	<p>Vegetation of the river flats comprises open woodland, tussock grassland, wetland and bog communities</p> <p>Grassland areas may contain many weeds species. The majority of the streambed is narrow and shallow with dense fringing shrub vegetation. This area was moderately and patchily burnt in the January 2003 bushfires.</p>	<p>Information</p> <p>(a) Lack of recent riparian vegetation survey.</p> <p>Threats</p> <p>(a) Weeds (mainly weeds associated with previous pastoral use).</p> <p>(b) Pressure for recreational fishing access.</p> <p>(c) Threat to Two-spined Blackfish from potential introduction of Brown Trout.</p> <p>Protection</p> <p>(a) Uncommon plants including <i>Discaria pubescens</i>, <i>Blechnum fluviatile</i>.</p> <p>(b) Threatened fish species (Two-spined Blackfish).</p> <p>(c) Cotter River form of the Leaf-green Tree Frog (<i>Litoria nudidigitus</i>).</p> <p>(d) Maintenance of status of Cotter Catchment as free of EHN virus.</p> <p>Management (Rehabilitation)</p> <p>(a) Post fire recovery (January 2003 bushfires) of riparian vegetation and habitat and aquatic fauna. Erosion and sedimentation following the fires.</p> <p>(b) Need to establish additional populations of Macquarie Perch to spread risk.</p>	<p>Information</p> <p>(a) Undertake a survey of this section as part of a systematic vegetation survey of ACT riparian areas.</p> <p>Threats</p> <p>(a) Monitor weed presence and undertake weed control as required, based on weed control priorities.</p> <p>(b) Maintain this section as Prohibited Waters for recreational fishing and continue current limits on access (no public vehicle access).</p> <p>(c) As above.</p> <p>Protection</p> <p>(a) As part of management, ensure protection of uncommon plants and their habitat (see s. 2.4.2 for specific actions).</p> <p>(b) As part of management, ensure protection of threatened fish species and their habitat, including protection from alien fish species.</p> <p>(c) As part of management, ensure protection of the habitat of the Cotter River form of the Leaf-green Tree Frog (see s. 3.3.3 for specific actions for uncommon species).</p> <p>(d) Maintain this section as Prohibited Waters for recreational fishing, which is the most effective means of avoiding accidental introduction.</p> <p>Management (Rehabilitation Activities)</p> <p>(a) Monitor post-fire recovery of aquatic fauna, riparian vegetation, riverine and riparian habitat. Evaluate means to assist recovery, if necessary. Take action to control ongoing erosion and sedimentation problems at particular sites, if necessary.</p> <p>(b) Investigate techniques for establishing a Macquarie Perch population.</p>
CO 3: Cotter River (Below Corin Dam to Bendora Dam)			
<p>Territory Plan</p> <ul style="list-style-type: none"> ■ Namadgi National Park <p>Management</p> <p>Namadgi National Park Management Plan 1986</p>	<p>Dry sclerophyll and wet sclerophyll forest communities characteristic of higher altitude valley areas usually extend down to the river. Above Bendora Dam the streambed is narrow, shallow and rocky, fringed by shrubby vegetation, below steep valley sides. This area was severely burnt in the January 2003 bushfires.</p>	<p>Information</p> <p>(a) Lack of recent riparian vegetation survey.</p> <p>Threats</p> <p>(a) For aquatic species, altered streamflow patterns and thermal pollution.</p> <p>(b) Pressure for recreational fishing access.</p> <p>(c) Threat to Two-spined Blackfish, Trout Cod and Macquarie Perch from potential introduction of Brown Trout.</p> <p>Protection</p> <p>(a) Threatened fish species (Two-spined Blackfish, Trout Cod and Macquarie Perch).</p> <p style="text-align: right;"><i>(Continues next page)</i></p>	<p>Information</p> <p>(a) Undertake a survey of this section as part of a systematic vegetation survey of ACT riparian areas.</p> <p>Threats</p> <p>(a) Maintain environmental flows and keep under review.</p> <p>(b) Maintain this section as Prohibited Waters for recreational fishing.</p> <p>(c) As above.</p> <p>Protection</p> <p>(a) As part of management, ensure protection of threatened fish species and their habitat, including protection from alien fish species.</p> <p style="text-align: right;"><i>(Continues next page)</i></p>

Table 5.1: (Continued)

Current Planning and Management	Description (for more details see Tables 2.2 and 4.2)	Planning and Conservation Issues for Identified River Section and Riparian Zone	Priority Actions
CO 3: Cotter River (Below Corin Dam to Bendora Dam) (continued)			
		<p>Protection (continued)</p> <ul style="list-style-type: none"> b) Maintenance of status of Cotter catchment as free of EHN Virus. c) Cotter River form of the Leaf-green Tree Frog (<i>Litoria nudidigitus</i>). <p>Management (Rehabilitation)</p> <ul style="list-style-type: none"> (a) Post fire recovery (January 2003 bushfires) of riparian vegetation and habitat and aquatic fauna. Erosion and sedimentation following the fires. 	<p>Protection (continued)</p> <ul style="list-style-type: none"> (b) Maintain this section as Prohibited Waters for recreational fishing, which is the most effective means of avoiding accidental introduction. Also highlight potential threat from inter-Basin water transfers. (c) As part of management, ensure protection of the habitat of the Cotter river form of the Leaf-green Tree Frog (see s. 3.3.3 for specific actions for uncommon species). <p>Management (Rehabilitation Activities)</p> <ul style="list-style-type: none"> (a) Monitor post-fire recovery of aquatic species, riparian vegetation, riverine and riparian habitat. Evaluate means to assist recovery, if necessary. Take action to control ongoing erosion and sedimentation problems at particular sites, if necessary.
CO 4: Cotter River (Below Bendora Dam to Cotter Dam)			
<p>Territory Plan</p> <ul style="list-style-type: none"> ■ Namadgi National Park ■ Special Purpose Reserve (upstream from Cotter Dam to boundary of Namadgi National Park) <p>Management</p> <p>Namadgi National Park Draft Management Plan 2005</p> <p>Lower Cotter Catchment: Draft Strategic Management Plan 2006</p>	<p>Below Bendora Dam, dry forest and variable shrub cover occupies the river valley. Above Cotter Dam, the riparian vegetation is flanked by pine plantation. This was destroyed in the January 2003 bushfires when the area was severely burnt.</p> <p>In 2006 the ACT Government determined that there would be a change in land use for the Lower Cotter Catchment from pine plantation to catchment protection for water supply, with native vegetation cover (natural regeneration and planting) (ACT Government 2006).</p>	<p>Information</p> <ul style="list-style-type: none"> (a) Lack of recent riparian vegetation survey. <p>Threats</p> <ul style="list-style-type: none"> (a) Weeds. (b) For aquatic species, altered flow patterns, thermal pollution. (c) Barriers to fish passage (road crossings). (d) Pressure for recreational fishing and other recreational access to Cotter Reservoir. (e) Cormorant predation (Macquarie Perch) in Cotter Reservoir. (f) Potential introduction of alien fish species (Redfin Perch, Carp). (g) Water extraction from Cotter Reservoir. (h) Sedimentation resulting from the effects of the January 2003 bushfires. <p>Protection</p> <ul style="list-style-type: none"> (a) Threatened fish and crayfish species (Trout Cod, Macquarie Perch and Murray River Crayfish). (b) Maintenance of status of Cotter catchment as free of EHN virus. <p>Management (Rehabilitation)</p>	<ul style="list-style-type: none"> (a) Undertake a survey of this section as part of a systematic vegetation survey of ACT riparian areas. <p>Threats</p> <ul style="list-style-type: none"> (a) Continue to undertake coordinated weed control based on weed control priorities. (b) Maintain environmental flows and keep under review. (c) Identify barriers to fish passage and rectify. Ensure new crossings are designed to allow fish passage. (d) Maintain closure of Cotter Reservoir to fishing and other water based recreational use. Do not stock fish for recreational purposes. (e) Encourage research into effects of cormorant predation, and if desirable, means to limit impacts. (f) Maintain closure of Cotter Reservoir to fishing and other water based recreational use. (g) Liaise with ACTEW regarding the impacts on aquatic fauna of future water supply options (for more detail see s. 4.12.2 and s. 4.12.4). (h) Encourage research into sediment delivery and movement. <p>Protection</p> <ul style="list-style-type: none"> (a) As part of management, ensure protection of threatened fish species and their habitat, including protection from alien fish species. (b) Maintain Cotter Reservoir as Prohibited Waters for recreational fishing, which is the most effective means of avoiding accidental introduction. Discourage inter-Basin water transfers <p>Management (Rehabilitation Activities)</p>
<i>(Continues next page)</i>			<i>(Continues next page)</i>

Table 5.1: (Continued)

Current Planning and Management	Description (for more details see Tables 2.2 and 4.2)	Planning and Conservation Issues for Identified River Section and Riparian Zone	Priority Actions
CO 4: Cotter River (Below Bendora Dam to Cotter Dam) (continued)			
		<p>(a) Post-fire recovery (January 2003 bushfires) of riparian vegetation and habitat. Erosion and sedimentation following the fires.</p> <p>Information</p>	<p>(a) Monitor post-fire recovery of aquatic species, riparian vegetation, riverine and riparian habitat. Evaluate means to assist recovery, if necessary. Take action to control ongoing erosion and sedimentation problems at particular sites, if necessary.</p> <p>(b) Ensure ecological integrity is maintained in undertaking native revegetation in former pine plantation areas in the riparian zone. This involves protection of natural regeneration, weed control and restoration with appropriate species sourced from seed of local provenance.</p>
CO 5: Cotter River (Below Cotter Dam to Murrumbidgee River)			
<p>Territory Plan</p> <ul style="list-style-type: none"> ■ Special Purpose Reserve 	<p>Native riparian vegetation in this area has been largely replaced by planted exotic species. <i>Casuarina cunninghamiana</i> lines the streambed and there is native shrub cover near the confluence with Murrumbidgee River confluence. Many of the <i>Casuarinas</i> were severely burnt in the January 2003 bushfires.</p>	<p>Information</p> <p>(a) Lack of recent riparian vegetation survey.</p> <p>(b) Lack of information on status of threatened fish and crayfish.</p> <p>Threats</p> <p>(a) Weeds.</p> <p>(b) For aquatic species, altered flow patterns, thermal pollution.</p> <p>(c) Barriers to fish passage (weirs and fish passage to Paddys River).</p> <p>Protection</p> <p>(a) Uncommon plants including <i>Pomaderris pallida</i>.</p> <p>(b) Threatened fish and crayfish species (Macquarie Perch, Murray Cod, Silver Perch, Murray River Crayfish).</p> <p>Management (Recreational Use and Rehabilitation)</p> <p>(a) Recreational use of the area.</p> <p>(b) Post-fire recovery (January 2003 bushfires) of riparian vegetation and habitat and aquatic fauna. Erosion and sedimentation following the fires.</p> <p>Planning</p> <p>(a) Potential impacts of provision of recreational facilities associated with recovery following January 2003 bushfires (see s. 5.3).</p>	<p>Information</p> <p>(a) Undertake a survey of this section as part of a systematic vegetation survey of ACT riparian areas.</p> <p>(b) Instigate monitoring of Macquarie Perch and Murray River Crayfish.</p> <p>Threats</p> <p>(a) Continue to undertake coordinated weed control based on weed control priorities.</p> <p>(b) Maintain environmental flows and keep under review.</p> <p>(c) Identify barriers to fish passage and rectify. Evaluate means to open fish passage to Paddys River.</p> <p>Protection</p> <p>(a) As part of management, ensure protection of uncommon plants and their habitat (see s. 2.4.2 for specific actions).</p> <p>(b) As part of management, ensure protection of threatened fish species and their habitat.</p> <p>Management (Recreational Use and Rehabilitation Activities)</p> <p>(a) Manage recreational use to minimise impacts on the riverine environment.</p> <p>(b) Monitor post-fire recovery of riparian vegetation and riverine and riparian habitat. Evaluate means to assist recovery, if necessary. Take action to control ongoing erosion and sedimentation problems at particular sites, if necessary.</p> <p>Planning</p> <p>(a) Assess development proposals (including those associated with recovery following the January 2003 bushfires) under relevant legislation, planning and management frameworks. Ensure that planning of recreational infrastructure recognises and protects riverine and riparian values.</p>

Table 5.1: (Continued)

Current Planning and Management	Description (for more details see Tables 2.2 and 4.2)	Planning and Conservation Issues for Identified River Section and Riparian Zone	Priority Actions
Molonglo River			
<i>(Special Requirements apply to the Molonglo River Corridor under the National Capital Plan.)</i>			
MO 1: Burbong to Blue Tiles (Immediately Upstream of Molonglo Gorge)			
<p>Territory Plan</p> <ul style="list-style-type: none"> ■ Nature Reserve ■ Rural leasehold ■ Pine plantation 	<p>Native vegetation in this section has been affected by previous pastoral use and the establishment of adjacent pine plantations. There is some remnant woodland.</p>	<p>Information</p> <p>(a) Lack of recent riparian vegetation survey.</p> <p>Threats</p> <p>(a) Willows and other weeds. (b) Heavy metal pollution in the river from the former Captains Flat mine potentially limits opportunities to re-establish aquatic fauna. (c) Potential invasion by alien fish (Redfin Perch, Carp) from downstream.</p> <p>Management</p> <p>(a) Ecological connectivity through pine plantation areas. (b) Need to establish additional populations of Macquarie Perch to spread risk.</p> <p>Planning</p> <p>(a) Potential urban edge effects (if urban development occurs in Kowen).</p>	<p>Information</p> <p>(a) Undertake a survey of this section as part of a systematic vegetation survey of ACT riparian areas.</p> <p>Threats</p> <p>(a) Continue to undertake coordinated weed control based on weed control priorities. (b) Investigate feasibility and techniques for re-establishing Macquarie Perch. (c) Instigate monitoring for Carp and Redfin Perch.</p> <p>Management</p> <p>(a) Seek to ensure that ecological connectivity is maintained and improved along the riparian zone in pine plantation areas. (b) Investigate techniques for establishing a Macquarie Perch population.</p> <p>Planning</p> <p>(a) Assess development proposals under relevant legislation, planning and management frameworks. Ensure that planning of recreational infrastructure recognises and protects river corridor values.</p>
MO 2: Molonglo Gorge to Lake Burley Griffin			
<p>Territory Plan</p> <ul style="list-style-type: none"> ■ Special Purpose Reserve ■ Rural leasehold ■ Other leasehold 	<p>The steep, rocky slopes of Molonglo Gorge support dry forest with <i>Callitris</i> and a scattered shrub understorey. Below Molonglo Gorge there are some isolated stands of <i>Casuarina luehmannii</i> and native shrubs. However, willows and other weed species dominate most of the riparian environment down to Lake Burley Griffin.</p>	<p>Information</p> <p>(a) Lack of recent riparian vegetation survey.</p> <p>Threats</p> <p>(a) Willows and other weeds. (b) Poor water quality in Molonglo River and macroinvertebrate sampling that indicates severely impaired stream condition. (c) Illegal fishing for threatened species.</p> <p>Management</p> <p>(a) Riparian ecological connectivity.</p> <p>Planning</p> <p>(a) Potential urban edge effects on Molonglo Gorge area (if urban development occurs in Kowen) and urban/industrial edge effects at Fyshwick.</p>	<p>Information</p> <p>(a) Undertake a survey of this section as part of a systematic vegetation survey of ACT riparian areas.</p> <p>Threats</p> <p>(a) Continue to undertake coordinated weed control based on weed control priorities. (b) Investigate reasons for poor water quality and impoverished macroinvertebrate assemblages in the Molonglo River. (c) Enforce ACT fishing regulations.</p> <p>Management</p> <p>(a) Undertake riparian habitat rehabilitation including that following removal of willows.</p> <p>Planning</p> <p>(a) Assess development proposals under relevant legislation, planning and management frameworks to ensure river corridor values are recognised in planning and the river corridor is given appropriate protection in physical planning. Ensure that planning of recreational infrastructure recognises and protects river corridor values.</p>

Table 5.1: (Continued)

Current Planning and Management	Description (for more details see Tables 2.2 and 4.2)	Planning and Conservation Issues for Identified River Section and Riparian Zone	Priority Actions
MO 3: Scrivener Dam to Coppins Crossing			
<p>Territory Plan</p> <ul style="list-style-type: none"> ■ Urban Open Space (Scrivener Dam to Tuggeranong Parkway) ■ Special Purpose Reserve (Tuggeranong Parkway to Coppins Crossing) ■ Rural leasehold 	<p>Riparian vegetation in this section is highly modified with only fragments of native vegetation remaining. There is dense woody weed growth below Scrivener Dam.</p>	<p>Information</p> <ul style="list-style-type: none"> (a) Lack of recent riparian vegetation survey. (b) Lack of information on fish species and platypus <p>Threats</p> <ul style="list-style-type: none"> (a) Willows and other weeds (including wide range of woody weeds). (b) Poor water quality (bottom discharge from Scrivener Dam). (c) Poor water quality from Yarralumla and Weston creeks (stormwater flows from highly urbanised catchment, gross pollutant traps at downstream end of concrete channels are the only treatment). <p>Management</p> <ul style="list-style-type: none"> (a) Management responsibility for the section is not defined and there is lack of active management based on a management plan. (b) Riparian ecological connectivity. <p>Planning</p> <ul style="list-style-type: none"> (a) Potential urban edge effects related to new urban development of Molonglo. 	<p>Information</p> <ul style="list-style-type: none"> (a) Undertake a survey of this section as part of a systematic vegetation survey of ACT riparian areas. (b) Undertake survey of fish and platypus. <p>Threats</p> <ul style="list-style-type: none"> (a) Undertake coordinated weed control based on weed control priorities. (b) NCA is reviewing environmental flow requirements for Lake Burley Griffin. (c) Water quality management plan is being prepared for Molonglo Valley, Woden valley and Weston Creek (ACTPLA). <p>Management</p> <ul style="list-style-type: none"> (a) Identify management responsibility, prepare a management plan and undertake management activities. (b) Undertake riparian habitat rehabilitation including that following removal of willows. <p>Planning</p> <ul style="list-style-type: none"> (a) Assess development proposals under relevant legislation, planning and management frameworks to ensure river corridor values are recognised in planning and the river corridor is given appropriate protection in physical planning including any appropriate adjustments to statutory and/or management boundaries. Ensure that planning of recreational infrastructure recognises and protects river corridor values.

Table 5.1: (Continued)

Current Planning and Management	Description (for more details see Tables 2.2 and 4.2)	Planning and Conservation Issues for Identified River Section and Riparian Zone	Priority Actions
MO 4: Coppins Crossing to Murrumbidgee River			
<p>Territory Plan</p> <ul style="list-style-type: none"> ■ Lower Molonglo River Corridor Nature Reserve <p>Management</p> <p>Lower Molonglo River Corridor Management Plan 2001</p>	<p>Protected in the gorge environment, vegetation in this section of the river displays high floristic diversity. Weeds typical of the ACT riparian zone are also found in this section.</p>	<p>Information</p> <p>(a) Lack of recent riparian vegetation survey.</p> <p>Threats</p> <p>(a) Willows and other weeds. (b) Barrier to Murray River Crayfish and Golden Perch movement from LMWQCC discharge.</p> <p>Protection</p> <p>(a) Threatened fish and crayfish species (Murray Cod, Macquarie Perch (historical presence in lower section), Murray River Crayfish). (b) Uncommon plants including <i>Bossiaea bracteosa</i>, <i>Pomaderris pallida</i>, <i>Desmodium brachypodium</i>, <i>Adiantum hispidulum</i>. (c) Habitat for Pink-tailed Worm Lizard (<i>Aprasia parapulchella</i>). (d) Raptor habitat (including nesting sites).</p>	<p>Information</p> <p>(a) Undertake a survey of this section as part of a systematic vegetation survey of ACT riparian areas.</p> <p>Threats</p> <p>(a) Undertake coordinated weed control based on weed control priorities. (b) Investigate translocation of Murray River Crayfish past discharge zone</p> <p>Protection</p> <p>(a) As part of management, ensure protection of threatened fish/crayfish and their habitat. (b) As part of management, ensure protection of uncommon plants and their habitat (see s. 2.4.2 for specific actions). (c) As part of management, ensure protection of the habitat of the Pink-tailed Worm Lizard (see s. 3.3.2 for specific actions). (d) Ensure protection of raptor habitat through management of recreational use and other potentially harmful activities.</p> <p>Planning</p> <p>(a) Assess development proposals under relevant legislation, planning and management frameworks to ensure river corridor values are recognised in planning and the river corridor is given appropriate protection in physical planning including any appropriate adjustments to statutory and/or management boundaries. Ensure that planning of recreational infrastructure recognises and protects river corridor values.</p>

Notes:

1. **Conservation** means all the processes and actions of looking after a place so as to retain its natural significance and always includes protection, maintenance and monitoring. Conservation may, according to circumstance, also include regeneration, restoration, enhancement, reinstatement, preservation or modification, or a combination of all these. Conservation includes conserving natural processes of change (as opposed to artificially accelerated change) (AHC 2002).
2. **Public Land Category and Management Objectives (adapted from Schedule 1 of the Land (Planning and Environment) Act 1991)**

Wilderness Area	(Management Objectives: Conservation of the natural environment and restricted public use)
National Park	(Management Objectives: Conservation of the natural environment and public use for recreation, education, research)
Nature Reserve	(Management Objectives: Conservation of the natural environment and public use for recreation, education, research)
Special Purpose Reserve	(Management Objectives: Public and community use for recreation and education)
Urban Open Space	(Management Objectives: Public and community use)

5.5

Management of Rivers and Riparian Zones for Conservation

5.5.1 Best Practice Management and Adaptive Management

The goals of this *Strategy* involve both the conservation of aquatic and riparian flora and fauna species and ecological communities, and the management and rehabilitation of habitats (Table 6.1). Management that is regarded by experts in a particular field to be of the highest standards at the time is termed 'best practice management'. In the context of biodiversity conservation, best practice management is that which promotes biodiversity and healthy ecosystem function. It is underpinned by monitoring and research, that assist in providing up to date information about the biodiversity effects of different management practices. The concept is discussed in more detail in ACT Government (2004a; 2005a).

Adaptive management has been defined as 'the systematic process for continually improving management policies and practices by learning from the outcomes of operational programs' (ACT Government 2006b). Adaptive management is an approach that recognises that management actions should be undertaken, even though many uncertainties remain because of lack of knowledge. Adaptive management requires clearly defined objectives based on current knowledge, rigorous review of the outcomes of actions, and subsequent change or refinement of management actions. Adaptive management is to varying degrees, experimental. For more detail see ACT Government (2004a; 2005a).

5.5.2 Conservation of Aquatic and Riparian Habitat

Conservation of aquatic and riparian habitats and ecological communities is a major national environmental issue about which there is a substantial literature, as well as national and state policies, management plans, recovery plans and a wide range of programs and activities. These provide a context for this *Strategy*, but it is beyond the scope of this *Strategy* to review them in detail. For an introduction and overview at the national level, see:

- (a) (Commonwealth) Department of Environment and Heritage <<http://www.deh.gov.au.html>>
- (b) *Overview of the Australian Government's Natural Resource Management Initiatives: Protecting, Conserving, Repairing* (Australian Government 2004). This briefly outlines two major national

initiatives: the Natural Heritage Trust and the National Action Plan for Salinity and Water Quality. <<http://www.nrm.gov.au/publications/nrm-overview/index.html>>

- (c) Murray–Darling Basin Commission (particularly the Native Fish Strategy 2003–2013 (MDBC 2004a)). <<http://www.mdbc.gov.au>>

The need to improve the management of rivers and riparian zones is made clear by two comprehensive nationwide assessments: the *Australian Catchment, River and Estuary Assessment 2002* (Commonwealth of Australia 2002a), and the *Australian Terrestrial Biodiversity Assessment 2002* (Commonwealth of Australia 2002b).

The primary task of the Assessment of River Condition (ARC) was to assess the aggregate impacts of resource use on rivers and identify the priority management challenges for their maintenance or improvement. The two main components of the ARC are features of the environment (ARC_E) and the aquatic biota (ARC_B). The ARC_E is made up of four indices: the Catchment Disturbance Index, the Hydrological Disturbance Index, the Habitat Index and the Nutrient and Suspended Sediment Index (Norris *et al.* 2001).

Nation-wide, the river assessments collated and interpreted data for about 14 000 river reaches across the more intensively used catchments. The assessments showed impaired aquatic biota (one-third of river lengths); significant modification of environmental features (85% of river lengths); modified habitat, mainly changes to sediment loads (more than half of river lengths); and increased nutrient (mainly phosphorus) and suspended sediment loads (over 90% of reaches with 33% substantially modified). In summarising management priorities, the rivers assessment noted that rivers with the most urgent need for rehabilitation and strategic management included parts of the Murray–Darling Basin. These rivers generally have highly modified catchments, are subject to high nutrients and suspended sediment loads, have lost much of their riparian vegetation, and have dams and levees that disrupt the movement of biota and material into, along and from the river. River reaches with habitat severely modified by dams need protection and restoration of environmental flows and fish passage.

Summary assessment of river condition in the ACT according to the two ARC indices is shown in Table 5.2. Thirty-six per cent of the river length assessed in the ACT had damaged biological communities, with 29% of the river length assessed as being in significantly impaired condition, indicating that

Table 5.2: Assessment of River Condition in the ACT Under the National Land and Water Resources Audit

Indices	Total Length of Reach in Each Category and Percentage of Total			
	Reference	Significantly Impaired	Severely Impaired	Extremely Impaired
ARC_B (aquatic biota)	169 km 64%	76 km 29%	17 km 7%	0 0
ARC_E (environmental features)	Largely Unmodified	Moderately Modified	Substantially Modified	Severely Modified
	43 km 16%	191 km 71%	36 km 13%	0 0

(Source: Norris *et al.* 2001, p. 57)

ARC_B contains data for 97% (262 km) of ACT stream lengths used in the audit.

ARC_E contains data for 100% (270 km) of ACT stream lengths used in the audit.

20–50 per cent of the different kinds of animals expected to occur have been lost from these communities. The Audit concludes that the key issues affecting ACT rivers are changes to all aspects of the hydrological regime including substantial changes to the quantity, timing and duration of flow. High loads of total phosphorus and elevated levels of suspended solids are also problems for ACT rivers (Norris *et al.* 2001, p. 56).

The *Terrestrial Biodiversity Assessment* based on bioregions and subregions across the continent (IBRA 5.1 (Environment Australia 2000)) also reported on riparian zones. The assessment concluded that:

- The condition of riparian zones is degraded (meaning recovery is unlikely in the medium term) across much of southern and eastern Australia (31% of subregions assessed) and an additional number require significant management intervention to achieve recovery (38% of subregions assessed);
- The trend for riparian zones is declining significantly across much of Australia (73% of subregions assessed).

The ACT is located in a broad area of south-eastern Australia where the average condition of riparian zones is categorised as *degraded* and the trend is *declining*. The six major threats are: overgrazing, exotic weeds, changed hydrology, increased fragmentation, feral animals and changed fire regimes. All of these are threats in the South Eastern Highlands Region (IBRA) of which the ACT is part.

Aquatic and riparian habitat conservation may involve management actions to:

- improve water quality;
- maintain or restore flow regimes;
- improve connectivity;

- control threatening processes (e.g. wildfire, weeds, stock grazing);
- restore, regenerate or reinstate vegetation communities or component species of those communities; and
- repair land degradation (e.g. erosion gullies in tributary creeks).

Rehabilitation may be undertaken in a variety of ways and with varying degrees of human intervention. The cost, experimentation needed (and consequent potential for failures), lack of knowledge of appropriate techniques, and the scale and difficulty of reversing detrimental habitat changes illustrate the benefit of maintaining existing good quality habitat (for a case study of a fish habitat rehabilitation project, see s. 4.12.3 and Lintermans 2004b).

Riparian rehabilitation projects in the ACT have included removal of problem willow species (e.g. Ginninderra Creek, Yarralumla Creek, Gudgenby River, Molonglo River and many other areas), soil conservation work in the catchment of Lake Burley Griffin between 1965 and 1998 focused in the last decade on stabilisation of connected gullies (NSW DLWC 2000), and preparation of a Sullivan’s Creek Catchment Management Plan included in which is the construction of small wetlands in O’Connor associated with urban redevelopment and water sensitive urban design. Rehabilitation of connecting creeks is an important component of aquatic and riparian habitat conservation. A major rehabilitation project is proposed for the former pine plantation areas of the Lower Cotter Catchment, given the change in land use focus to catchment protection for water supply (ACT Government 2006b).

Conservation actions for the recovery of native ecological communities may involve regeneration, restoration or reinstatement that represent

progressively greater degrees of human intervention. Definitions adopted for this *Strategy* are from the *Australian Natural Heritage Charter*, 2nd Edit. (AHC 2002).

- *Regeneration* means the natural recovery of natural integrity following disturbance or degradation.

Regeneration is essentially dependent on natural processes facilitating recovery from disturbance or degradation. It does not include physical intervention, but should be accompanied by monitoring and protection measures that do not create degradation (e.g. fencing of vegetation, prohibition on take of fish/crayfish species). Examples of regeneration in ACT rivers and riparian areas include some recovery of crayfish populations in the Murrumbidgee River following overfishing, and vegetation regrowth in riparian areas following the January 2003 bushfires, including in former pine plantation areas in the Lower Cotter Catchment. In many instances, environments have been so altered that regeneration cannot occur without some physical intervention e.g. weed control in riparian areas, removal of stock grazing, and *reinstatement* of fish species past barriers with the aim of establishing self-supporting populations.

- *Restoration* means returning existing habitats to a known past state or to an approximation of the natural condition by repairing degradation, by removing introduced species or by reinstatement.

A restoration process implies sufficient evidence of an earlier state to guide the conservation process. While historical and other records, the presence of remnant plant and/or animal species and ecological communities, modelling, and the existence of sites that appear relatively undisturbed provide some guidance, the actual species composition of pre-European ecological communities is unknown or uncertain. Restoration activities, consistent with the natural significance of the place, should therefore be focussed on maintaining and improving the native biological diversity of the site and improving its overall condition (Kirkpatrick *et al.* 1995, p. 87). Vegetation restoration may require weed control, direct seeding or planting with species currently growing or known to have grown in the area. Restoration of aquatic habitat includes removing barriers to fish passage (e.g. the construction of the rock-ramp fishway at Vanities Crossing in the ACT) and returning important in-stream features (e.g. snags and deep pools (see Lintermans (2004b) for an experiment in the ACT near Tharwa)).

- *Reinstatement* means to introduce to a place one or more species or elements of habitat or geodiversity that are known to have existed there naturally at a previous time, but that can no longer be found at that place.

Reinstatement is unlikely to be part of native vegetation management except on a very small scale or for particular purposes. While there is clearly a role for restoration of existing remnants that might include some specific reinstatement, large-scale expansion or 're-creation' of native vegetation communities is not feasible with current knowledge, funding and technology. This is particularly the case for understorey and groundcover species. It is now well established that vegetation restoration activities should aim to consolidate least disturbed areas and work outwards from these (see ACT Government 2004a (s. 5.9.3); ACT Government 2005a (s. 3.7.3)).

With regard to native fish, reinstatement of species that have experienced dramatic population decline is undertaken in the ACT for recreational, ecosystem function and conservation purposes (ACT Government 2000). Experimental reinstatement of hatchery bred Trout Cod has been undertaken in Bendora Reservoir and the Murrumbidgee River. There is also scope to translocate individuals from existing fish populations past natural or artificial barriers (e.g. Macquarie Perch in the Queanbeyan River above Googong Reservoir past a waterfall to upstream sections of the river in the Silver Hills area) (see s. 4.4.2 and s. 4.12.8). Monitoring is required to evaluate the results of these management actions.

5.6

Management Issues

This section identifies important management issues for aquatic and riparian species, the rivers and riparian areas that are the focus of this *Strategy*. This is not intended to be exhaustive and complements discussion of management issues for:

- watercourses and riparian areas in grassy woodlands generally (see, for example, MacLeod 2002a);
- the Murray–Darling Basin as a whole (e.g. the *Native Fish Strategy* (MDBC 2004a));
- the Murrumbidgee River catchment (Murrumbidgee Catchment Management Board 2003); and
- ACT rivers and riparian areas covered by management plans (s. 5.1.3), which effectively identify a wide range of management issues (though they are not categorised as such).

5.6.1 Management Plans

The lack of statutory management plans for some Public Land areas of the rivers and riparian zones has been referred to previously (s. 5.1.3).

- It is an objective of this *Strategy* that management plans are prepared for all Public Land areas of the rivers and riparian zones (Table 6.1.5).

5.6.2 Management Responsibility

The lack of active management of sections of the river corridors (in particular, the Molonglo River near Fyshwick and from below Scrivener Dam to Coppins Crossing) has been referred to previously (s. 5.1.3).

- It is an objective of this *Strategy* that management responsibility is established for the Molonglo River adjacent to Fyshwick and below Scrivener Dam to Coppins Crossing, and rehabilitation programs based on management plans are undertaken (Table 6.1.5).

5.6.3 Vegetation and Fauna Surveys

As noted in s. 5.3.2, there are deficiencies in the knowledge of species and ecological communities in the rivers and riparian zones. Surveys and regular monitoring have established a good understanding of the status of fish and the Murray River Crayfish, but information on other species and communities is more variable. Riparian areas have not been the subject of a systematic vegetation survey. Existing information sources are included with the descriptions of vegetation communities in s. 2.2.

Vegetation communities in the riparian zone are included in a current review of the classification of ecological communities in the ACT (Table 2.1). Future surveys in the riparian zone will assist in refining this classification, as well as providing more detailed information on component species, condition, ecology and habitat values.

- It is an objective of this *Strategy* that the type, location and condition of all aquatic and riparian ecological communities in the ACT are described and the information kept current by means of an appropriate monitoring program (Table 6.1.1).
 - Within this overall objective, a survey program should be prepared and undertaken in a strategic manner, giving priority initially to (a) areas under most threat from current or proposed land uses or activities, (b) areas of high use, (c) areas where data is the most deficient.

5.6.4 Stock Grazing: Protecting Riparian Zones

The importance of the rivers and riparian zones in the rural economy before and after the establishment of the Australian Capital Territory has been discussed in

s. 2.3.1. Rural leases currently border much of the Murrumbidgee River, the Gudgenby and Naas rivers (outside Namadgi National Park), Paddys River, and the lower Molonglo River. There are smaller areas adjoining the Molonglo River upstream of Lake Burley Griffin (Pialligo, Symonston, Burbong).

In general, uncontrolled livestock grazing of riparian zones and unrestricted access to streams has had major detrimental effects on riparian areas (including riverbanks), stream ecology and sediment loads. Particular effects include:

- lowered water quality (including increases in turbidity and nutrients);
- trampling and lack of regeneration of fringing aquatic vegetation that is important for bank stability and habitat e.g. *Phragmites* spp.;
- erosion and sedimentation due to the creation of tracks and bare areas, and soil compaction;
- deterioration in streambank stability, through trampling, track creation and loss of streambank vegetation;
- spread of weeds (into and out of riparian areas);
- disturbance to habitat, such as rocks and logs, and loss of ground surface detrital material (litter and woody debris);
- loss of habitat connectivity and impacts on the value of riparian areas as drought refuges for native species;
- lack of regeneration of native species, including dominant native tree cover; and
- loss of invertebrate and other species due to trampling and soil compaction, with associated effects on energy and nutrient cycling processes.

(Askey-Doran and Pettit 1999; Jansen and Robertson 2001; MacLeod 2002a; Price and Lovett 2002; Robertson and Rowling 2000)

Issues associated with managing livestock access to riparian zones are discussed in MacLeod (2002a) who states as a general principle that livestock should be excluded from watercourses to reduce soil erosion and maintain the quality of the water. Grazing should only be applied for conservation purposes, including weed control. The condition of riparian habitats generally responds rapidly to the exclusion of stock. The benefits and practicality of alternative approaches such as exclusion by fencing or strategic and controlled grazing management are the subject of ongoing debate. Management of grazing pressure on riparian lands should aim to maintain groundcover, with enough vegetation to protect the soil surface from heavy rain and provide a filter for nutrients and upslope sediments. The timing, intensity and duration

of grazing are important considerations for maintenance of biodiversity conservation and ecological functioning (Price and Lovett 2002). Weed control is likely to be an ongoing problem, especially in areas grazed for a long time (Jansen and Robertson 2001).

The most effective (and most expensive) approach is to fence out the riparian zone and provide alternative water sources (from formed access points at low erosion risk sites on the stream, pumped from the stream, from a streambed bore, or reticulated from upslope). A suggested alternative approach is to establish riparian paddocks, where stocking is managed in relation to the seasons, climatic conditions and ecological requirements e.g. seeding times for riparian plants. There is also a range of informal management actions that can be taken to reduce the local impacts of livestock and distribute grazing pressure (MacLeod 2002a, pp.163–164). MacLeod (pp. 158–161) could not find, however, a well-documented or even anecdotal example of targeted stock management that has successfully reduced stock impacts on riparian zones without fencing.

With regard to the management of grazing in the Murrumbidgee River Corridor, the stated intention in the Management Plan (Environment ACT 1998, p. 45) is to ‘progressively remove grazing from the riverbank and selected creek tributaries’. In the Lower Molonglo River Corridor, grazing of riverbanks occurs under licence for weed and fire fuel control (Environment ACT 2001b). Grazing is included in the Controls under the River Corridors Land Use Policies, Part B13 of the *Territory Plan* (ACTPLA 2005):

- Livestock grazing, excluding horse agistment, shall only be permitted where retention of open grasslands or savanna woodlands is desired for landscape, ecology or management reasons. In environmentally sensitive areas grazing shall only be permitted for the purpose of environmental management such as vegetation management or fire hazard reduction.
- It is an objective of this *Strategy* that the impact of inappropriate stock grazing is controlled, reduced or eliminated by appropriate planning, research and/or management actions (Table 6.1.3).
 - It is an action of this *Strategy* to complete the riparian fencing program to prevent uncontrolled stock grazing in riparian areas (Table 6.1.3).

5.6.5 Management of Public Access

Recreational use of riparian areas in the ACT is discussed in s. 2.3.1. Following the bushfires of January 2003, recreation and tourism use and opportunities in non-urban areas of the ACT have been

investigated (Non-Urban Study Steering Committee 2003). The Cotter Reserve and adjacent areas is a particular focus in this study (see also, Shaping Our Territory Implementation Group (2004)). Increased recreational access and activity in the Molonglo River corridor is a likely outcome of planned residential development in Molonglo (adjoining the river section between the Tuggeranong Parkway and Coppins Crossing) and potentially on the Kowen Plateau (adjoining Molonglo Gorge) (ACT Government 2004b).

- It is an objective of this *Strategy* that Government and non-government organisations recognise the biodiversity conservation values of the rivers and riparian zones and incorporate their conservation requirements in planning, development and land management activities (Table 6.1.4). In particular:
 - River corridor values are recognised in planning studies for new urban areas (Molonglo, Kowen) and river corridors are given appropriate protection in physical planning;
 - Planning of recreational infrastructure recognises and protects river corridor values. Recreational infrastructure remains concentrated at nodes and linear impacts are minimised.

Low impact linear walking trails along the river corridors from the recreation nodes are an appropriate form of access provided they are sited to avoid damage to sensitive areas and habitat disturbance.

5.6.6 Weeds and Pest Animals

WEEDS

The susceptibility of riparian zones to weed invasion is discussed in s. 2.3.1 and the common weed species in the ACT are listed. Weeds are one of the most intractable management problems for riparian areas, benefiting from the moister and often higher nutrient conditions, especially if there is runoff from agricultural land. It is generally not practicable to completely eliminate weed species (though this is still a worthy long-term objective) but to aim for containment and control. Particularly important aspects are follow-up work to eliminate new outbreaks, and avoidance of reinvasion from upstream. For particular weed species or groups of species, their management requires a consideration of the potential range of control methods (e.g. chemicals, fire, grazing, physical removal, revegetation with desirable species that will suppress weed growth, biological control), preferably outlined in a management plan. Ten-year (2002–12) management plans have been prepared for many declared pest plants in the ACT and other weed species, including some of the main species found in riparian zones (ACT SOE 2003d). These plans are being reviewed and updated due to new classifications of weed species

under the *Pest Plants and Animals ACT 2005*. For species dispersed by water, weed control work is most effective if it is commenced in headwater areas and continued downstream.

In riparian areas where native vegetation has been wholly or partially replaced by weed species, the latter often provide a vegetation structure for birds and other animals. Weed control programs need to be strategic, with phased removal of weed species and replanting of substitute native species.

- It is an objective of this *Strategy* that the impact and/or occurrence of weeds has been reduced or eliminated by appropriate management actions (Table 6.1.3). A weed control program should be based on river sections and weed control priorities.

Particular management actions related to this objective include:

- Continuing to undertake a comprehensive weed control program for riparian areas focused on high priority areas and weed species, and following up weed control work with revegetation of native species to reduce opportunities for reinvasion and provide habitat.
- Revegetating areas close to the rivers with species adapted to changing riverflows and able to withstand occasional high velocity flows.
- Advising lessees and other users of land adjacent to the riparian zone of the need to minimise fertiliser run-off, which is related also to erosion control.
- Controlling factors that facilitate weed invasion and reinvasion (e.g. erosion gullies, vehicle use, recreation).
- Evaluating the effectiveness of weed control programs and revising as necessary.
- Assessment of the biodiversity outcomes of weed control activities.

The wide range of weed species occurring in ACT riparian zones is discussed in s. 2.3.1. Two particularly problematic species/group of species are considered here: African Lovegrass (*Eragrostis curvula*) and willows (*Salix* spp.).

These are declared pest plants in the ACT in the *Pest Plants and Animals (Pest Plants) Declaration 2005* (No 1) made under the *Pest Plants and Animals Act 2005*.

African Lovegrass

This species is highly invasive of riparian areas and is widespread along rural roadsides and in the Murrumbidgee River Corridor. Native to southern Africa, African Lovegrass is a variable pasture species with many cultivated forms known as the '*Eragrostis curvula complex*' (Environment ACT 2002b). African

Lovegrass is highly productive and is used in South Africa and in some countries where it has been introduced, for hay and forage (Parsons and Cuthbertson 1992). In Australia, it is only palatable to stock in its early growth stages before seed-set. It produces copious quantities of seed and rapidly dominates sparse, over-grazed pastures and roadsides, forming dense swards to the exclusion of other species. Its spread is enhanced by water courses and in the Murrumbidgee River Corridor it is a threat to the habitat of the Pink-tailed Worm Lizard. The *ACT African Lovegrass Management Plan* (Environment ACT 2002b) focuses on control of new and scattered infestations while undertaking management of existing heavy infestations.

The control program for African Lovegrass in the ACT includes:

- spot spraying of isolated plants and patches in the Murrumbidgee River Corridor;
- spraying of verges of rural roads; and
- a sustainable grazing program in riparian zones in rural areas.

Other important aspects of control are limiting vehicle movement in infested areas during seeding, vehicle cleaning, community and landholder advice, and revegetation aimed at reducing opportunities for reinvasion.

Willows

(All willow species except Weeping Willow (*Salix babylonica* var. *babylonica*) and the hybrids Pussy Willow (*S. x calodendron*) and *S. x reichardtii* are declared pest plants in the ACT).

Willows are the dominant woody weed species of streambanks and streambeds in the ACT (see s. 2.3.1). As well as vegetative reproduction, many willows are now reproducing from seed and by hybridisation. Some species are aggressive colonisers of any suitable substrate and have been favoured by river regulation and bank degradation. While they may have value in bank stabilisation, their growth in streambeds, and tendency to choke channels with growing and fallen trunks that results in channel diversion and bank erosion also has the opposite effect. Willows also have negative effects on aquatic habitat through leaf fall that can cause de-oxygenation, and growth of root mats that cover the banks and bottom of streams and destroy habitat. Generally, the disadvantages of willows are seen to outweigh their advantages (Rutherford *et al.* 1999). Their biology, environmental effects and potential for future spread are now well documented (see Cremer *et al.* 1995; Cremer 1996; Cremer 1999; Lang 1999; Schulze and Walker 1997).

Willows may be considered to have cultural heritage value but this mainly relates to the widely planted Weeping Willow (*Salix babylonica* var. *babylonica*), which is not on the ACT declared pest plant list, and where appropriate, may be retained for heritage or aesthetic purposes.

Willow removal is a costly and difficult task and should be followed by riparian revegetation programs to assist in avoiding new infestations. For best results, a long-term catchment based program is required, commencing in headwater areas and including follow-up treatments. In the ACT, extensive problem willow removal has been undertaken along the Naas and Gudgenby rivers, the Molonglo River including Molonglo Gorge, the Cotter River between Bendora Dam and the Cotter Reservoir, Paddy's River, and the parts of the Murrumbidgee River as well as Jerrabomberra and Woolshed creeks and Canberra urban creeks. Advice to landholders on the desirability of maintaining native riparian vegetation cover and stable bank conditions, and not planting willow species may be a valuable component of control programs.

PEST ANIMALS

Alien fish species and their impact on native species are discussed in s. 4.6, and monitoring and control of alien fish species is referred to in s. 4.12.6. Broad-scale eradication of established alien species is not currently possible, and control options are limited because of the potential impact of measures on native species. Control measures include:

- (a) Prevention of establishment of new pest species through legislative controls such as adoption of the National Noxious Fish List recently developed by the National Ornamental Fish Policy Working Group;
- (b) Eradication of localised populations (e.g. trout above Gibraltar Falls in the ACT);
- (c) Prevention of spread of established pest fish (e.g. potentially using surveillance monitoring; consideration of issues in proposed inter-basin water transfers);
- (d) Enforcement of the ban in the ACT on using live fish as bait.

While eradication of pest animals may be the long-term goal, this is rarely achievable, and an appropriate management objective is to undertake control programs that reduce undesirable impacts of pest animals to an acceptable level. The main terrestrial vertebrate pests in ACT riparian areas are noted in s. 3.1.3. The ACT approach to vertebrate pest management is set out in the *ACT Vertebrate Pest Management Strategy* (ACT Government 2002). Pest

animal management objectives, programs and practices are also detailed in management plans for Public Land areas such as the reserves of the Murrumbidgee and Molonglo River Corridors (Environment ACT 1998, 2001b) and Namadgi National Park (ACT P&CS 1986, ACT Government 2005d). An important component of pest animal control is quick response to new occurrences of known or potential pest species, when eradication may be possible e.g. for Red-eared Slider Turtle (*Trachemys scripta elegans*) not known to be currently established in the ACT.

- It is an objective of this *Strategy* that the impact of pest animals is controlled, reduced or eliminated by appropriate planning and/or management actions (Table 6.1.3).
 - It is an action of this *Strategy* to maintain pest animal control programs and report occurrences of known or potential new pest species e.g. Red-eared Slider Turtle (Table 6.1.3).
- It is an objective of this *Strategy* that (a) releases of aquarium and other pest species to streams, and (b) spread and impact of alien fish species is controlled, reduced or eliminated by appropriate planning and/or management actions (Table 6.1.3).
 - Actions of this *Strategy* are to:
 - (a) Investigate means to reduce (a) the risk of releases of aquarium and other pest species to streams and (b) the impacts of already established species.
 - (b) Encourage investigation into control mechanisms to prevent the spread of established pest species (terrestrial vertebrates, alien fish) (Table 6.1.3).

5.6.7 Habitat Removal: Rocks, Firewood

Rocks, fallen timber and woody debris are important micro-habitat features. The importance of rocks in the habitat of the Pink-tailed Worm Lizard has been discussed in s. 3.3.2. Rocks may also provide sheltered habitat niches for plant species. Standing old and dead trees and fallen logs and branches are significant faunal habitat. Collection of hardwood for commercial purposes and from areas of Public Land is not permitted in the ACT. Under the *Nature Conservation Act 1980*, rural lessees may use timber on their properties for firewood but are not permitted to sell it. Access restrictions mean that firewood collection is no longer a significant threat to woodland and other tree cover in the ACT. However, there may be local habitat effects due to removal of fallen timber by residents in urban areas adjoining reserves, in campfires and for fire hazard fuel reduction.

Maintenance of rocks, fallen timber and woody debris is appropriately considered in management plans and other management arrangements and activities for riparian areas.

- It is an objective of this *Strategy* that specific recognition is given to habitat protection for the Pink-tailed Worm Lizard (*Aprasia parapulchella*) in planning studies for the Molonglo and Murrumbidgee river corridors (Table 6.1.4).
 - It is an action of this *Strategy* to continue to develop and promote ‘best practice’ management of riparian zones and their component species giving particular attention to the protecting and managing the habitats of threatened, uncommon and declining species (Table 6.1.5).

The following management considerations are pertinent:

- **Access control:** in particular, limiting vehicle access and siting walking tracks away from important rocky habitat areas.
- **Alternative fuels:** in riverside recreation areas, providing wood for barbecues or gas barbecues.
- **Education:** providing educational materials and/or signs to advise of the importance of fallen timber and woody debris for habitat.

5.6.8 Fishing: Law Enforcement

Recreational fishing is Australia’s largest outdoor participation sport, with about one-fifth of the population participating both nationally and in the ACT (Henry and Lyle 2003). Fishing in the ACT is governed by the *Fisheries Act 2000*. This legislation details the gear types and quantities that may be used for fishing, along with bag and size limits for fish species, and closed seasons or total prohibitions for particular species or water bodies. These fishing controls are designed to provide a satisfying and sustainable recreational experience. The provisions of the *Fisheries Act 2000* are largely consistent with the relevant fisheries legislation in NSW and Victoria, to minimise potential for confusion amongst anglers.

- It is an objective of this *Strategy* that recreational fishing in the ACT is managed so as to provide a satisfying and sustainable recreational experience, and to protect threatened, uncommon and declining species (Table 6.1.5).
 - It is an action of this *Strategy* to continue to develop and promote ‘best practice’ management of recreational fishing, giving particular attention to protecting and managing threatened, uncommon and declining species, and promoting consistency in fisheries regulations with NSW (Table 6.1.5).

5.6.9 Fire

The January 2003 bushfires, which burnt 70 per cent of the ACT, have resulted in substantial planning and land use changes in areas drained by the Murrumbidgee, Molonglo and Cotter rivers. Subsequent to the fires, the Murrumbidgee River and land to the west of the river between Tharwa and Kambah Pool has been defined in the *Canberra Spatial Plan* (ACT Government 2004b) and the *Strategic Bushfire Management Plan* for the ACT (ACTESA 2005) as the western boundary of a Bushfire Abatement Zone to protect urban Canberra. This Zone provides a statutory planning basis to guide land management to reduce fuel loads, and land planning principles, including land use restrictions and performance measures for fire hazard reduction (*Spatial Plan*, p. 87). Protection of urban Canberra has therefore become a priority objective of fire management in the Murrumbidgee River Corridor, in addition to those objectives set out in the Management Plan for the corridor itself (Environment ACT 1998). Fire ecology is an important ongoing research need, including the integration of ecological and protection needs in fuel management. The origins, spread and means of control of landscape scale wildfires, and levels of fuel management in areas such as land west of the Murrumbidgee River in the ACT and adjacent land in New South Wales (including Kosciuszko National Park) are highly contested matters (see, for example, House of Representatives Select Committee into the recent Australian bushfires 2003; Leaver 2002).

Changes in fire regimes in the ACT since European settlement are discussed in s. 2.3.1. A range of conservation planning issues related to the January 2003 bushfires are outlined in s. 5.3 and potential impacts on aquatic communities are listed in s. 4.8.1.

- It is an objective of this *Strategy* that the impact and occurrence of inappropriate fire regimes is reduced or eliminated by appropriate planning, research and management actions (Table 6.1.3).

In the medium and longer term, an important management issue is the recovery of riparian vegetation communities, in particular, the Casuarina cunninghamiana Tableland Riparian Woodland and the Callitris endlicheri Tableland Dry Woodland/Open Forest. Table 6.1 contains specific actions related to these communities including monitoring of their recovery and review of fire management policies based on that recovery.

5.6.10 Environmental Flows

The purpose and importance of environmental flows for the maintenance of aquatic ecosystem structure and function, including the survival of threatened and

uncommon species, is discussed in s. 4.12.2, together with a brief outline of the environmental flow guidelines developed for the ACT. Given the uncertainties in determining environmental flows, an adaptive management approach is required. This involves preparing guidelines based upon the best available knowledge at a particular time and reviewing them on a regular basis. This approach has been followed in the ACT with the first guidelines (1999) being reviewed after a five-year period and revised guidelines prepared (ACT Government 2006a). Given their need to integrate environmental, social and economic considerations and in the context of population growth and increasing water needs, environmental flows are likely to remain an important management issue for ACT rivers.

- It is an objective of this *Strategy* that ‘best practice’ management is applied to rivers and riparian zones in the ACT with particular attention to the habitat of threatened, uncommon and declining species (Table 6.1.5).
 - It is an action of this *Strategy* to prepare and keep under review environmental management policies and guidelines (e.g. fish stocking, environmental flows) that reflect commitment to active and effective conservation of rivers and riparian areas and conservation management of aquatic ecological resources (Table 6.1.5).
 - For specific actions related to threatened fish species and other aquatic species, see s. 4.12.2.

5.6.11 Erosion and Sedimentation

Erosion in catchments and the subsequent sedimentation of aquatic habitats is one of the primary threats to aquatic fauna and processes. Sedimentation smothers feeding, breeding and resting habitats, and reduces in-stream habitat and substrate diversity (see s. 4.4.1). Intact riparian zones can provide significant filtering of overland transport of sediments and protection from streambank erosion (McKergow *et al.* 2002), as well as a number of other ecological functions. Canberra’s urban lakes and the stormwater system provide significant protection against urban sediment impacting upon downstream ecological communities. However, large amounts of sediment are already present in river channels, either as a result of historical catchment management (e.g. Murrumbidgee, lower Naas, Paddys rivers) or through recent events such as the 2003 bushfires (e.g. Cotter, Orroral and upper Naas rivers). For most of these rivers, protection of the natural flow regime assists in preventing accumulation of sediment at any particular location. For the Cotter River, managed releases from impoundments assist in moving sediment along the stream channel (see Environmental Flows, s. 4.12.2).

- It is an objective of this *Strategy* that the ecological condition and habitat quality of rivers and riparian zones in the ACT is maintained or improved by appropriate rehabilitation activities (Table 6.1.5).
 - It is an action of this *Strategy* to prepare and keep under review environmental management policies and guidelines (e.g. fish stocking, environmental flows) that reflect commitment to active and effective conservation of rivers and riparian areas and conservation management of aquatic ecological resources (Table 6.1.5). (Give particular attention to the channel maintenance flows to protect habitats for threatened, uncommon and declining species.)
 - It is an action of this *Strategy* to investigate and undertake appropriate rehabilitation activities (see s. 4.12.3). This may involve streambed, riverbank and wider riparian activities including those of an experimental kind (Table 6.1.5).

5.6.12 Extractive Industries

Historic land management practices or large floods have resulted in substantial quantities of sediment being stored in river channels. For example, large quantities of sediment stored in the Tharwa–Point Hut Crossing reach of the Murrumbidgee River in the ACT are thought to have originated in the catchment upstream of the ACT as a result of a series of large floods in the mid-late 1800s (AWT and Fluvial Systems 1999). These sediments have been steadily moving down the river channel as each minor flood reworks in-stream deposits. The quantity of sediment involved may be too large for conventional land or river management activities to effectively deal with, and so important aquatic habitats such as pools have been lost through infilling with sediment. The Murrumbidgee River Corridor Management Plan (Environment ACT 1998) identifies controlled sand and gravel extraction as a potential option for rehabilitating the river channel to a pool and riffle structure. Such extractive activities could only be used for habitat rehabilitation purposes. A pilot project in the Murrumbidgee River at Tharwa identified that there were opportunities for sand and gravel extraction to play a role in habitat enhancement programs (Lintermans 2004b).

- It is an objective of this *Strategy* that the ecological condition and habitat quality of rivers and riparian zones in the ACT is maintained or improved by appropriate rehabilitation activities (Table 6.1.5).
 - It is an action of this *Strategy* to investigate and undertake appropriate rehabilitation activities. This may involve streambed, riverbank and wider

riparian activities including those of an experimental kind (Table 6.1.5).

- It is an action of this *Strategy* to investigate options for the use of closely monitored commercial extractive industries to remove in-stream sand and gravel deposits, as part of a habitat enhancement program (Table 6.1.5).

5.6.13 Water Quality Management

The water quality in aquatic habitats is a primary consideration for ecosystem function and maintenance of aquatic life. As noted in s. 4.4.6, reduction in water quality in the Murray–Darling Basin is due to increased nutrients, turbidity, sedimentation, salinity, artificial changes in water temperature, pesticides and other contaminants (MDBC 2004a). Key factors affecting water quality in ACT lakes and rivers are rural land uses (agriculture and forestry, including the legacy of past rural land use), urban development (including storm water runoff), chemical pollution (e.g. hydrocarbons, pesticides), climatic conditions (especially events such as drought or heavy storm rains), water releases from the lower levels of urban lakes and ponds (cold, deoxygenated water with excessive nutrient loads), nutrient enrichment (discharge of treated sewage effluent, inputs from rural enterprises), endocrine disruptors (potentially present in sewage discharge (see s. 4.4.6)), and catchment wide extreme events such as the January 2003 bushfires.

The approach taken to protect water quality in the ACT draws upon the framework established by the *National Water Quality Management Strategy* (ANZECC/ARMCANZ 2000) with catchment specific management policies aimed at achieving defined environmental and social objectives. The ACT strategy for sustainable water use is set out in *Think water, act water* (ACT Government 2004d), which contains specific actions in relation to the issues raised (Volume 1). Regular water quality monitoring programs have been undertaken in the ACT since 1969 enabling an analysis of trends (Australian Department of Construction *et al.* 1978). The results of the annual water quality monitoring program, including the macroinvertebrate component, are contained in an annual *ACT Water Report* (ACT Government 2004f). Continued growth of the Canberra and regional population, and related urban, commercial and infrastructure development, will place ongoing pressures on the maintenance of water quality in lakes and streams, even with the mitigation of these impacts by well designed sediment and pollution control structures and legislation. In those areas burnt the January 2003 bushfires, water quality is likely to be adversely affected for many years (ACT SOE 2003b).

Scrivener Dam on the Molonglo River creates the largest lake in urban ACT and in common with other urban impoundments, does not have a multi-level off-take for water releases, which only occur through overtopping or release through a valve at the base of the dam. The issue of the poor quality of the water released from the dam has been recognised for some time (NCPA 1995) without resolution. The National Capital Authority is currently reviewing how it meets its environmental flow obligations both in Lake Burley Griffin and the Molonglo River downstream, which include temperature and flow variations to mimic natural conditions (ACT Government 2005b).

This *Strategy* does not include objectives or actions related to water quality, given the existing comprehensive policy framework for water management in the ACT including the strategy *Think water, act water* (ACT Government 2004d), legislation (*Environmental Protection Act 1997* and *Water Resources Act 1998*), planning policies ('Water Use and Catchment Policies' of the *Territory Plan*), guidelines and plans (*Environmental Flow Guidelines*, *Water Resources Management Plan*), and ongoing monitoring and reporting (carried out by a range of government agencies and community groups and with the exception of Lake Burley Griffin (managed by the National Capital Authority) reported in the annual *ACT Water Report* e.g. ACT Government 2004e).

5.7

Management Agreements and Networks

5.7.1 ACT Land Keepers Program

Living Environment is an ACT Government and community partnership with the Natural Heritage Trust (Australian Government) with respect to funding programs to address priority issues relating to biodiversity, water quality and flow, soil health, salinity and the capacity of the community to address these issues. Delivery of part of this program is through the ACT Land Keepers program, a partnership between Environment and Recreation and Greening Australia (ACT and SE NSW). This program has four components:

- VegLink:** on-ground activities in native vegetation protection and enhancement.
- Biodiversity Incentives:** on-ground conservation work on rural and non-urban land.
- Greening Industry:** on-ground conservation work with agricultural and horticultural enterprises; and

- (d) **ACT River Rescue:** implementing riparian habitat recovery along priority streams in the ACT to address biodiversity and water quality.

Projects targeting riparian habitat priorities include sites in the Ginninderra, Molonglo and Southern ACT Catchments. Activities include:

- fencing off creeks to allow (a) erosion control in major gullies and other soil conservation works, (b) protection of remnant vegetation, and (c) to facilitate control of grazing stock;
- revegetation projects that supplement remnant native vegetation and help restore ecological connectivity across the landscape; and
- weed control, particularly of willows and weeds of national significance.

Each of these categories of projects contributes to restoration of riparian function and potentially the quality of river environments and the water that flows through them. They form some of the essential on-ground works that will be needed over many years to implement the actions outlined in the *Strategy* (s. 6.2 and s. 6.5).

The ACT Minister for the Environment and the Australian Ministers for Environment and Heritage and Agriculture, Fisheries and Forestry approve projects funded through the Land Keepers program. Priorities and strategic targets are set out in the ACT Natural Resource Management Plan 2004–2014 (ACT NRM Board 2004) (see s. 6.3). This Strategy will be one of many sources that inform the Natural Resource Management Plan, through regular reviews of both the Plan and its investment program.

Many ACT community groups are involved in conservation activities related to riparian areas. This *Strategy* supports the work of such groups (Table 6.1.5, s.6.5.1).

5.7.2 Land Management Agreements

Land Management Agreements provide a basis for co-operative land management between lessees of rural land in the Australian Capital Territory and ACT Government agencies responsible for managing rural and non-urban land in the Territory. A Land Management Agreement (LMA) is required under the *Land (Planning and Environment) Act 1991* (section 186c) for all non-urban leases in the ACT and is linked to the granting of a long-term lease (20 and 99 years). LMAs are in place for the majority of leases in riparian zones. Some land in the Gudgenby–Naas catchment is held under agistment for which LMAs do not apply.

The principal objective of LMAs is to establish management practices on leases that support the land management aims of both the lessee and the ACT Government. This involves agreement on general management goals and responsibilities; documentation of the current state of the property (including nature conservation, cultural heritage or other significant values); and identification of land management issues and the means for their resolution. Environment and Recreation provides environmental information to lessees, drawing attention to conservation issues, in particular, presence of, or habitat for, threatened species and ecological communities. LMAs also address uncontrolled grazing and the fencing of riparian areas.

Lessees are required to address the following objectives in the LMA within a framework of sustainable agricultural and pastoral land use practices:

- Retain or improve the ecological functioning and integrity of the natural and modified resources of the leased area.
- Preserve the extent and character of any threatened ecological community or population of a threatened species.
- Pursue all development and management of the land in a way that is consistent with any Action Plan for a threatened species or ecological community.
- Manage vegetation identified in the LMA as being of significant conservation value, with the aim of maintaining its structure, floristics and habitat value.
- Ensure that any activities do not adversely impact on riparian or other wetland areas.

Land Management Agreements also provide for Land Action Plans to be prepared for a range of issues, including drought risk management, pest plants and animals, sites of significant natural or cultural heritage value, maintenance of water quality, and protection of riparian zones and other native vegetation. Lessees are required to ensure that a flexible grazing strategy is in place designed to achieve conservation objectives.

A review of each Land Management Agreement is required every five years or on the re-issuing, variation or transfer of the lease or on the written request of the Lessee or the Territory, whichever occurs first. If existing management practices are retained and there is no adverse impact on the environment over this period, no changes to the Agreement will be required.