

## ACTION PLAN No.12

In accordance with section 21 of the *Nature Conservation Act 1980*, the **Trout Cod (*Maccullochella macquariensis*)** was declared an **endangered** species on 27 December 1996 (formerly Instrument No. 1 of 1997 and currently Instrument No. 192 of 1998). Section 23 of the Act requires the Conservator of Flora and Fauna to prepare an Action Plan in response to each declaration. This is the Action Plan for the:

### Trout Cod *Maccullochella macquariensis*

#### Preamble

The *Nature Conservation Act 1980* establishes the ACT Flora and Fauna Committee with responsibilities for assessing the conservation status of the ACT's flora and fauna and the ecological significance of potentially threatening processes. Where the Committee believes that a species or ecological community is threatened with extinction or a process is an ecological threat, it is required to advise the Minister for the Environment, Land and Planning and recommend that a declaration be made accordingly.

Flora and Fauna Committee assessments are made on nature conservation grounds only and are guided by specified criteria as set out in its publication *Threatened Species and Communities in the ACT* July 1995.

In making its assessment of the Trout Cod, the Committee concluded that it satisfied the criteria indicated in the adjacent table.

An Action Plan is required in response to each declaration. It must include proposals for the identification, protection and survival of a threatened species or ecological community, or, in the case of a threatening process, proposals to minimise its effect.

While the legal authority of this Action Plan is confined to the Australian Capital Territory, management considerations are addressed in a regional context.

#### Criteria Satisfied

- 1.1 Species is known or suspected to occur in the ACT region and is already recognised as endangered or presumed extinct in an authoritative international or national listing.
- 1.2 The species is observed, estimated, inferred or suspected to be at risk of premature extinction in the ACT region in the near future, as demonstrated by:
  - 1.2.1 Current severe decline in population or distribution from evidence based on:
    - 1.2.1.1 direct observation, including comparison of historical and current records.
    - 1.2.1.2 severe decline in rate of reproduction or recruitment; severe increase in mortality; severe disruption of demographic or social structure.
    - 1.2.1.4 very high actual or potential levels of exploitation or persecution.

## Links with other Action Plans

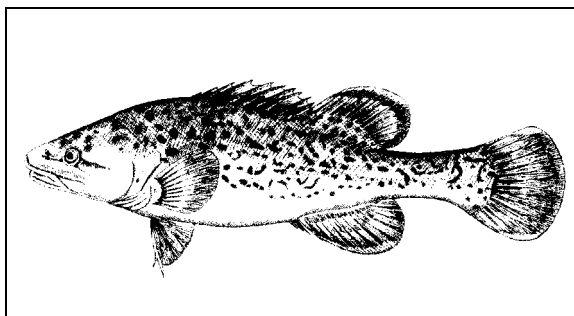
Measures proposed in this Action Plan complement those proposed in the Action Plans for other threatened aquatic species, such as the Two-spined Blackfish (*Gadopsis bispinosus*), Macquarie Perch (*Macquaria australasica*) and Murray River Crayfish (*Euastacus armatus*). Action Plans are listed at the end of this document.

## Species Description and Ecology

The Trout Cod *Maccullochella macquariensis* is a member of the Percichthyidae which contains the Australian freshwater basses and cods. The family contains two genera in eastern Australia: *Maccullochella* and *Macquaria*. Other species in the genus *Maccullochella* include the well known Murray Cod (*M. peelii peelii*), the nationally threatened Mary River Cod (*M. peelii mariensis*) and Eastern Freshwater Cod (*M. ikei*). *M. macquariensis* is similar in appearance to *M. peelii peelii* and was only formally recognised as a distinct species in the 1970s (Berra and Weatherley 1972).

### DESCRIPTION

*M. macquariensis* is a large elongate deep-bodied fish (Figure 1), slightly laterally compressed and very similar to *M. peelii peelii*. The dorsal profile of the head is straight whereas in *M. peelii peelii*, it is concave. The mouth is terminal and large with the gape extending to behind the posterior of the eye. The upper jaw overhangs the lower jaw whereas in *M. peelii peelii*, the lower jaw is equal or protruding.



**Figure 1:** Trout Cod (*Maccullochella macquariensis*). Scale: Approximately one sixth natural size.

The dorsal colouration is generally blue-grey with small dark grey to black spots or dashes, extending to the lower sides. The ventral surface is light grey to white. Adult and juvenile

*M. macquariensis* have a dark stripe through the eye.

In contrast, the dorsal colouration of *M. peelii peelii* is typically olive-green to yellow-green with dark mottling (rather than spotting) extending to the lower sides. *M. peelii peelii* juveniles may have a dark eye stripe but it rarely persists in fish greater than 150 mm total length.

Maximum size of *M. macquariensis* is 16 kilograms and approximately 700 mm but fish over 3 kilograms are rare.

### HABITAT

The historical habitat preferences of *M. macquariensis* were never documented and the rivers where the species formerly occurred have probably changed dramatically since the species inhabited them. The two localities where the species currently survives and breeds are quite different in character. The Murray River from Yarrowonga to Cobram is a large (60-100 m wide), slow flowing and deep (>3 m) river with a sand, silt and clay substrate, and contains abundant snags and woody debris. Seven Creeks (Victoria) is a relatively narrow (5-7 m wide) stream having a rock, gravel and sand substrate. The pools are generally less than 2 m deep and are interspersed by rapids and cascades (Douglas *et al.* 1994).

The physical characteristics of the Murrumbidgee River in the ACT are intermediate between Seven Creeks and the Murray River. In general, it appears that *M. macquariensis* adults are essentially a pool-dwelling, cover-seeking fish.

### BEHAVIOUR AND BIOLOGY

There has been little published on the behaviour or biology of *M. macquariensis* with much information residing in ongoing research projects. The most comprehensive summary of information is by Douglas *et al.* (1994) from which much of the following information is taken.

The species is a carnivorous, top-order predator with the diet including freshwater crustaceans such as yabbies, crayfish and shrimp, as well as fish and aquatic insects. In Bendora Reservoir they have been recorded as eating yabbies, mudeyes, blackfish and the occasional frog.

Like *M. pealii pealii*, *M. macquariensis* is believed to form pairs and spawn annually, usually in spring and probably in response to increasing day-length and water temperature. The fertilised eggs are adhesive, demersal, opaque and 2.5-3.6 mm in diameter. It is thought that the eggs are laid on a hard substrate such as submerged logs, clay banks or rocks. The eggs hatch 5-10 days after fertilisation at 20°C with newly hatched larvae being approximately 6-9 mm total length. Larvae begin feeding about 10 days after hatching.

The species reaches sexual maturity when younger and smaller (3-5 years, 0.75-1.5 kg) than *M. pealii pealii* (4-6 years, 2-2.5 kg).

It has been suggested that *M. macquariensis* was more common in the cooler, upper reaches of rivers (Cadwallader and Backhouse 1983) but there is little evidence to support this suggestion. Certainly the one remaining natural population in the Murray River below Yarrowonga does not fit this model. In the Murray River, *M. macquariensis* is usually found associated with snags and wood debris in areas of relatively fast flowing current. Unpublished research suggests that the species prefers deeper, faster water than *M. pealii pealii* in this location (J. Koehn pers. comm.). In Seven Creeks, larger *M. macquariensis* individuals are often found in the deeper pools but smaller fish have also been captured amongst boulders, logs and other cover in shallower waters.

## DISTRIBUTION

*M. macquariensis* was once widespread in the southeastern region of the Murray-Darling Basin with records from the Murray, Murrumbidgee and Macquarie rivers in New South Wales/Australian Capital Territory and the Goulburn, Broken, Campaspe, Ovens, King, Buffalo and Mitta Mitta rivers in Victoria (Berra and Weatherley 1972; Cadwallader and Gooley 1984; Cadwallader 1977; Greenham 1981).

In the Canberra region, the last recorded capture of the species was from the Gigerline Gorge on the Murrumbidgee River in the late 1970s (Lintermans *et al.* 1988). The report of *M. macquariensis* from the Molonglo River (Merrick and Schmida 1984) appears to be an error as no reliable record from this locality is known. Recent fish surveys of the Murrumbidgee River in the ACT have failed to

locate *M. macquariensis* (Lintermans 1995a, 1997, 1998, unpubl. data).

There are now only two self-supporting populations remaining, one in the Murray River below Yarrowonga and the other in Seven Creeks above Euroa in Victoria. The Seven Creeks population is the result of translocations of "cod" from the Goulburn River in 1921 and 1922 (Douglas *et al.* 1994).

As part of a national recovery plan, *M. macquariensis* is being artificially bred by both the New South Wales and Victorian fisheries agencies (Ingram and Rimmer 1992). The cod are then being stocked into streams (and some reservoirs) within the former range of the species. Two sites in the ACT have been stocked with 8,750 fish released into Bendora Reservoir in 1989-90 (Lintermans 1995b) and a total of 34,500 released into the Murrumbidgee River at Angle Crossing in 1996-1998.

The species has also been released in the Murrumbidgee River at a number of sites in the Canberra region outside the ACT. These include:

- two sites near Cooma;
- one site below Adaminaby;
- one site near Gundagai; and
- one site near Wagga Wagga.

The locations of sites stocked with *M. macquariensis* in the ACT region are shown in Figure 2.

## Conservation Status

*M. macquariensis* is recognised as a threatened species in the following sources:

### International

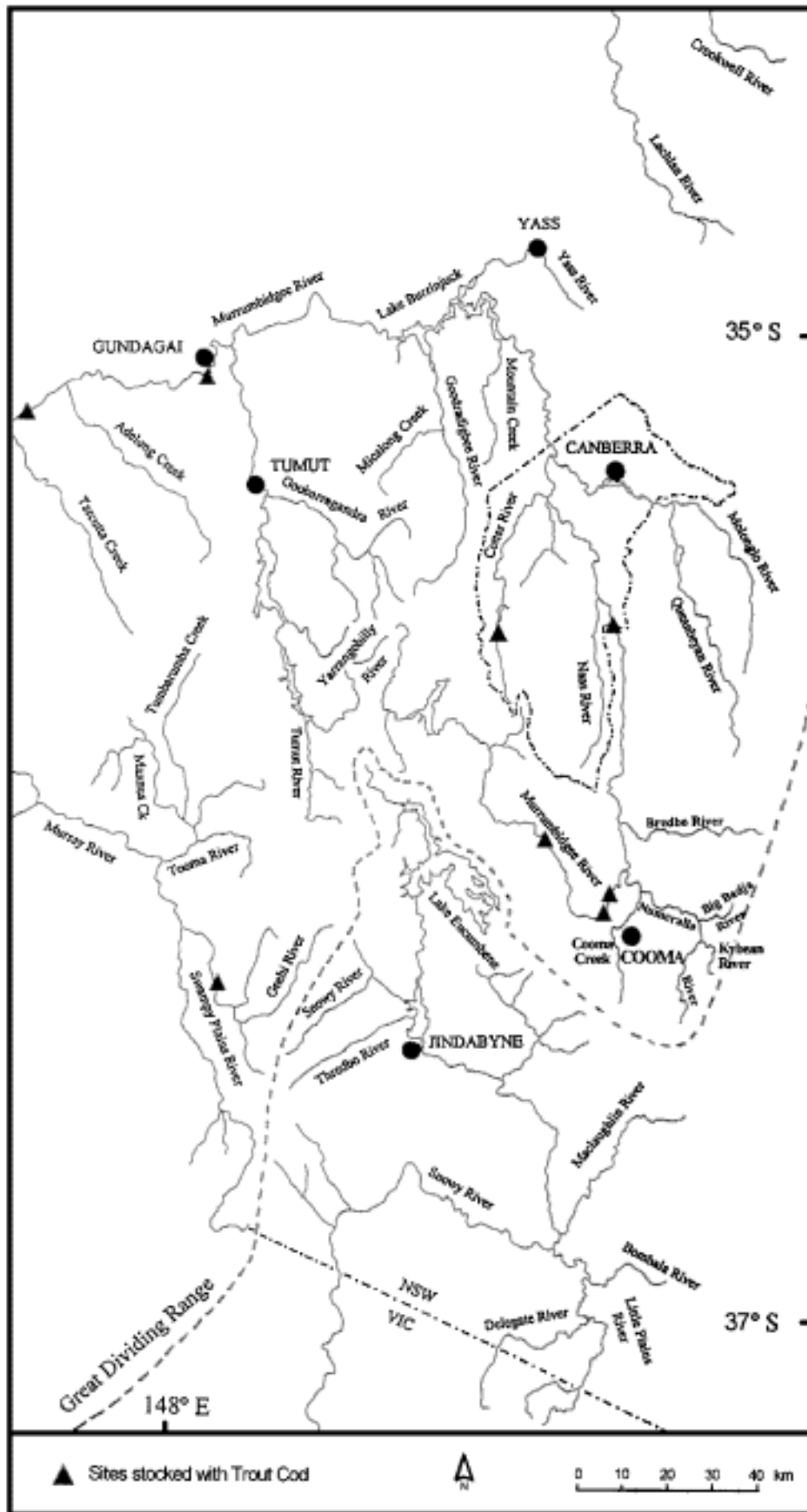
*Endangered*. - IUCN Red List of Threatened Animals 1994 (Groombridge 1993).

### National

*Endangered*. - Schedule 1, Part 1 of the *Endangered Species Protection Act 1992* (Commonwealth).

*Endangered*. - Australian Society for Fish Biology (Harris 1987).

*Endangered*. - Action Plan for Australian Freshwater Fishes (Wager and Jackson 1993).



**Figure 2** Locations of sites stocked with Trout Cod.

Produced by Wildlife Research and Monitoring, Environment ACT.

## Australian Capital Territory

Endangered. - Section 21 of the *Nature Conservation Act 1980*, Instrument No.192 of 1998 (formerly Instrument No.1 of 1997).

Special Protection Status Species. - Schedules 6 and 7 of the *Nature Conservation Act 1980*, Instrument No. 197 of 1998.

## New South Wales

Endangered. - Part 7A of the *Fisheries Management Amendment Act 1997*.

## Victoria

Threatened taxon. - Schedule 2 of the *Flora and Fauna Guarantee Act 1988*.

Cadwallader *et al.* (1984) listed *M. macquariensis* as *endangered* in Victoria and this categorisation was retained by Koehn and Morison (1990) when they reviewed the conservation status of Victorian fish.

The species is also the subject of Action Statement No. 38, prepared by the Victorian Department of Conservation and the Environment (DCNR 1993).

## Threats to Populations in the ACT Region

The major threats to the continued survival of native fish species in freshwater habitats are overfishing, habitat alteration and introduced fish species. All of these threats are thought to have had an impact on populations of *M. macquariensis*.

### HABITAT DESTRUCTION OR MODIFICATION

Alteration or destruction of fish habitat is widely regarded as one of the most important causes of native fish decline in Australia (Cadwallader 1978a; Koehn and O'Connor 1990a,b; Lintermans 1991a; Hancock 1993) and overseas (Moberly 1993; Maitland 1987).

Habitat modifications occur in many forms but the major classes are:

- barriers to fish passage;
- reduction in floodplain habitat;
- alteration to flow regimes below impoundments;
- reduction of instream habitat; and
- reduction in water quality (Lawrence 1991).

Preliminary, unpublished studies (J. Koehn pers. comm.) indicate that *M. macquariensis*

does not appear to have a substantial spawning migration and so barriers to movement are likely to have played a lesser role in their decline than in some other freshwater fish species. Barriers have probably affected dispersal and recolonisation after perturbation to some extent. Loss of floodplain habitat is likely to have been a contributing factor in the decline of the species in lowland rivers such as the Murray, Macquarie and lower Murrumbidgee rivers where woody debris in backwaters and flood channels may have been a favoured spawning and larval development habitat. However, in the upland areas such as the Murrumbidgee River in the ACT, loss of floodplain habitat is not considered to be a major cause of decline.

Alterations to flow regimes in conjunction with reductions of instream habitat and water quality may be implicated in the demise of the Canberra region populations of the species. General land degradation from overclearing and inappropriate land management, rabbit plagues in the 1920s, a proliferation of extractive industries and urban development within the upper Murrumbidgee catchment have undoubtedly contributed to general siltation of the Murrumbidgee River. The construction of Tantangara Dam probably also contributed substantial amounts of sediment to the river. Addition of sediment to rivers is particularly detrimental to fish which lay adhesive eggs on the substrate (Cadwallader 1978), as the species is thought to, since sediment smothers the eggs.

Sedimentation and the associated increase in turbidity are likely to affect visual feeders like *M. macquariensis* even more severely, as both the abundance and diversity of prey items are reduced, as well as reducing feeding success because of lowered water clarity.

The construction of Tantangara Dam on the upper Murrumbidgee River in 1960 has reduced the frequency of winter flooding and increased the occurrence of low flows (<1000 megalitres/day) in winter (Jorgensen 1983). This has possibly led to the continued accumulation of sediments in the river as there are now fewer and smaller high flow events which previously would have scoured the finer sediments out of the river bed.

## OVERFISHING

Overfishing is cited as one of the contributing factors in the decline of *M. macquariensis* (Douglas *et al.* 1994), and has been shown to be important in the decline of other native fish species such as Macquarie Perch (*Macquaria australasica*) (Cadwallader 1978; Harris and Rowland 1996) and Murray Cod (*M. peelii peelii*) (Rowland 1989; Jackson *et al.* 1993). Berra (1974) when discussing the now defunct ACT *M. macquariensis* population, noted that the ACT was subject to heavy angling pressure directed primarily at *M. peelii peelii*. As *M. macquariensis* was only described as a separate species in 1972, it is highly likely that anglers would not have distinguished between the two cod species, and that many *M. macquariensis* individuals were taken by angling.

## REDUCTION OF INSTREAM HABITAT

There has probably been little direct removal of instream habitat (such as the removal of logs from rivers and channelisation) as has occurred in lowland streams. Indirect causes of instream habitat reduction include sedimentation (see above) and the narrowing of stream channels below impoundments. Streams are often narrower and shallower below dams due to the storage capacity of the impoundments.

## REDUCTION IN WATER QUALITY

The major reductions in water quality which are most likely to have affected *M. macquariensis* in the Canberra region are sediment addition (see above) and changes to thermal regimes, either from the operation of impoundments or the clearing of riparian vegetation which shades streams.

## INTRODUCTION OF EXOTIC SPECIES

The establishment of introduced fish species is often cited as a cause of native fish declines in Australia, although much of the evidence is anecdotal. This is because the majority of introduced species became established in the mid to late 1800s when the distribution and abundance of native fish was poorly known or documented. However, there is convincing evidence of the Galaxiidae being adversely affected by the presence of both Brown Trout (*Salmo trutta*) and Rainbow Trout (*Oncorhynchus mykiss*) (Tilzey 1976; Frankenberg 1966, 1974; Fletcher 1979; Cadwallader 1979; Cadwallader and Backhouse 1983; Jackson 1981; Jackson and Williams 1980; Lintermans and Rutzou 1990).

The main interactions between trout and native species are thought to be predation and

competition for feeding, spawning or territorial requirements. Brown Trout (*S. trutta*) were first introduced into the Canberra region in 1888, being one of the first areas of New South Wales to be stocked (National Trust of Australia 1980). Rainbow Trout (*O. mykiss*) were first introduced into Australia and New South Wales in 1894 (Faragher 1986), so both trout species have been established in south-eastern NSW for a century or more. The lack of detailed information on the historical distribution of *M. macquariensis* means that the impacts of trout on the species are unknown. *S. trutta* are known to prey on *M. macquariensis* (NSW Fisheries unpubl. data).

Another potentially serious impact of introduced species is their capacity to introduce or spread foreign diseases and parasites to native fish species. Carp (*Cyprinus carpio*) or Redfin Perch (*Perca fluviatilis*) are considered to be the source of the Australian populations of the parasitic copepod *Lernaea cyprinacea* (Langdon 1989a). Carp (*C. carpio*), Goldfish (*Carassius auratus*) or Mosquitofish (*Gambusia holbrooki*) are probably implicated as the source of the introduced tapeworm *Bothriocephalus acheilognathi* which has recently been recorded in native fish species (Dove *et al.* 1997). This tapeworm causes widespread mortality in juvenile fish overseas.

Of more concern is the recent identification in Australia of the disease Epizootic Haematopoietic Necrosis Virus (EHNV). This virus, unique to Australia, was first isolated in 1985 on the introduced fish species *P. fluviatilis* (Langdon *et al.* 1986). It is characterised by sudden high mortalities of fish displaying necrosis of the renal haematopoietic tissue, liver spleen and pancreas (Langdon and Humphrey 1987). The disease also affects trout species which can act as vectors. Experimental work by Langdon (1989a,b) has demonstrated that a number of native fish species were extremely susceptible to the disease but *M. macquariensis* has not been examined.

EHNV was first recorded from the Canberra region in 1986 when an outbreak occurred in Blowering Reservoir near Tumut (Langdon and Humphrey 1987). Subsequent outbreaks have occurred in Lake Burrinjuck in late 1990, Lake Burley Griffin in 1991 and 1994, Lake Ginninderra in 1994 and Googong Reservoir, also in 1994. The spread of EHNV has been aided by its relatively resistant characteristics and the ease with which it can be transmitted from one geographical location to another on nets, fishing lines, boats and other equipment. Langdon (1989b) found that the virus retained

its infectivity after being stored dry for 113 days. Once EHNV has been recorded from a water body it is considered impossible to eradicate.

## Major Conservation Objectives

The major conservation objective of this Action Plan is to re-establish in the long term, viable, wild populations of *M. macquariensis* as a component of the indigenous biological resources of the ACT and as a contribution to regional and national conservation of the species. This includes the maintenance of the species' potential for evolutionary development in the wild.

The objective is to be achieved through the following strategies:

- Improving understanding of the biology and ecology of the species as the basis for managing its habitat.
- Reintroducing *M. macquariensis* to their former habitats in the Canberra region.
- Protecting sites and habitats that are critical to the survival of the species.
- Managing activities in the Murrumbidgee River catchment in the ACT to minimise or eliminate threats to fish populations.
- Increasing community awareness of the need to protect fish and their habitats.

## Conservation Issues and Intended Management Actions

### GENERAL ISSUES

#### Habitat Rehabilitation

The majority of riverine ecosystems in eastern Australia have been affected by human impact with a resultant substantial modification of aquatic habitats. Significant effects on the rivers of the ACT region include irrigation extraction, dam construction and agricultural practices. Poor land management practices in the mid to late 1800s in the upper Murrumbidgee catchment resulted in extensive soil erosion and sediment addition to rivers. Also, clearing of the riparian zone removed nearly all the large eucalypts which were previously common, hence, there remains no source of large woody debris (snags) to provide structural complexity and habitat diversity for both fish and invertebrate populations.

⇒ Environment ACT will investigate options for rehabilitating critical fish habitats. These options include the selective removal of

sand to restore critical pool/riffle habitats and provision of additional cover such as snags or boulders.

### Environmental Flows

Increasing attention worldwide is being focussed on the need to provide water allocations for the environment. When the three impoundments on the Cotter River were constructed, little thought was given to how the abstraction or diversion of water would affect the animals living in the river. It is now known that to stimulate breeding activity, many native fish species require environmental stimuli or triggers such as an increase in water flow and water temperature. Reservoirs have severely disrupted downstream flow and temperature patterns, with consequent deleterious impacts for fish communities.

In order to address these issues, the ACT Government has developed Environmental Flow Guidelines which prescribe minimum flows to be achieved in the Cotter River above and below Bendora Reservoir, and include provisions for baseline flows as well as providing higher flows in spring to encourage fish spawning. ACTEW is responsible for the operation of ACT water supply reservoirs and the release of water from them.

There is no evidence to suggest that *M. macquariensis* has successfully spawned in Bendora Reservoir even though they are now of reproductive age. This failure to spawn may be partly related to the artificial flow regime imposed by Corin Dam upstream. Some individuals have been washed out of Bendora Reservoir and are now resident in the Cotter River downstream. It is important that these fish have the opportunity to breed and so environmental flows below Bendora Reservoir are important in achieving this aim.

⇒ Environment ACT will liaise with ACTEW to ensure that the appropriate flows under the Environmental Flows Guidelines are released from Corin and Bendora reservoirs.

### Protection of the Cotter River catchment from invasion by introduced fish species.

The Cotter River contains three threatened fish species: Trout Cod (*M. macquariensis*), Macquarie Perch (*Macquaria australasica*), Two-spined Blackfish (*Gadopsis bispinosus*), and is one of the few rivers in the eastern Murray-Darling drainage which does not have Carp (*C. carpio*) or Redfin Perch (*P. fluviatilis*) established. Both of these introduced fish species are now widespread in the basin and the Canberra region. The construction of Cotter Dam in 1912 provided a barrier preventing invasion from the Murrumbidgee River of these two fish species. *C. carpio* were first recorded from the ACT in 1974 and *P. fluviatilis* became widely established in 1983 (Lintermans *et al.* 1990; Lintermans 1991b), long after the dam was completed.

Cotter Reservoir is not regularly used for the supply of domestic water to Canberra, with the water usually drawn from Corin and Bendora reservoirs. However, it is foreseeable that as the population of Canberra grows, there will be a need to augment existing water storages. One possibility is that Cotter Reservoir could be increased in volume through either raising the height of the existing dam or demolition and construction of a new dam wall. It is important that any evaluation of options for the future of Cotter Reservoir recognise the significance of the barrier posed by the existing structure.

⇒ Environment ACT will highlight the importance of maintaining the integrity of the Cotter Dam barrier to upstream fish colonisation in the event of reconstruction/augmentation of Cotter Dam.

Similarly, Bendora Dam acts as a barrier to the colonisation of the upper and middle Cotter catchment by Brown Trout (*Salmo trutta*).

⇒ Environment ACT will highlight the importance of maintaining the integrity of the Bendora Dam barrier to upstream fish colonisation.

Another mechanism for the unwanted introduction of exotic fish species is the use of live fish as bait. This is thought to be how the introduced Oriental Weatherloach (*Misgurnus anguillicaudatus*) became established in the Cotter River and Lake Eucumbene (Lintermans 1993). It is illegal to use live fish as bait under the ACT *Fishing Act 1967*, although discouraging bait fishing of any kind will provide further safeguards against "bait-bucket" introductions. The designation of the Cotter River as a "trout water" with only artificial fly or lures allowed as a fishing method assists in the prevention of establishment of unwanted fish.

Similarly, the stocking of fish species in the Cotter catchment is not supported as the introduction of additional species will encourage bait fishing and potentially impose further stress on threatened fish populations (ACT Government 1997).

The 1997 review by the ACT Environment Advisory Committee of the recreational usage of Cotter Reservoir recommended that the reservoir should remain closed to recreational fishing because of the threat posed to native fish species by the establishment of introduced fish. This recommendation was accepted by the Minister for Environment, Land and Planning in August 1997.

⇒ Environment ACT will continue the policy of maintaining the Cotter River below Bendora Dam as a declared "trout water" for artificial fly or lure fishing only (under the ACT *Fishing Act 1967*).

⇒ Environment ACT will maintain the policy of not stocking fish for recreational purposes in streams of the ACT or water supply reservoirs in the Cotter River catchment as outlined in the ACT Fish Stocking Plan (ACT Government 1997).

⇒ Environment ACT will maintain the existing ban on recreational angling in Cotter Reservoir as recommended by the ACT Environment Advisory Committee and accepted by the Minister for Environment, Land and Planning in August 1997.

⇒ Environment ACT will review the adequacy of the current fishing regulations to protect any populations of the species should breeding populations become established in the Cotter River below Bendora Dam.

### SURVEY

Knowledge of the extent of dispersal of stocked *M. macquariensis* in the upper Murrumbidgee River catchment is incomplete. Monitoring of stocking sites (both in the Murrumbidgee and other catchments) has demonstrated that stocked fish can be caught for two or three years following release, but that they then disappear from the fishery. It is suspected that these older fish are dispersing downstream away from the stocking site. The fate of these older fish needs to be confirmed as it has important ramifications for the stocking program.

⇒ Environment ACT (Wildlife Research and Monitoring (WR&M)) will survey the upper Murrumbidgee River catchment to examine whether the older members of the species are dispersing downstream from stocking sites.

## MONITORING

There are currently two stocked populations of *M. macquariensis* in the ACT: Bendora Reservoir on the Cotter River and Angle Crossing on the Murrumbidgee River. Monitoring of the Bendora population has been conducted regularly since 1992 (Lintermans 1995b) with the Angle Crossing population first monitored in 1997. The monitoring program aims to determine growth rate and survival of stocked fish and detect potential natural recruitment. As well as this site specific monitoring, Environment ACT undertakes regular monitoring of fish populations in the Murrumbidgee River in the ACT. This monitoring should be capable of detecting dispersal of *M. macquariensis* from the stocking sites.

⇒ Environment ACT (WR&M) will continue its monitoring program of the two ACT stocking sites.

⇒ Environment ACT (WR&M) will regularly monitor the fish population in the Murrumbidgee River in the ACT. Monitoring techniques will include those suited to detecting the presence of *M. macquariensis*.

⇒ Environment ACT (WR&M) will liaise with Victorian and NSW fisheries agencies to ensure that there is exchange of relevant information on the species.

## RESEARCH

The lack of knowledge of the ecological requirements and tolerances of *M. macquariensis* makes management of this species in the wild very difficult. Extrapolation of information from the two "wild" populations may be unwise. The lowland Murray River ecosystem is vastly different to the upland Murrumbidgee River and the Seven Creeks population is the result of human intervention and so not representative.

The fact that *M. macquariensis* is endangered and scarce means that any research must be minimally disruptive and not put at risk the resource we are trying to conserve.

⇒ Environment ACT (WR&M) will encourage research into a number of priority areas with key information gaps. These include breeding requirements, effects of

introduced species, habitat management, dispersal and stocking strategies.

## Breeding Requirements

Whilst *M. macquariensis* has been successfully bred in captivity, this involves artificially injecting fish with hormones and then manually stripping eggs and milt (Ingram and Rimmer 1992). Virtually nothing is known of the flow regime, temperature cues or spawning site requirements of the species.

## Effects of Introduced Species

The lack of information on the historical distribution of *M. macquariensis* means that the impacts of introduced species such as trout (*S. trutta*, *O. mykiss*), Redfin (*P. fluviatilis*), Carp (*C. carpio*) and Goldfish (*Carassius auratus*) are unknown. It is also not known whether the species has changed its habitat preferences or utilisation patterns (as galaxids have done) in response to the presence of introduced species. Brown Trout (*S. trutta*) are known to prey on *M. macquariensis* and aquarium studies have shown juveniles of the species and trout have similar territorial requirements (Cadwallader 1979). The disease status of *M. macquariensis* with respect to EHN virus is unknown. Research into the interactions between the species and introduced fish species is necessary.

## Habitat Management

Some knowledge is becoming available on the broad habitat requirements of *M. macquariensis* in the Murray River, but very little is known for the upper Murrumbidgee catchment. Important knowledge gaps that need attention are the identification of preferred and critical habitat and the effects of surrounding land use on these habitats. Research into habitat management needs to focus on the following:

- Seasonal use of microhabitat by different age classes of fish.
- The effect of land management practices (both logging and roading) on the habitat of the species.

## Dispersal

The dispersal requirements (both temporal and spatial) of the species are unknown (see **Survey** section above).

## Stocking Strategy

The current stocking strategy involves the release of moderate numbers of fish for a number of consecutive years. Investigation of the success of alternative stocking strategies would be informative.

## EDUCATION AND LIAISON

Large sections of the general community are unaware of the reasons for the decline of native fish, and the actions that can help to halt this. Provision of such information will enhance community understanding and engender community support for research and management actions. Options for providing this information include the internet (Environment ACT homepage, ACT Native Fish Information System), development of curriculum materials, as well as pamphlets and signs.

Some anglers cannot discriminate between threatened and non threatened fish species. Consequently some individuals of threatened species are not returned unharmed to the water after accidental capture. On-site identification aids at locations where threatened fish are likely to be caught would reduce the incidence of mis-identification of threatened fish species.

A 1995 review of the *Fishing Act 1967* proposed the appointment of a dedicated fisheries officer. This officer could deliver targeted education programs to anglers, fishing clubs, school children etc. The Government is drafting a new Fishing Act in response to the 1995 review.

⇒ Environment ACT will investigate options for the provision of information to the public on the reasons for fish declines.

⇒ Environment ACT is providing signage along the Murrumbidgee and Cotter rivers in the ACT to assist anglers identify threatened fish species.

## Protection

*M. macquariensis* has been a declared *protected fish with special protection status* (SPS) since the early 1980s. As such it has been protected in the ACT for some time, although as the species was thought to be locally extinct by the mid 1980s (Lintermans *et al.* 1988), this protection was largely academic until the reintroduction of stocked populations in 1989.

The stocked *M. macquariensis* population in Bendora Reservoir is relatively secure due to the remoteness of this location and the ban on

recreational angling above Bendora Dam in Namadgi National Park (Anon. 1986). The species is occasionally washed out of Bendora Reservoir with recent captures documented in the Cotter River downstream.

⇒ Environment ACT will retain the status of *M. macquariensis* as a protected fish with SPS under the *Nature Conservation Act 1980*.

⇒ Environment ACT will maintain the closure to fishing under the *Fishing Act 1967* in the Cotter River catchment above Bendora Dam.

## Socio-economic Issues

The main social benefit of conserving representative populations of *M. macquariensis* is meeting community concerns that further loss or extinction of native species be prevented.

Management of the Cotter River in Namadgi National Park for water supply purposes has resulted in minimal gross water quality degradation through turbidity, considerable reduction of nutrient transport through land disturbance and prevention of large scale introductions of human pathogens, such as *E. coli*, *Giardia* and *Salmonella*.

Management of the Cotter catchment for conservation of threatened fish species, including provision of environmental flows, is of concern to ACTEW in terms of the security of water supply and pricing of domestic water. Compliance with environmental flow guidelines may have some impact on the urban water supply potential of the Cotter catchment. This may result in greater use of the higher cost water from Googong Dam which currently supplements water supply from the Cotter catchment during periods of high demand.

## Legislative Provisions

The following legislation is relevant to conservation of flora and fauna in the ACT region:

### AUSTRALIAN CAPITAL TERRITORY

#### ***Nature Conservation Act 1980***

The Nature Conservation Act provides a mechanism to encourage the protection of native plants and animals (including fish and invertebrates), the identification of threatened species and communities, and the management of Public Land reserved for nature conservation purposes. Specified activities are managed via a licensing system.

Native plants and animals may be declared in recognition of a particular conservation concern and increased controls and penalties apply. Species declared as endangered must be declared as having special protection status (SPS), the highest level of statutory protection that can be conferred.

As an endangered species, *M. macquariensis* must be declared a SPS species and any activity affecting such a species is subject to special scrutiny. Conservation requirements are a paramount consideration and only activities related to conservation of the species or serving a special purpose are permissible. The Conservator of Flora and Fauna may only grant a licence for activities affecting a species with SPS where satisfied that the act specified in the licence meets a range of stringent conditions. Further information can be obtained from the Licensing Officer, Compliance and Quarantine Services, Environment ACT, telephone (02) 6207 6376.

#### ***Fishing Act 1967***

Amendments to the Fishing Act are being prepared to make it more consistent with the corresponding NSW fishing legislation. Amendments to the Act could strengthen its powers to protect native fish species by providing for bag, size and gear limits as well as being able to declare closed seasons or total protection for fish species. One proposed amendment involves prohibiting all fishing in a stretch of the Murrumbidgee River from Angle Crossing downstream to the Gudgenby River confluence. This closure is designed to protect the stocked *M. macquariensis* population in the river.

#### ***Land (Planning and Environment) Act 1991***

The Land (Planning and Environment) Act is the primary authority for land planning and administration. It establishes the Territory Plan, which identifies nature reserves, national parks and wilderness areas within the Public Land estate.

The Territory Plan also provides for flora and fauna guidelines which list criteria for the assessment of the potential impact of a land use proposal. These focus on a range of aspects of the ACT's ecological resources, including the protection of vulnerable and endangered species along with their habitats. The conservation requirements of threatened species and their habitats are considered specifically during this process.

The Act also establishes the Heritage Places Register. Places of natural heritage significance may be identified and conservation requirements specified.

Environmental Assessments and Inquiries may be initiated in relation to land use and development proposals.

### NEW SOUTH WALES

#### ***Fisheries Management Act 1994***

A new Part 7A covering threatened species conservation provisions relating to fish and marine vegetation was added via the *Fisheries Management Amendment Act 1997*, which came into effect on 1 July 1998. These provisions cover the identification, assessment and proclamation of endangered species, populations and ecological communities, vulnerable species and key threatening processes. They also provide for identification of critical habitat, mandatory impact assessment in the land use planning process and active recovery management. Under the Act, the species is totally protected.

### COMMONWEALTH

#### ***Endangered Species Protection Act 1992***

Under this legislation, *M. macquariensis* has been declared an **endangered** species. The Commonwealth is required to prepare and implement recovery plans for the species as it occurs in Commonwealth areas, and to cooperate with both the ACT, Victorian and NSW authorities in implementing protection measures. The Commonwealth also encourages joint preparation and implementation of a recovery plan across State and Territory boundaries (ANCA 1994). A recovery team comprising representatives from Victorian, New South Wales, ACT and

Commonwealth Governments, including the Murray Darling Basin Commission, has been coordinating an active research and management program. The funding for this national recovery effort expired in 1997.

### Consultation and Community Participation

In 1995, a discussion paper on recreational fishing in the ACT was widely circulated for public comment (ACT Parks and Conservation Service 1995). The purpose of the paper was to outline current fisheries management in the ACT and present a series of proposed changes to management practices. One proposal was to close to fishing a section of the Murrumbidgee River upstream of Tharwa in order to protect a stocked population of *M. macquariensis*. A total of 194 submissions representing the views of 1290 individuals was received on the discussion paper with 92 % of respondents supporting the proposed closure to protect the species (ACT Parks and Conservation Service 1996).

Representatives from Environment ACT (WR&M; ACT Parks and Conservation Service) maintain regular contact with officers from Planning and Land Management in the Department of Urban Services, fishing clubs and the ACT Sport and Recreational Fishing Council to raise awareness of issues involving fish communities.

A number of land management practices have the capacity to adversely affect fish populations, especially urban development, agricultural pursuits and forestry operations. These can generate soil erosion which leads to habitat destruction and deterioration in water quality. Environment ACT representation on appropriate intra- and interdepartmental committees and working groups will continue to provide opportunities for liaison on these matters.

⇒ Environment ACT will encourage community groups such as fishing clubs and the Australia New Guinea Fishes Association (ANGFA) to assist in the conservation of ACT fish populations and their habitats. Anglers will be encouraged to report any catches of threatened fish.

### Implementation, Evaluation and Review

#### RESPONSIBILITY FOR IMPLEMENTATION

Environment ACT (WR&M; ACT Parks and Conservation Service; Conservation and Land Management) have responsibility for coordinating implementation of this Action Plan. Specific actions on Territory Land will be subject to the availability of Government resources. Primary responsibility for conservation and management of the species on Territory Land will rest with Environment ACT.

#### EVALUATION

Implementation of this Action Plan will be a collaborative exercise between government agencies, landholders and the community generally. NSW participation will be critical in some cases. The Action Plan will be reviewed after three years. The review will comprise an assessment of progress using the following performance indicators:

- completion of commitments that can reasonably be expected to be finalised within the review timeframe (e.g. introduction of a statutory protection measure for a species; development of a management plan);
- completion of a stage in a process with a time line that exceeds the review period (e.g. design or commencement of a research program);
- commencement of a particular commitment that is of a continuing nature (e.g. design or commencement of a monitoring program for population abundance); and
- expert assessment of achievement of conservation objectives of the Action Plan.

The review will be reported to the ACT Flora and Fauna Committee. This will provide an opportunity for Environment ACT and the Flora and Fauna Committee to assess progress, take account of developments in nature conservation knowledge, policy and administration, and review directions and priorities for future conservation action.

The following conservation actions will be given priority attention:

⇒ completion of surveys in the upper Murrumbidgee River catchment to examine possible downstream dispersal;

⇒ establishment of a monitoring program to allow the detection of dispersal and

recruitment in stocked populations in the ACT;

⇒ commencement of a research program, especially on priority research topics; and

⇒ putting in place protection measures.

## Acknowledgments

Access to unpublished information was provided by Mark Lintermans, Senior Aquatic Ecologist, Environment ACT.

Unpublished information on habitat use at Yarrowonga was provided by John Koehn, Marine and Freshwater Resources Institute, Victoria.

The illustration of the species (Figure 1) was provided by NSW Fisheries.

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### List of Action Plans - February 1999

In accordance with Section 23 of the *Nature Conservation Act 1980*, the following Action Plans have been prepared by the Conservator of Flora and Fauna:

- No. 1: Natural Temperate Grassland - an endangered ecological community.
- No. 2: Striped Legless Lizard (*Delma impar*) - a vulnerable species.
- No. 3: Eastern Lined Earless Dragon (*Tympanocryptis lineata pinguicollis*) - an endangered species.
- No. 4: A leek orchid (*Prasophyllum petilum*) - an endangered species.
- No. 5: A subalpine herb (*Gentiana baeuerlenii*) - an endangered species.
- No. 6: Northern Corroboree Frog (*Pseudophryne pengilleyi*) - a vulnerable species.
- No. 7: Golden Sun Moth (*Synemon plana*) - an endangered species.
- No. 8: Button Wrinklewort (*Rutidosis leptorrhynchoides*) - an endangered species.
- No. 9: Small Purple Pea (*Swainsona recta*) - an endangered species.
- No.10: Yellow Box - Red Gum Grassy Woodland - an endangered ecological community (draft).
- No.11: Two-spined Blackfish (*Gadopsis bispinosus*) - a vulnerable species.
- No.12: Trout Cod (*Maccullochella macquariensis*) - an endangered species.
- No.13: Macquarie Perch (*Macquaria australasica*) - an endangered species.
- No.14: Murray River Crayfish (*Euastacus armatus*) - a vulnerable species.
- No. 15: Hooded Robin (*Melanodryas cucullata*) - a vulnerable species (draft).
- No. 16: Swift Parrot (*Lathamus discolor*) - a vulnerable species (draft).
- No. 17: Superb Parrot (*Polytelis swainsonii*) - a vulnerable species (draft).
- No. 18: Brown Treecreeper (*Climacteris picumnus*) - a vulnerable species (draft).
- No. 19: Regent Honeyeater (*Xanthomyza phrygia*) - an endangered species (draft).
- No. 20: Painted Honeyeater (*Grantiella picta*) - a vulnerable species (draft).

- No. 21: Perunga Grasshopper (*Perunga ochracea*) - a vulnerable species (draft).
- No. 22: Brush-tailed Rock-wallaby (*Petrogale penicillata*) - an endangered species (draft).
- No. 23: Smoky Mouse (*Pseudomys fumeus*) - an endangered species (draft).
- No. 24: Tuggeranong Lignum (*Muehlenbeckia tuggeranong*) - an endangered species (draft).

#### FURTHER INFORMATION

Further information on this Action Plan or other threatened species and ecological communities can be obtained from:

Environment ACT  
(Wildlife Research and Monitoring)

Phone: (02) 6207 2126

Fax: (02) 6207 2122

Environment ACT Homepage

<http://www.act.gov.au/envirom>

This document should be cited as:

ACT Government, 1999. *Trout Cod* (*Maccullochella macquariensis*):  
*An endangered species. Action Plan*  
No. 12. Environment ACT, Canberra.