

MANAGEMENT OPTIONS FOR MURRAY COD IN SOUTH AUSTRALIA



PIRSA Fisheries

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Government of South Australia
Primary Industries and Resources SA

An Invitation to Comment

The options outlined in this paper are proposed to inform discussion on the future management arrangements for sustainable recovery of the South Australian Murray Cod fishery.

Primary Industries and Resources South Australia Fisheries invites anyone with an interest in the Murray Cod fishery to make a submission **using the attached feedback form** (found on pages 46-50) regarding the proposed options outlined in this paper. A submission is a way to provide information, express your opinion and put forward your preferred course of action, including any alternative approaches.

You may wish to agree, disagree, or comment on either general or specific matters outlined in the paper or introduce other options. When making comment on a specific issue in the paper:

- refer each point to the appropriate section in the options paper;
- clearly state your point of view; and
- indicate your reasoning or source of information.

If you prefer you may limit your submission to a list of points.

You may choose to collaborate with a group of people to make a joint submission, which will assist in reducing the workload on some individuals and may be useful in increasing the pool of ideas.

All submissions will be treated as public documents unless specifically marked confidential, and may be quoted in full or in part in any further reports.

The closing date for submissions is 31 March 2010.

Submissions should be addressed to:
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Acronyms used in this document

Regions		Organisations	
SA	South Australia	PIRSA	Primary Industries and Resources of South Australia
QLD	Queensland	DEH	Department for Environment and Heritage
NSW	New South Wales	SARDI	South Australia Research and Development Institute
VIC	Victoria	NRM	Natural Resource Management (board)
MDB	Murray-Darling Basin	NFA(SA)	Native Fish Australia (South Australia)
		CRC	Cooperative Research Centre
Other		TSSS	Threatened Species Schedule Subcommittee
ESD	Ecologically Sustainable Development	DWLBC	Department of Water, Land Biodiversity and Conservation
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>	MDBA	Murray Darling Basin Authority (formally Commission)
NRM Act	<i>Natural Resource Management Act 2004</i>	DEWHA	Department of the Environment, Water, Heritage and the Arts
NFS	Native Fish Strategy	IUCN	International Union for Conservation of Nature
NP&W Act	<i>National Parks and Wildlife 1972</i>	SARFAC	South Australian Recreational Fishing Advisory Committee
EHN	Epizootic Haematopoietic Necrosis		
VER	Viral Encephalopathy and Retinopathy		
GUD	Goldfish Ulcer Disease		

1 INTRODUCTION

Murray Cod (*Maccullochella* spp) is the largest freshwater fish in Australia, reaching a recorded weight of greater than 100 kg and a length of 1.8 m. Murray Cod are slow growing and long-lived, potentially living to over 45 years of age.

Murray Cod is an important species of the Murray-Darling Basin (MDB) and an integral part of the riverine ecosystem. Murray Cod has acquired an iconic status by many Australian communities, due to its impressive size, being top of the food chain in the freshwater food web and the aggressive/territorial nature it displays. The Murray Cod fishery has significant cultural, environmental, recreational and economic values for all South Australians. These values signify the importance of managing the fishery, so future generations are able to enjoy Murray Cod in years to come.

Historically, Murray Cod were common throughout the South Australian MDB and supported a large commercial and recreational fishery. Today in South Australia there are no commercial fishing licences for targeting Murray Cod in the River Murray (ceased in 2003). The commercial Lakes and Coorong Fishery has access to Murray Cod but recent catches have been negligible. There is currently a closure to all fishing, including recreational fishing of the species. Significant changes to the lower River Murray, including extensive flow regulation and habitat modification (Walker 2006), have resulted in significant declines in the abundance and potentially the distribution of Murray Cod (Ye *et al.* 2000). The listing of Murray Cod as a species vulnerable to extinction under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) in 2003 is an indication that implementation of effective long-term management is vital for reducing the risk of further declines in the Murray Cod population.

An 'aspirational' target of restoring South Australian Murray Cod populations to 60% of pre-European levels over a 50-year period has been set by PIRSA Fisheries to align with the objectives of the implementation of the Murray-Darling Basin Authority's (MDBA) Native Fish Strategy (NFS). Effective communication, engagement and liaison between the range of national, state and regional management agencies, Aboriginal communities and interest groups, including recreational anglers and conservation groups, is essential to the successful recovery of the Murray Cod population and the recreational fishery.

2 PURPOSE

This purpose of this options paper is to provide the opportunity for all stakeholders to comment on the recovery of the South Australian Murray Cod population and the long-term future of the Murray Cod fishery. This paper sets out objectives and management strategies that aim to promote the recovery of the Murray Cod population. The paper outlines the following:

- Current knowledge of Murray Cod biology and ecology;
- Past management arrangements for the commercial and recreational fishery;
- Options for the future management of the Murray Cod fishery; and
- A framework for assessing the management of the fishery.

3 MANAGEMENT OPTIONS

This discussion paper has been distributed to provide recreational fishers, the broader community and other stakeholders and agencies with the opportunity to comment on proposed options for the future management of the Murray Cod fishery. Four options are proposed. PIRSA Fisheries recognises that there are risks and benefits to the fishery and the community associated with each option. The potential ecological, social and environmental impacts of each proposed option are discussed in section 7. A further three options are also provided, which could be implemented in conjunction with any of the other options to enhance the effectiveness of management arrangements. For example, option 1: maintain current fishing arrangements could be used with option A: area closures and option B: gear restrictions. Any management arrangements for Murray Cod would affect both the recreational and commercial fishing sectors.

The four proposed options for future management arrangements are:

1. Maintain existing fishing regulations
2. Establish a catch and release fishery
3. Extend the current fishing closure
4. List Murray Cod as a protected species

Further management arrangements that could be used in conjunction with these options are:

- A. Area closure
- B. Gear restrictions
- C. Stock enhancement

These options have been developed with the objects of the *Fisheries Management Act 2007* in mind. A framework detailing the specific objectives and management strategies for the future management of Murray Cod is provided at Table 1. The framework integrates a set of environmental principles into the management of the fishery to ensure that decision-making incorporates critical environmental factors. This approach aims to ensure that fundamental environmental processes are maintained or, where necessary, restored to maximise benefits for fish stocks. The overarching goal is:

Ensuring through proper conservation, preservation and fisheries management measures that South Australian Murray Cod populations are not endangered or over-exploited.

The ability of each option to achieve this goal must be considered in deciding which management arrangements to implement in the fishery. The cost-effectiveness of compliance will also be relevant to the evaluation of options or package of options.

Table 1. Management framework for the future management of Murray Cod

Goal	Objective	Strategy	Performance Indicators	Description
Ensuring through proper conservation, preservation and fisheries management measures that South Australian Murray cod populations are not endangered or over-exploited	1. Rehabilitate South Australia's Murray cod populations back to 60% of their pre-European settlement levels after 50 years of implementation	1a. Ensure recreational rules and regulations support sustainable use of the resource (options proposed in this paper)	Population (size/age) structure of Murray Cod in SA	Length and age frequency data build a picture of the population structure of the Murray Cod resource. This indicates whether there is a variety of different aged fish in the population, from juveniles to mature fish, whether juvenile fish are successfully recruiting to the fishery and how resilient the fishery is likely to be to fishing pressure.
			Relative abundance	An index of fish population abundance can be used to compare fish populations from year to year. This does not measure the actual numbers of fish, but shows changes in the population over time. PIRSA Fisheries collects some fishery-independent catch per unit effort information, but does not yet have a reliable indicator of relative abundance.
			Recruitment index	An index of the addition of new individuals to a stock shows is a way to measure changes in the spawning and recruitment success of a population over time.
	2. Reinstate flow regimes suitable for recruitment of Murray Cod within the next 5 years	2a. Improve coordination between Government agencies responsible for water flow management and natural resource management. 2b. Ensure that state and National water flow strategies take into account impacts on Murray Cod. 2c. Identify, protect and repair key aquatic and riparian habitats for Murray Cod in SA. 2d. Monitor monthly freshwater flow into SA.	Areas of lotic flow habitat exist in SA	Research indicates that lotic (flowing water) habitats may be a primary driver of Murray Cod recruitment.
			High river flows	High river flows have indicated a strong recruitment to the fishery.

	<p>3. Sufficient biological and environmental information is collected to make informed management decisions</p>	<p>3a. Establish baseline biological information for the fishery</p> <p>3b. Monitor the performance of the Murray Cod population through the fishery-independent assessment</p> <p>3c. Review and update research program to enable delivery of information on key performance indicators</p>	<p>Availability of baseline biological information</p> <p>Production of regular status reports</p>	<p>Knowledge gaps exist such as biological and ecological information on Murray Cod, including population dynamics.</p> <p>The provision of regular scientific information to PIRSA Fisheries on stock status informs management decisions and allows assessment of the effectiveness of management strategies.</p>
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Option 1: Maintain existing fishing regulations

Option 1 essentially describes maintaining the existing fishing arrangements, which allow for the target and take of Murray Cod using the permitted recreational devices (section 7.3.1). The management arrangements for this option are:

- Minimum legal size limit 60 cm
- Maximum legal size limit 100 cm
- Daily recreational bag limit per person: 1
- Daily recreational boat limit: 3

Annual seasonal closure 1 August – December 31

The commercial Lakes and Coorong Fishery would also be able to take Murray Cod under these arrangements.

The potential risk of making no changes to the current management of the fishery is that the Murray Cod population could further decline in South Australia. Murray Cod stocks have already suffered serious impacts from historical changes to the River Murray system and severe drought conditions.

PIRSA Fisheries does not support this option due to poor status of the Murray Cod resource and the associated risk of over-exploitation that any additional impacts of fishing activities may cause. Additional management strategies are considered essential to protect stocks and ensure the long-term sustainability of the fishery.

Option 2: Establish a catch and release fishery

This option would allow for the target and release of legal sized Murray Cod using current permitted devices (section 7.3.1) until the status of the resource improves. The annual seasonal closure (no take and no target of Murray Cod) from 1 August to 31 December would remain, to protect the population during the spawning season. If this option was adopted, guidelines would apply to the handling and release of Murray Cod, which is critical to the survival of individual fish. Handling guidelines would include:

1. Use a knotless landing net to support the fish in the water;
2. Do not remove the fish out of the water, take any photos while the fish is next to the boat;
3. Use a hook-out or long-nosed pliers to assist in removing hooks;
4. Cut the line outside the mouth for deep hooked fish and don't try to remove the hook; and
5. Fish grips can be used to restrain fish in the water, but they must be used with care

Licence holders in the commercial Lakes and Coorong Fishery would not be permitted to retain Murray Cod under this option until the status of the resource improved.

As shown on page 33, this option would provide few benefits to the recovery of the fishery in the long-term, acknowledging there are risks associated with the use of recreational fishing gear and handling of Murray Cod. A major concern associated with a catch and release fishery is the limited knowledge of recovery of large Murray

Cod after release; anecdotal evidence has suggested that post-release mortality is very high.

The imposition of catch and release restrictions under this option would be in place until certain conditions are met that indicate recovery of the population. A review of the arrangements would be triggered when a change in the population structure from the current large dominance of older >800 mm fish to a population structure where the length frequency indicates a significant proportion of fish in the 300 mm to 400 mm and 500 mm to 700 mm range.

Historical fisheries data indicate a strong association between high river flows (within channel and over-bank) and Murray Cod recruitment. Consequently, a key environmental indicator for potential Murray Cod recruitment will be River Murray discharge, measured as flow to South Australia (ML/d). Furthermore, recent research indicates that lotic (flowing water) habitats may be a primary driver of Murray Cod recruitment. Such habitats were common in the main channel of the River Murray prior to the construction of locks and weirs, even during drought. Nevertheless, these habitats are now essentially absent from the main river channel except during high river flows (> 40,000 ML/d) when the locks and weirs are removed.

There is a time lag between environmental conditions suitable for spawning and recruitment (e.g. flow or hydrodynamics) and the ability to accurately detect fish in the 'greater than 300 mm' and '500 mm to 700 mm' cohorts. In other words, successful spawning does not necessarily mean that the cohort of fish will successfully grow to the legal minimum size (and have the opportunity to reproduce). It will be several years before this can be detected in catch sampling. Therefore, if flowing water habitats are reinstated or strong environmental flows are received, it may take a number of years for the trigger to be reached.

Option 3: Extend the current fishing closure

Option 3 involves extending the closure that prohibits the target and the take of Murray Cod until the status of the resource improves. Licence holders in the commercial Lakes and Coorong Fishery would also not be permitted to retain Murray Cod under this option until the status of the resource improved.

Maintaining the current all-year closure would provide additional protection to the Murray Cod population from fishing pressure and increased opportunities for recovery of the stock when favourable environmental conditions return. It is acknowledged that there are a number of risks to social and economic values associated with this option in the short-term and long-term (refer to page 34). However, a closure of this nature would benefit the recovery of the population in the long-term and provide for the re-establishment of a sustainable recreational fishery in the future.

The imposition of an extended closure under this option would be in place until certain conditions are met that indicate recovery of the population. A review of the arrangements would be triggered when a change in the populations structure from the current large dominance of older >800 mm fish to a population structure where the length frequency indicates a significant proportion of fish in the 300 mm to 400 mm and 500 mm to 700 mm range.

As previously mentioned in option 2, if flowing water habitats are reinstated or strong environmental flows are received it may take several years for the trigger to be reached.

Option 4: List Murray Cod as a Protected Species

Listing Murray Cod as a protected species under the *Fisheries Management Act 2007* would establish a long-term prohibition on all take or target of Murray Cod.

This option could potentially cause economic loss and social flow-on impacts to local and regional towns in the short and long-term by removing recreational fishing opportunities. However, legislative protection would establish secure management arrangements to conserve the Murray Cod population and would help to recover current depleted stocks over the long-term. This measure could be reviewed in the future if there is a full recovery of the Murray Cod population

Option A: Area closure

An area closure could effectively enhance any of the four options, by implementing further restrictions that limit access to or effort in the fishery. Different controls could be implemented to restrict the type of fishing activities (e.g. type of gear used) in a particular area and at a particular time. The enhanced restrictions could offer additional protection to important Murray Cod populations, juveniles and habitats and help in achieving the long-term benefits of sustaining the fishery.

Option B: Gear restriction

Option B is to limit the type of fishing gear that could be used in the River Murray. For example, in order to reduce the likelihood of incidental catch of Murray Cod a ban on the use of lures larger than 15 cm could be implemented. Additional gear restrictions could reduce both overall effort in the fishery and more importantly reduce the likelihood of Murray Cod being caught. Other gear restrictions such as banning certain types of lures or banning the use of large hooks can each reduce the amount of effort placed on Murray Cod. As shown in Table 6, placing further gear restrictions on the fishery could help reduce the impact to the Murray Cod fishery and benefit the fishery in the long-term.

Option C: Stock enhancement.

Option C provides the opportunity of stocking areas of the South Australian River Murray with hatchery-reared fish to aid in the recovery of Murray Cod stocks. Given the continued severe drought conditions across the Murray-Darling Basin, which have severely impacted on the availability of habitat and food for Murray Cod, a stock enhancement program may be unlikely to be the best tool for recovering depleted stocks. Considering that there is a range of potential negative impacts, high costs and little understanding of the likely benefits, this option poses a number of risks.

PIRSA Fisheries' policy to date has been to working towards recovering Murray Cod stocks through addressing the primary reasons for its decline, primarily by improving the health of the River Murray. However, a review of the feasibility of a stock enhancement program for Murray Cod could be undertaken to assess the relative benefits and risks in more detail. PIRSA has received feedback that recreational stocking should be provided as a last resort if Murray Cod continue to decline.

4 PIRSA FISHERIES' PREFERRED OPTIONS

Pages 14 - 20 below analyse the risks and benefits associated with each option.

Considering the environmental, social and economic risks and benefits of each approach, PIRSA Fisheries' preferred option is Option 3. The additional options A, B or C could be used in conjunction with this option.

This consultation process is designed to receive feedback from interested persons and groups about the preferred options, or combination of options. A feedback form is attached to this paper to assist in providing this feedback.

Strategy 1: Ensure recreational rules and regulations support sustainable use of the resource

Option 1: Maintain existing management arrangements

Maintain size limits:

- Minimum legal limit 60 cm
- Maximum legal limit 100 cm
- Daily recreational bag limit per person: 1
- Daily recreational boat limit: 3
- Seasonal closure 1 August – 31 December

Ecological impacts	Social impacts	Economic impacts
<p>Short-term risks</p> <ul style="list-style-type: none"> • Limits the recovery of Murray Cod stocks under existing predicted drought conditions and lack of flows • Potential further decline of population 	<p>Short-term risks</p> <ul style="list-style-type: none"> • None 	<p>Short-term risks</p> <ul style="list-style-type: none"> • None
<p>Long-term risks</p> <ul style="list-style-type: none"> • Over-exploitation of Murray Cod could prevent the species' recovery, due to low recruitment and low flow conditions 	<p>Long-term risks</p> <ul style="list-style-type: none"> • Risks to future recreational fishing opportunities for Murray Cod if fishery declines and does not recover. 	<p>Long-term risks</p> <ul style="list-style-type: none"> • Economic loss by associated industries (e.g. tourism, tackle/retail) if fishery declines and does not recover
<p>Short-term benefits</p> <ul style="list-style-type: none"> • None 	<p>Short-term benefits</p> <ul style="list-style-type: none"> • Allows recreational target and take of Murray Cod 	<p>Short-term benefits</p> <ul style="list-style-type: none"> • Maintain economic benefits from activities associated with recreational fishing of Murray Cod
<p>Long-term benefits</p> <ul style="list-style-type: none"> • None 	<p>Long-term benefits</p> <ul style="list-style-type: none"> • None 	<p>Long-term benefits</p> <ul style="list-style-type: none"> • No economic benefits from activities associated with recreational Murray Cod fishing if fishery declines and does not recover

Option 2: Catch and release fishing

Recreational anglers would be permitted to target and release any size Murray Cod – No take

Seasonal closure 1 August – 31 December – No target or take

Ecological impacts	Social impacts	Economic impacts
<p>Short-term risks</p> <ul style="list-style-type: none"> Lack of understanding of post-release mortality of Murray Cod 	<p>Short-term risks</p> <ul style="list-style-type: none"> No take of Murray cod would affect those who fish to eat 	<p>Short-term risks</p> <ul style="list-style-type: none"> Some economic loss if recreational fishers travel interstate to target and take Murray Cod Increase demand for research
<p>Long-term risks</p> <ul style="list-style-type: none"> Impacts on Murray Cod could prevent the species' recovery, due to low recruitment and low flow conditions 	<p>Long-term risks</p> <ul style="list-style-type: none"> None 	<p>Long-term risks</p> <ul style="list-style-type: none"> Economic loss by associated industries (e.g. tourism, tackle/retail) if fishery declines and does not recover Ongoing research costs
<p>Short-term benefits</p> <ul style="list-style-type: none"> Some protection provided from returning fish to the system 	<p>Short-term benefits</p> <ul style="list-style-type: none"> Allows recreational targeting of Murray Cod 	<p>Short-term benefits</p> <ul style="list-style-type: none"> Maintain some economic benefits from recreational targeting of Murray Cod
<p>Long-term benefits</p> <ul style="list-style-type: none"> None 	<p>Long-term benefits</p> <ul style="list-style-type: none"> Allows recreational targeting of Murray Cod 	<p>Long-term benefits</p> <ul style="list-style-type: none"> Uncertain No economic benefits from activities associated with recreational Murray Cod fishing if fishery declines and does not recover

Option 3: Closure of fishery

Ban on the target and take of Murray Cod

Ecological impacts	Social impacts	Economic impacts
<p>Short-term risks</p> <ul style="list-style-type: none"> Incidental catch from recreational fishers targeting other species may occur 	<p>Short-term risks</p> <ul style="list-style-type: none"> Denied access to recreationally fish for Murray cod 	<p>Short-term risks</p> <ul style="list-style-type: none"> Some economic loss if recreational fishers travel interstate to target and take Murray cod Increase demand for research
<p>Long-term risks</p> <ul style="list-style-type: none"> Species recovery dependent on future improved flow conditions and successful recruitment 	<p>Long term risks</p> <ul style="list-style-type: none"> None 	<p>Long-term risks</p> <ul style="list-style-type: none"> Ongoing research costs
<p>Short-term benefits</p> <ul style="list-style-type: none"> Protects existing stock to provide better opportunities for successful Murray Cod recruitment and recovery when improved environmental flows return to the river 	<p>Short-term benefits</p> <ul style="list-style-type: none"> None 	<p>Short-term benefits</p> <ul style="list-style-type: none"> None
<p>Long-term benefits</p> <ul style="list-style-type: none"> Increased opportunity for Murray Cod population to recover under more favourable environmental flow conditions 	<p>Long-term benefits</p> <ul style="list-style-type: none"> If recovery triggers for Murray Cod population are met, there would be improved recreational fishing opportunities when fishery is re-opened 	<p>Long-term benefits</p> <ul style="list-style-type: none"> If recovery triggers are met and fishery re-opened, increase in economic benefits from activities associated with improved recreational fishing

Option 4: Protected species list

Permanent ban on the target and take of Murray Cod

Ecological impacts	Social impacts	Economic impacts
Short-term risks <ul style="list-style-type: none"> • Incidental catch from recreational fishers targeting other species may occur 	Short-term risks <ul style="list-style-type: none"> • No recreational fishing opportunities 	Short-term risks <ul style="list-style-type: none"> • Some economic loss if recreational fishers travel interstate to target and take Murray Cod • Increases demand for research
Long-term risks <ul style="list-style-type: none"> • Species recovery dependent on future improved flow conditions and successful recruitment 	Long-term risks <ul style="list-style-type: none"> • No recreational fishing opportunities for a significant period of time 	Long-term risks <ul style="list-style-type: none"> • Economic losses if recreational fishers travel interstate to target and take Murray Cod
Short-term benefits <ul style="list-style-type: none"> • Protects existing stock to provide better opportunities for successful Murray Cod recruitment and recovery when improved environmental flows return to the river 	Short-term benefits <ul style="list-style-type: none"> • Recognition of conservation value of Murray Cod 	Short-term benefits <ul style="list-style-type: none"> • None
Long-term benefits <ul style="list-style-type: none"> • Increased opportunity for Murray Cod population to recover under more favourable environmental flow conditions 	Long-term benefits <ul style="list-style-type: none"> • Recognition of conservation value of Murray Cod 	Long-term benefits <ul style="list-style-type: none"> • None

Further Management Arrangements

Option A: Area closure

Restricts or prohibits fishing activities within a certain area/s and/or at a particular time of year. Could be short-term closure for limited period, or permanent seasonal closure, or permanent closure.

Ecological impacts	Social impacts	Economic impacts
<p>Short-term risks</p> <ul style="list-style-type: none"> • Does not protect all populations within the MDB in SA • Murray Cod make seasonal movements to spawn and therefore could be taken outside of the closure • Displacement of fishing effort to other areas 	<p>Short-term risks</p> <ul style="list-style-type: none"> • Limits access to particular areas 	<p>Short-term risks</p> <ul style="list-style-type: none"> • Some economic loss to communities from banning fishing for Murray Cod in closed area/s and/or at a particular time of year.
<p>Long-term risks</p> <ul style="list-style-type: none"> • If used in isolation or not designed appropriately, will not protect existing populations. Therefore, long-term risks depend on how this option is used in combination with other options. • Displacement of fishing effort to other areas 	<p>Long-term risks</p> <ul style="list-style-type: none"> • Limits access to particular areas 	<p>Long-term risks</p> <ul style="list-style-type: none"> • As above, depending on type of closure
<p>Short-term benefits</p> <ul style="list-style-type: none"> • Protection to important breeding populations 	<p>Short-term benefits</p> <ul style="list-style-type: none"> • Recreational fishing allowed for Murray Cod in areas not affected by the closure 	<p>Short-term benefits</p> <ul style="list-style-type: none"> • Economic benefits to local/regional communities not affected by the closed area from recreational fishing for Murray Cod
<p>Long-term benefits</p> <ul style="list-style-type: none"> • Protection to important breeding populations 	<p>Long-term benefits</p> <ul style="list-style-type: none"> • Recreational fishing allowed for Murray Cod in areas not affected by the closure 	<p>Long-term benefits</p> <ul style="list-style-type: none"> • As above, depending on type of closure

Option B: Gear restrictions

Prohibit the use of certain types of fishing gear (for example ban lures 15 cm or larger)

Ecological impacts	Social impacts	Economic impacts
Short-term risks <ul style="list-style-type: none"> • None 	Short-term risks <ul style="list-style-type: none"> • Denied use of certain gear 	Short-term risks <ul style="list-style-type: none"> • Some economic loss to tackle shops from a reduction in demand from recreational fishers for gear
Long-term risks <ul style="list-style-type: none"> • None 	Long-term risks <ul style="list-style-type: none"> • None 	Long-term risks <ul style="list-style-type: none"> • Some economic loss to tackle shops from a reduction in demand from recreational fishers for gear
Short-term benefits <ul style="list-style-type: none"> • Reduces likelihood of accidentally catching Murray Cod when targeting other species and therefore reduces impact • Limits pressure to fishery from reduced effort 	Short-term benefits <ul style="list-style-type: none"> • None 	Short-term benefits <ul style="list-style-type: none"> • None
Long-term benefits <ul style="list-style-type: none"> • Reduces likelihood of accidentally catching Murray Cod when targeting other species and therefore reduces impact 	Long-term benefits <ul style="list-style-type: none"> • None 	Long-term benefits <ul style="list-style-type: none"> • None

Option C: Stock enhancement

Implement a stock enhancement the SA River Murray with hatchery-reared fish

Ecological impacts	Social impacts	Economic impacts
Short-term risks <ul style="list-style-type: none"> Limited understanding impacts of restocking 	Short-term risks <ul style="list-style-type: none"> Unknown 	Short-term risks <ul style="list-style-type: none"> Large costs involved in producing hatchery reared fish. Increase to research and monitoring costs
Long-term risks <ul style="list-style-type: none"> Genetic-related impacts Possible disease issues from introduction of hatchery fish Changes to fish dynamics, might lead to decreases in other species considering that Murray Cod is a high order predator 	Long-term risks <ul style="list-style-type: none"> Unknown 	Long-term risks <ul style="list-style-type: none"> Large costs to provide hatchery reared fish with potential small benefits to fishery Ongoing research and monitoring/evaluation costs
Short-term benefits <ul style="list-style-type: none"> Possible increase to the population of fish in the river system 	Short-term benefits <ul style="list-style-type: none"> Improved recreational fishing opportunities if released fish survive and successfully recruit to the fishery 	Short-term benefits <ul style="list-style-type: none"> Economic benefit associated with improved recreational fishing opportunities if released fish survive and successfully recruit to the fishery
Long-term benefits <ul style="list-style-type: none"> Unknown 	Long-term benefits <ul style="list-style-type: none"> Unknown 	Long-term benefits <ul style="list-style-type: none"> Unknown

5 CURRENT KNOWLEDGE OF MURRAY COD

5.1 Murray Cod Decline

Since early European settlement, Murray Cod populations in the MDB have undergone extensive declines in abundance and distribution, with some local extinction occurring. Many factors have contributed to their decline, including altered hydrological regimes, habitat loss and degradation, barriers to fish movement, disease, over fishing and the introduction of alien species (Koehn J.D. 2005; Rowland 2005).

In South Australia, one of the major threats to Murray Cod is the significant changes to the River Murray through the introduction of dams, weirs and channels to regulate and manage water. River regulation has greatly altered the natural flow regime of the lower River Murray, and changes include reduction in flow rate and volume, extended periods of critical low flows and no flows, loss of flow variation, loss of flowing water habitats and loss of medium flood events. This has impacted on the successful recruitment of Murray Cod. 'Recruitment' is a fisheries term to describe the successful reproduction and growth of individuals into the fishery.

The effects of flow regulation were evident in the lower River Murray by the late 1920s and more broadly by 1950s (Rowland 1989; Walker 2001; Walker and Thoms 1993). Natural recruitment success of Murray Cod is considered to be limited and much less frequent now than in the period preceding regulation of water flows in the MDB. While some successful recruitment may occur during period of low flow, it has been suggested that increased flow in late winter is recognised as a trigger for pre-spawning migration and research has shown a strong correlation between large scale recruitment and spring flooding (Humphries *et al.* 1999; Ye *et al.* 2000). Successful recruitment observed in conjunction with floods is believed to result from the development of additional food sources that are essential to the survival of large numbers of Murray Cod larvae. Increasing river regulation in the MDB has decreased the frequency of overbank floods. Furthermore, when flooding does occur, floodplain productivity may be limited by the poor condition of floodplains throughout the Murray Darling Basin (Norris *et al.* 2001).

In 2000, the South Australia Research and Development Institute (SARDI) published the first stock assessment report on Murray Cod using data collected from the landings of the commercial fishery (Ye *et al.* 2000). The report highlighted the significant decline in Murray Cod landings over the history of the fishery.

In 2003, Murray Cod was listed as a species that was nationally vulnerable to extinction under the *Environment Protection and Biodiversity Conservation Act 1999*.

In 2007, SARDI published a status report highlighting little indication of strong recruitment in the South Australian Murray Cod population since the mid 1990s.

In 2008, Murray Cod was upgraded to 'critically endangered' on the International Union for Conservation of Nature Red List due to its abundance being drastically reduced across its natural range. It is now considered rare in many parts of the MBD.

In 2009, a 12-month closure was implemented to protect the South Australian population from further decline. This closure prohibited fishing for Murray Cod by recreational fishers and Lakes and Coorong Fishery commercial operators.

5.2 Stock Status and Assessment

Stock status and stock assessment reports provide an analysis of information relevant to the status of a fish stock to support management of the species/fishery. They guide fisheries managers to make decisions about planning for current and future management of fisheries resources.

In November 2000, the first South Australian stock assessment report specific to Murray Cod was published (Ye *et al.* 2000). This report provided a detailed review of the fisheries biology and ecology of Murray Cod and information on biological performance indicators. The report highlighted the significant decline in Murray Cod landings from 140 tonnes in the late 1950s to approximately 20 tonnes in 1964/65 (Figure 1). Apart from some fluctuations in the mid and late 1960s, the South Australian catch averaged less than 10 tonnes per year from the early 1970s through to a closure from 1990 – 1993. The fishery recommenced in 1994 (due to high flows), catches increased gradually to approximately 25 tonnes in 1999/2000. This report identified that the Murray Cod fishery was “fully exploited” and, based on historical fisheries data, Murray Cod depend on regular flooding for successful recruitment.

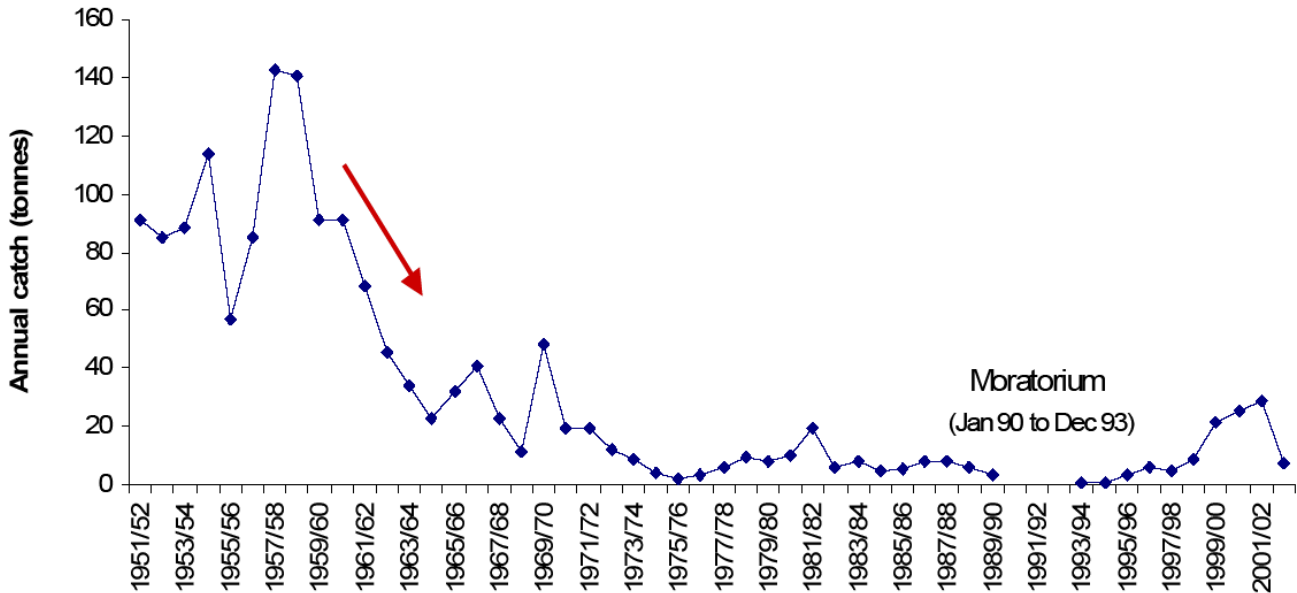


Figure 1: Murray Cod commercial landings from the South Australian inland fisheries 1951/52 to 2002/03 (Ye and Zampatti 2007).

In March 2007, a stock status report on Murray Cod was released. This report updated key biological information on Murray Cod and evaluated current stock status. The report considered information collected through the Native Fish Monitoring Program, MDBA projects and the National and Indigenous Recreational Fishing Survey. The report

highlighted evidence that there had been little recruitment in Murray Cod populations in the South Australian reaches of the River Murray since 1994 with the population dominated by fish in the large size range (>800 mm) and older year classes (15 +) (refer to Figure 2 below).

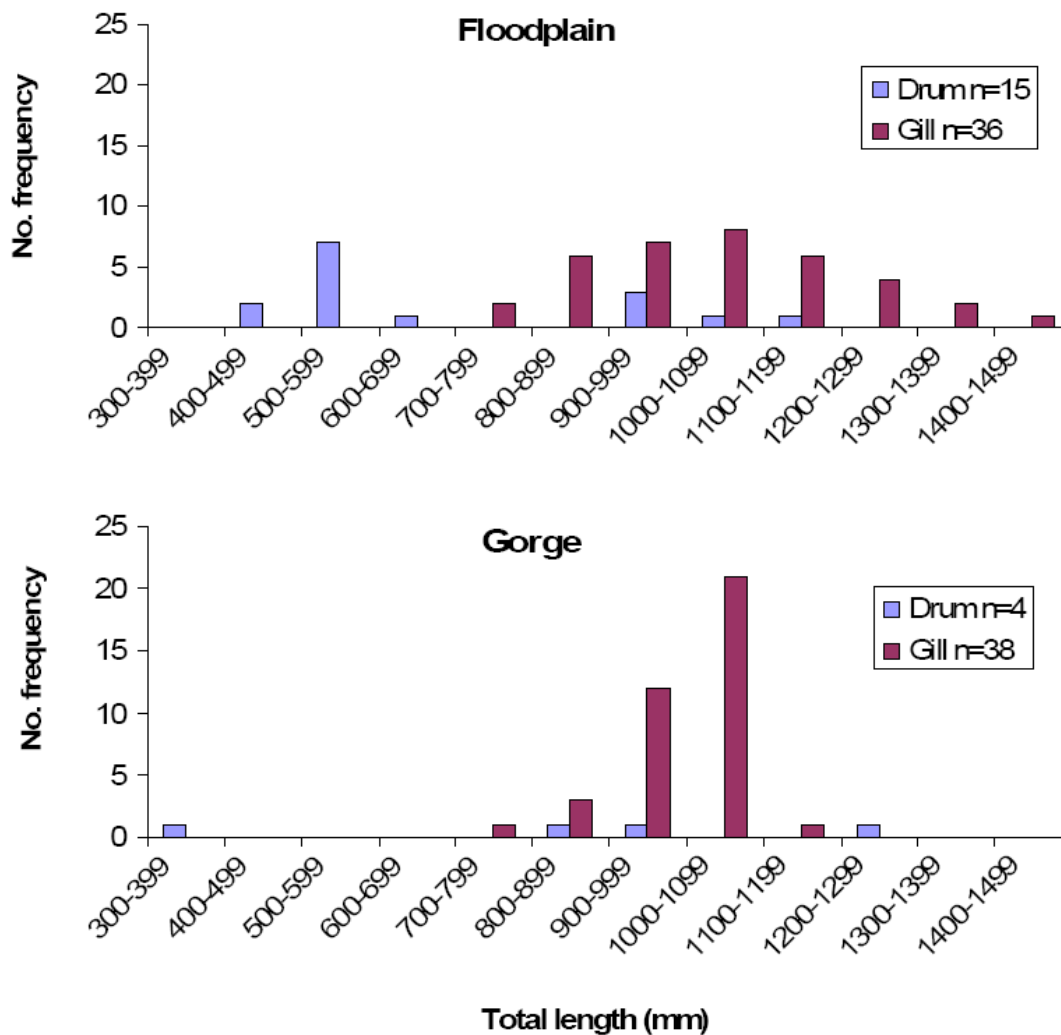


Figure 2. Size frequency data of Murray Cod sampled through the native fish-monitoring program between January 2005 and April 2006 (Ye and Zampatti 2007).

The stock status report indicated that the current low flows into South Australia were negatively affecting recruitment because the spawning and early life history of Murray Cod is linked to flow events. The ongoing impacts of the drought such as reduced turbidity, low water levels and current water management in the River Murray were also exposing Murray Cod to increased vulnerability to recreational fishing pressure. Considering this pressure and the continued severe drought conditions and lack of flows across the MDB, the report stated there was a risk that stocks may decline further unless strong year classes could recruit to the fishery and recommended that a precautionary approach to management of Murray Cod should be adopted. Importantly, key areas such as flowing anabranches (e.g. Chowilla) were identified as important regions for recruitment of Murray Cod, particularly during years of sustained low and stable flows in the River Murray (Ye and Zampatti 2007).

It is considered vital that the current size of the Murray Cod population/spawning biomass is maintained to ensure spawning success and some probability of recruitment to the fishery when there are improved river flows and enhanced habitat conditions in the future (Ye and Zampatti 2007).

5.3 Research Activity

5.3.1 National and Indigenous Recreational Fishing Survey 2000/01

The National and Indigenous Recreational Fishing Survey (Henry and Lyle 2003) was a joint initiative of the Commonwealth and State / Territory Governments to obtain fisheries statistics to support management of non-commercial fishing. The survey was undertaken in 2000/01, with the aim to collect nationally consistent and comparable data on catch, effort, participation rates, demographics, economic activity, attitudes, and awareness in non-commercial fishing activities. The survey provided crucial information to South Australia including important information on recreational fishing for Murray Cod across South Australia. The survey estimated that the harvested biomass of Murray Cod in South Australia was 23 tonnes.

5.3.2 South Australian Recreational Fishing Survey 2007/08

PIRSA Fisheries conducted a survey of recreational fishing activities undertaken by South Australian residents in 2007/08 (Jones 2009). The survey followed the same methodology as the 2000/01 National Recreational and Indigenous Fishing Survey, using an improved technique to analyse the data, which has enabled PIRSA Fisheries to make direct comparisons between the data collected during both surveys.

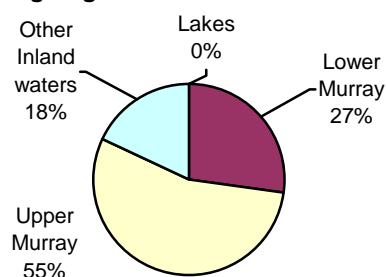
An estimated 1,853 Murray Cod were reported to have been caught by SA recreational fishers in 2007/08, with 507 harvested and 1,346 released, representing a release rate of 72.7% (Table 2). The lower River Murray was the only region where a harvest was reported, with only releases occurring in the upper River Murray and other inland waters of the state. No Murray Cod were reportedly caught in the lower lakes region (Table 2, Figure 3A). Slightly higher total numbers were caught by boat fishers than shore based fishers and line fishing was the only method of capture (Figure 3B).

Low sample numbers of both participants reporting that they were fishing for Murray Cod as well as low numbers of harvested Murray Cod that were measured, resulted in low levels of precision for all estimates (numbers and harvest weights) for this species. The figures provided should only be considered as indicative. It appears that there has been little change in the total numbers of fish caught; however, release rates have increased from 48% to 72%.

Table 2. Regional total, harvested and released catch estimates, with 95% CL for Murray Cod in 2007/08 (Jones 2009)

Fishing Region	Total Number caught	95 % C.L. (+/-)	Harvested numbers	95 % CL (+/-)	Released numbers	95% CL (+/-)	Release Rate (%)
Lakes	0	0	0	0	0	0	-
Lower River Murray	507*	972	507*	971	0	0	0
Upper river Murray	1,014*	813	0	0	1,014*	813	100.0
Other Inland waters	333*	647	0	0	332*	647	100.0
Total SA	1,853*	1,691	507*	971	1,346*	1,384	72.7

A Fishing Region



B Fishing platform

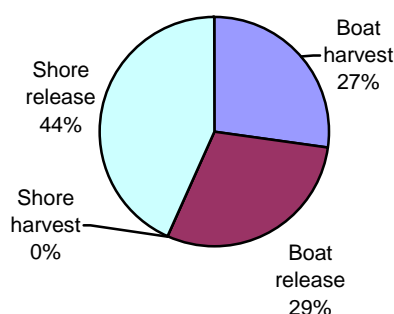


Figure 3. Proportion (%) of Murray Cod (numbers) caught by A: Fishing region, and B: Fishing platform, by SA recreational fishers during 2007/08 (Jones 2009).

5.3.3 Native Fish Monitoring Program

In January 2005, a long-term fishery independent monitoring program (Native Fish Monitoring Program) was implemented by PIRSA Fisheries and SARDI Aquatic Sciences with the assistance of commercial River Fishery licence holders. The aim of the sampling program is to collect biological information for key native fish species in the River Murray and to measure biological performance indicators for stock assessment. The sampling program is undertaken by drum netting and gill netting.

In August 2009, the program has been amended to focus more effort on Murray Cod sampling (see Appendix A). The program will continue to provide key information on assessing the performance of the fishery.

5.3.4 Murray-Darling Basin Authority Projects

The Murray-Darling Basin Authority is funding two projects that are collecting data on fish assemblages in the South Australian catchment of the lower River Murray. The 'Sea to Hume Dam' fish passage project and Chowilla Fish Ecology project are providing key information on Murray Cod.

The Chowilla Fish Ecology Project is a collaborative research project of SARDI and the SA MDB NRM Board that is funded through the MDBA Living Murray Environmental Works and Measures Program. This project investigates a number of aspects of the

ecology of fish and fish assemblages in the Chowilla Anabranch system and adjacent Murray River. Specific investigations in this project include:

1. Spawning and movement of Murray Cod.
2. Impact of experimentally altering flow regime on behaviour of Golden Perch and Murray Cod.
3. Living Murray “condition monitoring” at approximately 20 sites in the system.

The ‘Sea to Hume Dam’ is a program that was initiated by the Murray-Darling Basin Commission (now Authority) to improve fish passage to over 2000 km of the River Murray, from the sea to Hume dam by installing 14 new fishways. The program was established with a monitoring program, which had five main objectives:

1. To determine if the fishways are reducing fish accumulations downstream of weirs;
2. To assess if fishways are appropriately designed and located;
3. To assess the ecological performance of each fishway;
4. To assess improvements to the Murray River fish community post fishways; and
5. To improve the functionality of existing fishways.

A team of freshwater fish scientists from New South Wales, Victoria and South Australia were assembled to quantitatively assess fishway performance and any associated longer term benefits from improved fish passage. The tri-state research team were tasked with testing four major questions:

1. Are the fishways optimally designed, located and operated?
2. Are accumulations of fish downstream of barriers being reduced?
3. Are the fishways enabling passage of a wide size range (40 to 1000 mm long) and the whole fish community?
4. Are there positive changes in abundance and diversity of native fish in the Murray River post fishway construction?

These projects will provide data for the next couple of years and are due to end in 2010.

5.4 Biological Information

Murray Cod (*Maccullochella spp*) belongs to the family Percichthyidae, which includes the other cod species Trout Cod (*M. Macquariensis*) and Clarence River Cod (*M. Ikei*) (Seafood Services Australia 2007). Murray Cod is naturally wide spread throughout most of the Murray-Darling system except for the upper reaches of some tributaries in Victoria and southern New South Wales (Lake 1971).

5.4.1 Habitat

Murray Cod habitat varies greatly from small clear rocky streams to the generally turbid, slow-flowing rivers and creeks. Murray Cod are generally found in or near deep holes and prefer habitats containing cover such as rocks, fallen trees, stumps, and clay banks or overhanging vegetation (Harris and Rowland 1996).

5.4.2 Diet

Murray Cod is a top order predator in the Murray River (Ebner 2006). Its diet consists of fish such as European Carp, Redfin, Goldfish, Bony Herring, freshwater Catfish and various small-bodied fish (Rowland 1988a). Crustaceans such as Yabbies, freshwater Prawns and Shrimp are also commonly consumed and it has been reported that amphibians, turtles and small terrestrial animals including birds, mammals and reptiles have been found in the stomach of Murray Cod (Rowland 1988a). Larval Murray Cod initially consume small to microscopic zooplankton after hatching and as the larvae begin to mature, they feed on macroinvertebrate larvae and aquatic insects (Rowland 1992). Juvenile Cod will consume a variety of aquatic invertebrates (Rowland 1992).

5.4.3 Breeding

Murray Cod age and size at maturity varies between populations (Rowland 1998b). They generally mature at 4 – 6 years and approximately 500 – 600 mm total length. Nevertheless, age and size at maturity data for populations of Murray Cod in the lower Murray River is lacking. Murray Cod have a relatively short, well-defined breeding season, with spawning occurring in spring and early summer cued by increasing photoperiod (ie. longer days) and water temperature (Rowland 1983). Females can lay up to 90,000 eggs, with the number of eggs dependant on the size of the female. Eggs are deposited on hard surfaces such as inside hollow logs, or on rocks or clay banks. Murray Cod spawn annually (Humphries 2005), but in the lower River Murray relatively strong year classes may only be established when the breeding season coincides with high river flows both within channel and overbank (Rowland 1998; Ye *et al.* 2000; Ye and Zampatti 2007).

5.4.4 Age and Size

Murray Cod is a long-lived species with a life span that extends to at least or greater than 45 years (Anderson *et al.* 1992). The largest Murray Cod reported to be captured was 1.8 m in length and 113.6 kg in the Barwon River near Walgett in 1902. Using Rowland's 1988 growth rate trend the largest fish could have an estimated age greater than 75 years (Kearney & Kildea 2001). Within the MDB growth rates and body forms of Murray Cod may vary considerably between populations from different regions and different habitats. Growth is generally characterised by increasing weight when Murray Cod are older than 10 years.

5.4.5 Movement

In the mid reaches of the Murray River (ie. in the Yarrawonga/Lake Mulwala region) Murray Cod may undertake seasonal migrations. These include upstream movements, potentially for spawning, from Lake Mulwala into tributaries of the Murray River (e.g. the Ovens River) followed by a return downstream movement to a particular location in the lake.

Recent investigations of Murray Cod movement in the lower Murray River suggest that Murray Cod may undertake spawning and non-spawning movements of 10s – 100s km along the main channel of the Murray River and between main channel and off-channel habitats (e.g. the Chowilla Anabranch system) (B. Zampatti pers. Comm.). However, Murray Cod can also be sedentary and different life stages may show differences in behaviour and movement.

5.4.6 South Australian Distribution

Historically, Murray Cod in South Australia were common along the main channel and anabranches of the River Murray, the lower lakes and some sections of streams draining from the Mount Lofty Ranges (Hammer, 2004). Since the early 1900s, a range of anthropogenic impacts, including extensive flow regulation and habitat modification, have resulted in significant declines in the abundance and potentially the distribution of Murray Cod. A number of important populations in South Australia have been identified in the Murray Cod Draft National Recovery Plan (National Murray Cod Recovery Team 2009) and include:

South Australian Region	Reasons for Importance
1. Lower River Murray (floodplain and gorge reaches)	<ul style="list-style-type: none"> • Population structure dominated by large fish (>700mm), limited recruitment since 2000 • Recreational fishing, purely based on wild population • Aboriginal culture, education for local community • Educationally important lower Murray fish community
2. Chowilla anabranch system	<ul style="list-style-type: none"> • Unique habitat in South Australia (flowing waters and dense large woody structure) • Good population structure • High abundances of reproductively mature fish
3. Lakes Alexandrina and Albert	<ul style="list-style-type: none"> • Historically only an important part of the commercial fishery during drought years • May provide a refuge

Table 3. Location of Important Populations of Murray Cod in South Australia MDB (National Murray Cod Recovery Team 2009) and reasons for importance

6 LEGISLATIVE AND POLICY FRAMEWORK

The management of the Murray Cod fishery in South Australia is a complex and challenging task. PIRSA Fisheries is the main agency responsible for some of the actions to sustainably manage Murray Cod stocks. However, other actions are not managed by PIRSA Fisheries (e.g. environmental flows and habitat rehabilitation). In these areas, PIRSA Fisheries is able to assist with knowledge and information, but the legislation for on-ground work or protection is the responsibility of other State and National departments such as the Natural Resource Management (NRM) Boards, Department for Environment and Heritage (DEH), Department of Water Land and Biodiversity Conservation (DWLBC) and MDBA. Outlined below is legislation and policy from state and national governments.

6.1 *Fisheries Management Act 2007*

South Australian fisheries are subject to the *Fisheries Management Act 2007* and associated regulations, which provide for the management, development and use of South Australian's fisheries in an ecological sustainable manner that prevents over exploitation of the resource.

An object of this Act is to protect, manage, use and develop the aquatic resources of the State in a manner that is consistent with ecologically sustainable development and, to that end, the following principles apply:

- (a) proper conservation and management measures are to be implemented to protect the aquatic resources of the state from over-exploitation and ensure that those resources are not endangered;
- (b) access to the aquatic resources of the State is to be allocated between users of the resources in a manner that achieves optimum utilisation and equitable distribution of those resources to the benefit of the community;
- (c) aquatic habitats are to be protected and conserved, and aquatic ecosystems and genetic diversity are to be maintained and enhanced;
- (d) recreational fishing and commercial fishing activities are to be fostered for the benefit of the whole community;
- (e) the participation of users of the aquatic resources of the State, and of the community more generally, in the management of fisheries is to be encouraged.

The principle set out in subsection (1) (a) has priority over the other principles.

Recreational fishing restrictions are implemented through the *Fisheries Management (General) Regulations 2007*.

Actions under the *Fisheries Management Act 2007* must also seek to further the objects of the *River Murray Act 2003* and the *Objectives for a Healthy River Murray* under that Act.

6.2 *The River Murray Act 2003*

The aim of the Act is to provide for the protection and enhancement of the River Murray and related areas and ecosystems. Of particular importance to Murray Cod under this

Act are the *Objectives for a Healthy River Murray*. The four objectives include river health, environmental flow, water quality and human dimensions objectives.

6.3 The Environmental Protection and Biodiversity Conservation Act 1999

In 2003, Murray Cod was listed under the Commonwealth Environmental Protection and Biodiversity Conservation Act 1999 as a species that was nationally 'vulnerable' to extinction. The Act is the Australian Government's legislation and provides a legal framework to protect and manage matters of national significance. The Act protects Australia's native species and ecological communities by providing for:

- identification and listing of species and ecological communities as threatened;
- development of conservation advice and recovery plans for listed species and ecological communities;
- development of a register of critical habitat;
- recognition of key threatening processes; and
- where appropriate, reducing the impacts of these processes through threat abatement plans.

A draft recovery plan is currently being developed by the National Murray Cod Recovery Team. The purpose of the plan is to promote the recovery of Murray Cod in the MDB and describes the legislative context for the plan, other implications of threatened species listings (such as environmental impact assessment) and current knowledge on the biology, ecology, threats and management of Murray Cod. The plan will outline a series of recovery objectives, actions and criteria for evaluating the success of the plan.

6.4 Native Fish Strategy for the Murray-Darling Basin 2003-2013

The Native Fish Strategy (NFS) is a whole of basin approach to tackling the key threats to native fish populations in the Murray Darling Basin. The goal of the strategy is to rehabilitate native fish communities in the MDB back to 60% of their estimated pre-European settlement levels after 50 years of implementation. The NFS is built around 13 objectives directed at improving the status of native fish populations in the Basin, which have been condensed into six driving actions. Within the 13 objectives, a number of important initiatives are directly relevant to the sustainability of Murray Cod. These initiatives include the provisions for:

- allocation of environmental flows;
- habitat restoration work;
- the provision of fish ways and fish passage,
- protection of important habitats; and
- management of alien fish species.

The Native Fish Strategy is an important national policy that has been taken into account in the development of the management options. The range of management, research and monitoring strategies set out in this Paper are consistent with the objectives of the Native Fish Strategy.

6.5 Natural Resources Management Act 2004

This legislation relates to protection of ecosystems, ecological drivers and species with an overall aim to assist in the achievement of ecologically sustainable development. Eight Regional NRM Boards have been established across South Australia, as delegated by the *NRM Act 2004*, the SA MDB NRM Board has direct influence on management of Murray Cod. Each Board is responsible for developing and implementing a Natural Resources Management Plan for their region. Areas of responsibility include weed and pest animal management, salinity, biodiversity enhancement, water/environmental flow management, capacity building and community engagement.

6.6 National Parks and Wildlife Act 1972

The first attempt to provide an official State list of threatened freshwater fishes, based on defined criteria, was undertaken from available information at the time (2002) by a panel of experts guided by the Threatened Species Schedule Subcommittee (TSSS) with the intent of listing under the threatened species legislation of the *National Parks and Wildlife Act 1972*. The TSSS were concerned about the seriousness of the situation and investigated strategies to increase awareness about the plight of freshwater fish in SA. The preparation of an Action Plan was considered one of the most appropriate ways to address the varied and often specific issues relating to freshwater fish conservation, particularly as such a plan would provide valuable background information and strategies for the recovery of each species. In particular, Murray Cod was classified as 'vulnerable' by the panel of experts and provided a number of conservation actions that are required in recovery of Murray Cod stocks. The draft Action Plan is still under consideration by the SA Department of Environment and Heritage.

6.7 Other Jurisdictions

Other states within the Murray-Darling Basin manage and regulate the Murray Cod fishery and other species of fish through their relevant Acts and supporting legislation. Each state in the MDB currently has its own regulations in place to manage Murray Cod. States are currently working towards a coordinated approach to research management.

7 MANAGEMENT OF THE FISHERY

7.1 Historical Overview

7.1.1 Aboriginal Traditional Fishing

Ponde is the name used for Murray Cod by Aboriginal people of the lower River Murray. In Aboriginal mythology, the Murray Cod was responsible for the formation of the Murray River and its fish (Rowland 1988). According to legend, “the Murray Cod burst forth from the depths of the earth at the source of the River Murray, which was then only a small stream of water trickling to the southern ocean. The Murray Cod struggled down the narrow stream, digging with its head and swinging its powerful tail, making it wide, forming bends and creating the River Murray. The Great Prophet, Nepelle, and the creative hero, Ngurunderi, then speared the huge cod at the site known as Lake Alexandrina. They cut it into pieces and threw them back into the water, naming them *Tarki* (Golden Perch), *Tukkeri* (Bony Bream), *Tinuwarre* (Silver Perch) and all the other fish of the inland waters. When they had finished, they threw the rest back and said ‘You keep on being *Ponde* (Murray Cod)’ (Rowland, 1988). ”Murray-Darling fish, such as Murray Cod, have traditionally played a major role as a food source and as a cultural icon for indigenous Australians (Lawrence, 1971).

In South Australia, the Ngarrindjeri and Nganguraku people have their traditional homelands along the Murray River and the Coorong, and maintain an intimate and detailed knowledge of the land, the wildlife, seasons and climate.

Under the *Fisheries Management Act 2007*, Aboriginal traditional fishing is agreed with native title claimants and other stakeholders through Indigenous Land Use Agreements negotiated under the native title legislation. No agreements are in place in relation to Murray Cod.

7.1.2 Recreational Fishing

Fishing for Murray Cod has provided an important recreational and sporting activity along the South Australian River Murray since European settlement. Many early accounts of fishing in South Australia refer to fish being-taken as part of recreational pursuits, to supplement food supplies and to trade for goods and services. The River Murray has evolved to become an important region for recreational fishers due to its impressive river scenery; a boom in tourism industry of houseboats and river shacks; easy access from Adelaide to regional towns; and the presence of the iconic Murray Cod and other fish species.

Initially controls such as size limits and measures aimed at controlling total harvesting capacity (e.g. gear restrictions and spatial and temporal closures etc) were generally introduced to be consistent with those in place for commercial fishers and were not specifically targeted at the recreational sector. However, over time the need for specific management arrangements for recreational activity developed due to increases in the popularity of fishing; improvements in recreational opportunities; and the growing number of people living or holidaying on or near the coast.

The recreational fishing opportunities provided by the Murray Cod fishery and throughout the state contributes to the overall well-being of many South Australians. As well, the recreational community contributes significantly to state and regional economies through tourism, the purchase of fishing equipment, vessels, bait supplies and fuel etc. Protection of Murray Cod populations is important for maintaining recreational fishing opportunities and the businesses that benefit from recreational fishing tourism.

7.1.3 Commercial River Fishery and Lakes and Coorong Fishery

Since early European settlement, Murray Cod was a key commercial species in the South Australian Inland Waters fishery. Transport constraints in the initial years of the fishery mainly concentrated on upper-river regions, closer to population centres and railheads (Leslie 1995) and the majority of production was sold to meet local demand or shipped to markets (Pillar 1980). The establishment of rail linkages in the early 1900s allowed the export of fish catch from the upper South Australian waters to be shipped to the higher value Melbourne markets (Leslie 1995). Harvesting of Murray Cod in the initial River Murray Fishery was unregulated, with both recreational and commercial effort unlimited as to gear types or entry. In 1923, the reach fishery was first established under the associated regulations of the South Australian Fisheries Act 1917 (Poole 1984). Each commercial fisher under this system took responsibility for their own reach. The system continued until the restructure to a non-commercial fishery in June 2003 (see Table 4).

The Lakes and Coorong Fishery is a separate commercial fishery managed through a regime of input and output controls such as limited entry, gear restrictions, spatial and temporal closures. Murray Cod is a permitted species in the fishery. The take of Murray Cod is currently prohibited due to a statewide closure.

7.2 History of the Management Arrangements in the Recreational and Commercial Murray Cod Fisheries

The table below provides a historical overview of the changes in management arrangements for the fishery.

Table 4. History of Management Changes in the Murray Cod Fishery

Time	Reasons for changes to the Murray Cod Fishery
1880s	Approximate commencement of the Murray Cod fishery.
1900s	First sign of significant decline in Murray Cod stocks.
1906	South Australia Government introduced requirement for all commercial fishers to hold a commercial fishing licence.
1917	Fisheries Act of 1917 brought controls on the types and dimensions of gear used for fishing, restricted certain areas for fishers, introduced legal minimum lengths for most common species and outlawed certain practices.
1923	Introduced 'reach system'. River was divided into 222 sections (reaches) which were allocated to individuals and worked on a commercial basis.

1936	<p>A conference was held between South Australia, New South Wales and Queensland over concerns to the large decline of Murray Cod stocks.</p> <ul style="list-style-type: none"> • A closed season was arranged to protect spawning season - September until November. • A minimum legal length was set at 460 mm to protect breeding stocks.
1960-79	Policy implemented of not renewing reach licences of persons who were not fishing reaches to satisfaction or were located near Riverland populations.
1972	Licensed commercial fishers required to provide monthly catch data.
1972 – 1987	Number of reaches reduced from 73 to 42. Allowed access to fish backwaters and for licences to be reallocated on a two-for-three basis to fishers with a demonstrated history in the fishery.
1989	Recreational fishing using drum nets prohibited from 1 st July.
1990-1994	Moratorium on the commercial and recreational take of Murray Cod caused by sustainability concerns.
1991	The Fisheries Scheme of Management (River Fishery) Regulations 1991 were introduced.
1994	<p>Moratorium was lifted in 1994 due to high flows received and an understanding of Murray Cod recruitment. When the moratorium was lifted, it was agreed to reduce pressure on the Murray Cod fishery that the recreational limits needed to be changed.</p> <ul style="list-style-type: none"> • The minimum size limit was changed from 46 cm to 50 cm. • A maximum size limit of 110 cm was set in place to protect adult breeding Murray Cod. • Recreational effort was further regulated by a bag limit of 2 Cod per fisher per day and a boat limit of 6. • Further gear restrictions were applied including two rod/handline limits and in attendance requirements
1998	Thirty reaches remained, two licence holders were moved downstream to improve statistical coverage of the River fishery.
2000	<p>Further restrictions were placed on the Murray Cod fishery, due to information from the Murray Cod assessment that Murray Cod status was “fully fished” and that there had been no strong recruitment of Murray Cod since the early 1990s. Further changes were applied to reduce the effort to the fishery:</p> <ul style="list-style-type: none"> • The maximum legal length was changed from 110 cm to 100 cm; • The closed season was extended to 1st September to 31st December (inclusive).
July 2002	<p>Publication of Native Fish Strategy for the Murray-Darling Basin 2003-2013.</p> <p>Lists eight key threats to native fish populations of which fishing (recreational, commercial and illegal) is one. Priority objectives identified as repair and protection of fish habitat, ecosystem function and water quality.</p>

2003	Minister notifies licence holders of incoming prohibition on the use of gill nets and a restructure of the fishery. The fishery is to become a non-native fishery with six licences issued, which will be non-transferable.
3 July 2003	Murray Cod listed as 'vulnerable' under the Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i> .
July 2003	National Recreational and Indigenous Fishing Survey published. First published approximation of the recreational catch of Murray Cod in the River Murray by recreational fishers. Recreational Harvest = 22.1 tonnes Angler catch at maximum bag limit = 89% Ratio 2000/01 Recreational: Commercial Harvest = 46:54 From Jones (2005)
October 2007	Release of second stock status report, which significantly highlighted evidence that there has been little recruitment in the populations since 1994 and given the continued severe drought conditions and lack of flows across the Murray-Darling Basin that further protection is needed. Further changes were made to the Murray Cod fishery, due to lack of strong recruitment since 1994: <ul style="list-style-type: none"> • The minimum size limit was changed from 50 cm to 60 cm (to compliment new arrangements in Victoria and New South Wales); • The daily recreational bag limit was reduced from 2 per person to 1 per person; • The daily boat limit was reduced from 6 to 3; and • The annual closed season from September to December was extended to include the month of August.
October 2008	Murray Cod status was upgraded to 'critically endangered' on the IUCN Red List.
January 2009	PIRSA Fisheries implemented a ban on the take of Murray Cod for 2009. Since the release of the 2007 stock status report and the continuation of low flows and predicted conditions of drought, the closure was implemented to protect the stock from further decline.

7.3 Current Management Controls

PIRSA Fisheries manages the Murray Cod fishery through a combination of input and output controls aimed at ensuring the total catch is maintained within sustainable limits and to ensure that recreational access to the fishery is equally distributed between recreational participants. These controls include limitations on the type and amount of fishing gear that may be used, spatial and temporal closures, legal size limits for individual species and bag and boat limits.

7.3.1 Recreational Gear restrictions

Gear restrictions are an input control that limits the intensity of gear that fishers can use to catch fish. Regulations across South Australia and in particular the River Murray, permit each person to use:

- up to two rods, or
- two handlines, or

- one of each.

Each line may have:

- up to three hooks attached; or
- up to five hooks joined eye to shank or threaded together. This will be considered as one hook.

7.3.2 Closed season

A closed season is designed to protect Murray Cod and other fish species during their breeding seasons and to reduce the interference that fishing activity may have upon spawning behaviour and events. Currently, South Australia has imposed a closed season for Murray Cod from 1 August to 31 December every year.

7.3.3 Size limits

In all fisheries, it is important to ensure that there is an effective breeding biomass to support the fishery. Size limits are a tool used by fisheries managers to ensure that enough fish reach their breeding size and have an opportunity to reproduce before they are caught. Limits may also be used to ensure larger spawners are protected and can reproduce. The minimum size limit for Murray Cod is 60 cm and the maximum size limit is 100 cm.

7.3.4 Bag and Boat Limits

Bag and boat limits are an output control used to cap the total catch in the recreational sector to ensure catch levels remain within sustainable limits. The maximum daily bag limit for Murray Cod is one per person. If three or less people are fishing from a boat, the personal bag limit applies to each person. If three or more people are fishing from a boat, the combined boat limit (that is the total number of fish that can be landed onto the boat) is two.

Table 5. Summary of Current Management Arrangements for Murray Cod in South Australia, 2009.

Murray Cod (<i>Maccullochella</i> spp)	
Minimum size limit	60 cm
Maximum size limit	100 cm
Bag limit	1
Boat Limit	2
Closed season	1 August – 31 December

7.3.5 Current closure

Overriding all of these arrangements, a prohibition on fishing activities for Murray Cod was introduced for 12 months from 1 January to 31 December 2009. Continuation of this closure is one of the options for consideration in this options paper.

7.4 Stock Enhancement

7.4.1 Regulations

There has been no stock enhancement program for Murray Cod in the River Murray. The South Australian *Fisheries Management Act 2007* currently prohibits the release of any exotic fish, farmed fish or any fish that have been kept apart from their natural habitat into any “waters”. The Act defines “waters” to mean any sea or inland waters including any body of water or watercourse of any kind occurring naturally or artificially created. It is therefore an offence to release any cultured fish (restocking) or translocated fish from their natural habitat unless the Director of Fisheries has issued a permit in accordance with section 78 of the Act for this activity to occur.

7.4.2 Current Stocking Policy

Generally, fish stocking programs are not supported by PIRSA Fisheries, but are considered on a case-by case basis. There are no Government owned hatcheries for stocking purposes, although hatchery facilities exist within a number of Government agencies (South Australian Research and Development Institute) and universities. There are a number of privately owned hatcheries, predominantly used for aquaculture businesses.

Exemptions have been approved for projects to establish artificial refuge populations and/or for enhancing local populations of critically endangered small native fish species. In recent years, these have been approved for programs developed by the Cooperative Research Centre (CRC) for Freshwater Ecology with the Department of Environmental Biology, University of Adelaide.

7.4.3 Recreational Native Fish Stocking Enhancement

Fish stocking of inland waters has been regarded as the solution to fisheries problems. However, it is important to understand that wild fish acquire a unique value, a value that is difficult or impossible to replicate with hatchery bred fish.

Stocking is seen as the short-term bandage answer to the issue, this position has developed because the technology for massive-scale hatchery propagation is well established and pouring large numbers of young fish into waterways appears to be a quick-fix technological way of dealing with often more difficult and complex solutions to such problems.

Unfortunately, the stocking concept often diverts attention and remedial action from fundamental fisheries problems such as;

- lack of environmental flows,
- historical over-fishing,
- introduction of disease
- interruption to fish passage; and
- impacts of alien species, like carp.

Stocking of any freshwater fish in South Australia has a number of potential risks. Key themes reported worldwide in published literature (Gillanders et al 2006, Bealin & Tikel 2003, Harris 2003) concerning stock enhancement include:

- stocking of fish does give rise to competition and/or predation effects;

- stocking of fish will lead to a variety of genetic-related impacts;
- stocking of fish will lead to the unintentional introduction of pathogens or other organisms, which could impact on wild populations;
- a number of ecosystem level effects, exceeding the carrying capacity of the system, trophic cascades, and extinctions of other species are possible;
- limited historical success in both biological and economic contexts;
- limited historical evaluation of stocking programs; and
- difficulty evaluating the success of stocking programs.

The South Australia Government is implementing the MDBA Native Fish Strategy, achieving several significant steps by attempting to:

- restore environmental flows through the environmental flows strategy for the River Murray;
- instigated a non-native based fishery for species such as carp; and
- restoring the migratory pathways for native fish through implementation of the 'Sea to Hume Dam' fish passage project.

Instead of filling our waterways with stocked fish, South Australia is attempting to improve our fish stocks through efforts to enhance natural recruitment. Wild strains of native fish are supported and encouraged to recruit, grow and migrate by effectively managing and restoring the river-flow and habitat, removing barriers to migration and ensuring sustainable exploitation, which are issues that have been the primary causes of their decline.

However, other states do stock Murray Cod for recreational fishing purposes.

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Appendix A: Fishery-independent Monitoring Program for Murray Cod 2005-2009 and 2009-2012

In January 2005, PIRSA Fisheries and SARDI Aquatic Sciences implemented a long-term fishery independent monitoring program, as data from the commercial fishery is no longer available to inform research due to the restructuring of River Fishery in July 2003. The aim of this sampling program is to collect biological information for key native fish species (Murray Cod and Golden Perch, with a higher focus on Golden Perch) and to measure biological performance indicators for stock assessment. The sampling program is undertaken with the assistance of two former River Fishery licence holders.

Following initial support and training from SARDI, monthly sampling has been carried out by commercial fishers at six sites along the lower River Murray below Locks 1-6. Three of the sites were within the gorge section (above Wellington and below Overland Corner) and three in the floodplain section (between the SA/NSW border and Overland Corner). A standard set of sampling gear (provided by SARDI) was used at each site, with nets set and checked over three consecutive nights.

The set of gear included:

- 10 small-mesh drum nets (January to April);
- 4 multi-panel gillnets (45 x 2 m, 38, 51, 70, 114, 152 mm meshes) (January to April)

Additional methods were used to specifically target Murray Cod including

- 5 large funnel/mesh drum nets (August to April)
- 4 large mesh gillnets (50 x 2 m) with various mesh sizes i.e. 203, 254, 305 and 356 mm (August and September)

All fish captured from each net were identified to species, counted, and total lengths measured for all Murray Cod and Golden Perch and a sub-sample of 20 individuals per species or other species for each gear type. A research log was provided by SARDI to record all relevant information.

In August 2009, PIRSA Fisheries and SARDI Aquatic Sciences continued the implementation of the long-term (2009/10-2011/12) fishery independent monitoring program with a key focus on Murray Cod. The focus of the sampling program is to establish a scientifically rigorous monitoring program which provides sufficient information to confidently assess the population estimates of Murray Cod in the lower River Murray, SA, including abundance, size/age structures and recruitment index.

The focus over the next three years of the sampling program will be to:

- Develop scientifically rigorous methods for assessing population estimates (key biological performance indicators) of Murray Cod suitable for a range of representative 'sites' in the lower River Murray.
- Implement the methods developed in above method as a pilot study; Recommended survey-design (temporal and spatial, statistical sampling strategy, and proposed analyses) as a foundation for the long-term monitoring.

- Improved knowledge of environmental factors that influence Murray Cod population dynamics including recruitment (e.g. flows, water-quality and habitat structure) - this will be facilitated by long-term datasets.
- Develop or extend existing MDB population models, incorporating new quantitative data, which provides a useful tool to explore options for fishery and/or conservation management.

In the past years, assessments of the stock status of key native fish (including Murray Cod) in SA have mainly been dependent on commercial catch and effort data and information collected voluntarily by commercial fishers. Since July 2003, the SA River commercial fishery ceased for Murray Cod; and a moratorium was announced on recreational fishing for this species in 2009 in South Australia. Currently there is no regular targeted assessment of fish stock, or regular collection of recreational fishery data for Murray Cod in any State, with which to establish trends in population indicators.

Appendix B: Current Threats to Murray Cod Population

River regulation and stock enhancement are threats that have been mentioned previously within the paper, however there are numerous other contributing factors that impact on the Murray Cod populations. The MDB NFS through it stated six driving actions are currently working towards remediating these impacts.

Barriers to movement

The construction of barriers within the MDB such as locks and weirs form a barrier that obstructs/prevents the movement of Murray Cod. There are more than 3,600 barriers within the MDB (Koehn 2005). Research has developed our understanding of the movements of Murray Cod, both for adults and larvae (Koehn 2005 and Humphries et al 2002). Murray Cod movement in both upstream and downstream directions is restricted by the ability of pre-spawning, large, adult individuals to negotiate fishways and return safely downstream (Koehn 2005). Instream barriers may also limit the subsequent downstream drift of Murray Cod larvae, which provides re-colonisation and recruitment of the species.

Changes to water quality

The Murray Darling Basin Native Fish Strategy identifies reduced water quality is one of the eight threats to native fish management in the MDB. Reduced water quality can arise from a result of increased nutrient levels, turbidity, sedimentation, salinity, artificial changes in water temperature, pesticides and other contaminants (Koehn 2005). The main factors that will impact on water quality in the lower Murray are the quality of water arriving from upstream density stratification, salinity and pathogens. The quality of water have all been suggested as causes for fish kills including Murray Cod.

Exotic Fish.

The MDB contains at least 11 established exotic fish species (MDBC 2003). The abundance, distribution and characteristics of some exotic species continue damage to Murray Cod populations. There are many exotic fish species which can have significant impacts through predation, competition, habitat destruction and disease introduction. The following exotic fish are established in the lower Murray:

- European Carp and hybrids (*Cyprinus Carpio*);
- Goldfish (*Carassius Auratus*);
- Gambusia (*Gambusia Holbrooki*);
- Rainbow Trout (*Oncorhynchus Mykiss*);
- Redfin Perch (*Perca Fluvialis*);
- Brown Trout (*Salmo Trutta*); and
- Tench (*Tinca Tinca*)

Habitat loss

The removal of structural woody habitat has been widespread in the MDB rivers, over a large number of years, as they were seen to impede the paths of the paddle steamers. Recent research has developed a better understanding on the importance of this habitat to juvenile and adult Cod (Koehn 1996). Murray Cod are dependent on large structural woody habitat for habitat and shelter. Desnagging has undoubtedly reduced or destroyed prime habitat for adult Murray Cod, and has also led to fragmentation of remaining available habitat (Koehn 2005). Other impacts to Murray Cod habitat is

sediment deposition which can lead to a decline in available hard substrate, and the smothering of vital spawning substrates.

Over-fishing

Commercial fishing of Murray Cod had a significant impact on the population decline. The significant decline from 140 tonnes in the early 1940s to around 10 tonnes in 2000/01 indicates the impact of commercial fishing on the population (Qifeng et al 2007). However, no commercial fishing of Murray Cod occurs in South Australia. It is recognised that current fishing regulations may be inadequate to protect breeding adult Murray Cod within the SA MDB.

Disease

Little is known about the prevalence and impact of diseases on Murray Cod. The major concern probably relates to those exotic diseases introduced to Australia with imported fish which have found their way into the environment. Diseases and pathogens of potential major concern include the Epizootic Haematopoietic Necrosis (EHN) virus, Viral Encephalopathy and Retinopathy (VER), Goldfish Ulcer Disease (GUD), Asian Fish Tapeworm *Bothriocephalus acheilognathis* and the parasitic copepod Anchorworm *Lernaea cyprinacea*. The introduced Redfin Perch carries EHN (Langdon *et al.* 1986), to which Murray Cod are highly susceptible (Langdon 1989; Langdon *et al.* 1986; Langdon *et al.* 1987; MDBC 2004).



Community Feedback Form

Murray Cod Options Paper

Submissions should be addressed to:
Jonathan McPhail
Inland Fisheries Management Officer
PIRSA Fisheries
GPO Box 1625,
Adelaide SA 5001

Name: _____

Age (optional):

<input type="checkbox"/>	5-14
<input type="checkbox"/>	15-29
<input type="checkbox"/>	30-44
<input type="checkbox"/>	45-59
<input type="checkbox"/>	60+

Address: _____

Email: _____

What is your interest in the management of Murray Cod?

- Recreational Fishing
- Tourism
- Cultural
- Conservation
- Other _____

Where do you fish or what area is most important to you?

If you fish, do you fish for other species besides Murray Cod?

Before the closure was put in place, did you generally catch and release Murray Cod, or keep your catch?
