

Murray Cod (2018)

Maccullochella peelii



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STOCK STATUS OVERVIEW

Jurisdiction	Stock	Fisheries	Stock status	Indicators
Australian Capital Territory	Australian Capital Territory	N/A	Depleted	Fishery-independent surveys
Queensland	Queensland	N/A	Undefined	Fishery-independent surveys, recreational fishing surveys
New South Wales	New South Wales	N/A	Undefined	Historical fishery catch, fishery-independent surveys, recreational fishing surveys
Victoria	Victoria	N/A	Undefined	Historical fishery catch, fishery-independent surveys, recreational fishing surveys
South Australia	South Australia	N/A	Depleted	Historical fishery catch, fishery-independent surveys

N/A Not Applicable (ACT), N/A Not Applicable (NSW), N/A Not Applicable (QLD), N/A Not Applicable (SA), N/A Not Applicable (VIC)

STOCK STRUCTURE

Murray Cod is the largest solely freshwater fish in Australia. It occurs throughout most of the Murray–Darling system, except for the upper reaches of some tributaries in Victoria, the Australian Capital Territory and southern New South Wales. Investigation of the genetic structure in the Murray–Darling Basin has demonstrated that there is one large genetically

panmictic biological stock throughout most of its distribution [Rourke et al. 2011]. However, genetically distinct populations have been identified in the more isolated Lachlan, Macquarie and Gwydir catchments [Rourke et al. 2011]. This separation appears to be the result of restricted gene flow due to the isolated nature of these catchments [Rourke et al. 2011]. Although genetic studies suggest the existence of one biological stock, there are differences in management arrangements and available information in the various jurisdictions.

Here, assessment of stock status is presented at the jurisdictional level—Australian Capital Territory, Queensland, New South Wales, Victoria and South Australia.

STOCK STATUS

Australian Capital Territory

Murray Cod have never been commercially harvested in the Australian Capital Territory, but have long been targeted recreationally both in the Murrumbidgee and Molonglo Rivers and in urban lakes. Murray Cod numbers are generally considered to be much lower than pre-European levels. The species declined considerably before 1980, with major declines occurring in the 1960s [Greenham 1981]. A recent compilation of historic newspaper reports of fish catches in the Canberra region identified abundant historical catches compared to present [Kaminskas 2015]. The Australian Capital Territory riverine population is separated from downstream populations by the impassable barrier presented by Burrinjuck Dam. Burrinjuck was constructed in 1928 and has never had a fishway to facilitate connection of upstream and downstream populations, hence populations upstream are a separate management unit. A biennial fish monitoring program in the Murrumbidgee River from 1994–present found little change in adult abundance, but sampling techniques (net-based) pre-2008 were not particularly appropriate for sampling this species [Australian Capital Territory Government, unpublished data]. Boat electrofishing, employed 2002–present (alongside netting), found higher numbers of Murray Cod than recorded by netting. There has been no significant increase in overall number since 2010.

A recreational fishing survey in 1999–2001 of the Murrumbidgee River in the Australian Capital Territory identified that Murray Cod were the equal highest species targeted, along with Golden Perch (*Macquaria ambigua*) [McGovern and Lintermans 2003]. The National Recreational and Indigenous Fishing Survey [Henry and Lyle 2003] did not report harvest data for the Australian Capital Territory. In 2016 a survey of Australian Capital Territory and region residents, identified Murray Cod were targeted by 63 per cent of anglers, with 29 per cent reporting captures in the past 12 months and only two per cent of anglers reporting harvest [Schirmer and Mylek 2016]. Recent research has demonstrated the potential for anglers to contribute to stock assessment of Murray Cod in the Australian Capital Territory [Ross-Magee 2018].

Stocking occurs in a number of urban lakes to provide recreational fishing opportunities, as well as to provide an apex predator for these artificial systems [Australian Capital Territory Government 2015, Lintermans 2000]. Approximately 705 500 fingerlings have been stocked since the program began in 1980 [Australian Capital Territory Government, unpublished data, Australian Capital Territory Government 2015], with an average of 25 000 stocked annually since 2000. Stocking of fish for recreational purposes is not conducted in riverine environments in the Australian Capital Territory, and there have been no conservation stockings of the species [Australian Capital Territory Government 2015]. Stocked populations in urban lakes continue to provide localised and well-regarded recreational fisheries, but are not self-sustaining.

In recent years range expansion has been observed in the upper Murrumbidgee, with adults and juveniles being regularly recorded upstream of the Australian Capital Territory border. This expansion was potentially originated from stocking by the New South Wales Department of Primary Industries upstream of the Australian Capital Territory since 2008. Larval genetic investigations have identified hybridisation between Murray Cod and Trout Cod (*Maccullochella*

macquariensis) in the Australian Capital Territory [Couch et al. 2016]. This hybridisation is more likely to be of conservation concern for stocks of the endangered Trout Cod, than Murray Cod. However, the long-term effects of introgressive hybridisation on both species is unknown.

New South Wales

The abundance of Murray Cod is considered to be much-reduced compared to that of pre-European settlement levels in New South Wales [Harris and Gehrke 1997]. Concerns were raised as early as 1880 regarding declines in abundance, based largely on falling catch rates within the commercial fishery [Rowland 1989]. While fishing effort remained at around the same level, annual commercial catches declined from a high in the mid-1950s of around 140 tonnes (t), to less than 35 t by the mid-1960s, indicating a substantial decline in catch per unit effort [Rowland 1989]. The annual catch remained below 35 t in the majority of years until the commercial fishery was closed in New South Wales in 2001 [Rowland 1989].

The recreational fishery for Murray Cod has continued to grow in New South Wales and encompasses two main sectors; impoundment fisheries and riverine fisheries. The 2000–01 national survey estimated that around 161 000 Murray Cod were caught annually by New South Wales residents across New South Wales, with around 26 per cent of these fish harvested [West et al. 2016] and the rest released. A more recent survey in 2013–14 found that angler effort had increased since 2000–01, but total catch remained similar (165 557 fish) [West et al. 2016]. However, harvest had declined considerably, from 26 per cent of the total catch in 2000–01, to 13 per cent in 2013–14. A targeted creel survey undertaken in 2012–13 across 76 km of the Murrumbidgee River estimated annual catches of Murray Cod in this area to be as high as 32 000 fish, with only around five per cent retained [Forbes et al. 2015b]. The results of these more recent surveys suggest that the recreational sector is increasingly targeting the species, but are also more commonly practising catch-and-release.

A number of management actions have been implemented to facilitate species recovery across New South Wales. This has included restocking, with ~14 million hatchery-reared fry and fingerlings released into many of the State's impoundments and rivers since the late-1970s. Until recently, little was known of the efficacy of these stockings, and it was largely assumed that they were a primary contributor to the recovery of the species in many river systems. An assessment of stocking success was recently undertaken in two rivers in the southern Murray–Darling Basin and one impoundment in north-western New South Wales [Forbes et al. 2015a]. There was a comparatively low proportion of stocked Murray Cod among those sampled in the Murray (seven per cent) and Murrumbidgee (15 per cent) Rivers [Forbes et al. 2015a]. In contrast, stocked Murray Cod comprised almost the entire population in Copeton Dam (94 per cent) [Forbes et al. 2015a]. These data suggest that while stocking is helping to enhance Murray Cod populations in impoundments, natural recruitment, potentially driven by other management actions such as closed seasons, size-and-bag regulations and habitat rehabilitation, are also likely contributing to population recovery in rivers. In 2014, in line with Victoria, a State-wide harvest slot of 550–750 mm was introduced, with the daily bag limit of two and possession limit of four, remaining the same. Recent targeted surveys in the Border Rivers region of northern New South Wales has shown somewhat of a negative outcome in the overall population structure of Murray Cod in the two rivers sampled pre- and post-slot, with truncation evident at 500–550 mm and no discernable increase in the number of fish above 750 mm.

Anecdotal reports and scientific surveys suggest that Murray Cod numbers are increasing in at least some New South Wales rivers, whilst in others, numbers appear to be stable or may be declining [Barwick et al. 2014, Rowland 2013]. Based on a long-term monitoring program over 17 years at 27 sites across New South Wales, it has been suggested, in those areas experiencing increases, that it could be as high as 740 per cent [Rowland 2013]. However, to-date there has

been insufficient research undertaken to validate these estimates, and there has been no or little attempt to estimate total abundance or biomass at the local scale or across the State as a whole. There is also an absence of time-series data to provide a measure of recruitment and fishing mortality. As such, at this time there is insufficient information available to confidently classify the status of this stock.

On the basis of the evidence provided above, Murray Cod in New South Wales is classified as an **undefined stock**.

Queensland Anecdotal evidence provided by recreational anglers have described substantial declines in Murray Cod populations in Queensland [Steven Brooks pers. comm.]. It is generally accepted that native fish populations in the Murray–Darling Basin’s rivers have declined to an estimated 10 per cent of the levels before European settlement [Murray–Darling Basin Commission 2004]. The decline is thought to have resulted from a combination of flow regulation, habitat degradation, reduced water quality, barriers to movement, introduced species and overexploitation from illegal fishing [Murray–Darling Basin Commission 2004].

Approximately 100 000 fingerlings have been stocked each year throughout their range in Queensland since the mid-1980s. A large proportion of these fingerlings are stocked into impounded waters, where natural recruitment levels are low [Steven Brooks pers. comm.]. The Murray–Darling Basin Authority Sustainable Rivers Audit, fishery-independent monitoring and anecdotal evidence from recreational fishers suggest an increase in numbers in the Border Rivers region, which may be attributed to extensive stocking in this catchment [Butler et al. unpublished data, Steven Brooks pers. comm.]. The audit and other fishery-independent monitoring have been undertaken in several other rivers and catchments in Queensland [Murray–Darling Basin Commission 2004, Steven Brooks pers. comm.]. However, the lack of consistency in sampling methodologies and the low numbers of Murray Cod recorded during the monitoring makes accurate biomass estimates difficult.

The Queensland area of the Murray–Darling Basin has never supported a commercial fishery, although there is a recreational fishery throughout the northern Murray–Darling catchment. The species is mostly targeted within the Dumaresq, Macintyre, Moonie, Condamine, Balonne and Warrego Rivers and their tributaries; fish are also occasionally reported from the Paroo River [Steven Brooks pers. comm., Taylor et al. 2012]. A survey of recreational participation and catch was conducted in 2014 [Webley et al. 2015], but harvest estimates for Murray Cod were unreliable. A recent study in the Border Rivers region suggests that harvest of this species remains high, with most fish being removed from the population within two years of reaching legal size [Butler et al. unpublished data]. While this suggests that fishing pressure is high, data are presently too uncertain to accurately estimate fishing mortality. Therefore, there is insufficient information available to confidently classify the status of this stock.

On the basis of the evidence provided above, Murray Cod in Queensland is classified as an **undefined stock**.

South Australia In South Australia, previous stock assessments in the Murray River and Lower Lakes noted a significant decline in annual commercial landings from 140 t in the late-1950s, to less than 10 t in the 1970s–80s [Ye et al. 2000, Ye and Zampatti 2007]. Following a moratorium on commercial and recreational fishing from January 1990–December 1993, combined with high flows in the early-1990s, annual catch increased gradually to 28.5 t in 2001–02. The Murray Cod commercial fishery ceased in the South Australian Murray River in July 2003 following restructuring of inland native fisheries. Although Murray Cod is still a ‘permitted species’ to be taken in the commercial Lakes and Coorong Fishery, there is currently a temporary closure (implemented since 2010 under the *Fisheries Management Act 2007* [South Australia]) that prohibits commercial

harvest. Unlike other states/jurisdictions, Murray Cod had not historically been stocked in the South Australian reaches of the Murray River [Gillanders and Ye 2011]. Since 2016, however, the Department of Primary Industries and Regions, South Australia, and RecFish South Australia, have released about 300 000 fingerlings into different river reaches in the South Australian lower Murray.

Murray Cod is a popular recreational fish species in South Australian inland waters. The 2007–08 South Australian Recreational Fishing Survey estimated that 507 Murray Cod (around 2.1 t) were harvested from the lower Murray River [Jones 2009]. No Murray Cod were reported as caught in the Lower Lakes region. There was little change in the total number of fish caught since the 2000–01 survey [Henry and Lyle 2003], but release rates increased from 48 per cent in 2000–01 to 73 per cent in 2007–08 [Jones 2009], potentially reducing recreational fishing mortality. The 2007–08 figures should only be considered as indicative because the precision levels of all estimates were low as a result of low numbers of participants reporting Murray Cod catch, as well as low numbers of Murray Cod harvested. There was a moratorium on recreational fishing for Murray Cod in South Australia in 2009 and 2010. Since 2011, a catch-and-release fishery has been permitted for this species in the South Australian Murray River during the open season, except for a closure area in Chowilla. The most recent South Australian Recreational Fishing Survey in 2013–14 [Giri and Hall 2015] did not report any catch of this species in the lower Murray River.

In the absence of a commercial fishery, or dedicated fishery-independent monitoring programs, the primary measures for biomass and fishing mortality are total catch and catch per unit effort (CPUE) from three long-term (8–11 year) fish assemblage monitoring projects in the lower Murray River from 2002–13 [Zampatti et al. 2014]. During this period, CPUE data from electrofishing and drum netting indicated that relative abundance was low. Length-frequency distributions indicated that fish collected in main channel habitats of the lower Murray River were predominantly large (more than 800 mm total length), and represented a broad range of age classes (8–46 years). Murray Cod recruitment was minimal in the predominantly still-water main channel habitats during the drought in 2001–10, despite some recruitment in the flowing water habitats of the Chowilla anabranch system [Zampatti et al. 2014]. Nevertheless, some juvenile fish (less than 500 mm total length) were collected in main channel habitats in years following increases in river flow (for example, 2010–11 and 2011–12) [Zampatti et al. 2014]. From 2014–18, annual recruitment was detected in the main channel of the lower Murray River and these cohorts seem to have persisted in the population during subsequent years [Ye et al. 2018, SARDI unpublished data]. Recent long-term catch per unit effort electrofishing data from 2014–18 indicates similar, albeit slightly increased, abundance of Murray Cod in the main channel of the lower Murray River, relative to 2002–13, reflecting recent recruitment [Ye et al. 2018, SARDI unpublished data]. These data provide an indication of a fairly stable adult population, and periodic successful recruitment, but no evidence of any substantial increase in abundance towards historical levels prior to the mid-1960s. The above evidence indicates that the biomass of this stock is likely to be depleted and that recruitment is likely to be impaired. The above evidence indicates that the current fishing mortality is constrained by management to a level that should allow the stock to recover from its recruitment impaired state; however, measureable improvements are yet to be detected.

On the basis of the evidence provided above, Murray Cod in South Australia is classified as a **depleted** stock.

Victoria

In Victoria, Murray Cod numbers are considered to be much lower than pre-European levels [Cadwallader and Gooley 1984]. During the 19[th] century Murray Cod were considered abundant in the Loddon, Campaspe and Goulburn Rivers [Wilson 1857]. However, by the middle of the 20[th] century, populations of Murray Cod had declined in these rivers [Cadwallader 1977]. In Victoria,

commercial catches were highest between 1954–55 and 1960–61, at approximately 10–15 t per year but reduced to approximately 1.5 t per year on average over the next 10 years and were negligible thereafter [Ingram and De Silva 2004]. Management actions such as the prohibition of commercial netting post 1999, introduction of strict recreational bag and size limits, restrictions on fishing methods such as set lines and considerable hatchery stocking have likely resulted in the recovery observed in some populations by the 1990s. However, no consistent, long-term estimates of harvest by anglers or population abundances have been recorded for Victoria.

Hatchery-reared Murray Cod have been stocked in Victoria since 1979 and anecdotal information suggests that recreational catch has significantly increased in waters where stocking has occurred. For example, in the Nagambie Lakes anglers commonly catch Murray Cod, suggesting the fish stocking program is making a significant contribution since its commencement in 2009. This contribution is likely to increase as more fish recruit into the fishery [Hunt and Giri 2015]. In 2016–17, approximately 1 147 000 Murray Cod were stocked into 38 waterways across Victoria and the number is expected to increase in coming years as part of a government initiative (Target One Million) to grow recreational fishing in the State [Victorian Fisheries Authority 2017]. Surveys in 2014 of some stocked waters indicated that the contribution of Murray Cod from stocking was highly variable (11–100 per cent) [Ingram and De Silva 2004]. Other surveys, such as the Murray–Darling Basin Authority Sustainable Rivers Audit [Davies et al. 2008], indicate that fish biomass appears to have increased in some catchments (Ovens, Goulburn and Loddon Rivers) and declined in others (Broken and Kiewa Rivers) [Davies et al. 2012].

The last State-wide estimate of recreational catch was measured as part of the National Recreational and Indigenous Fishing Survey in 2001–01 [Henry and Lyle 2003]. This survey estimated that 11 943 Murray Cod were harvested by Victorian recreational fishers, equating to around 27.4 t of biomass. Between 2006 and 2008, recreational fishing creel surveys have been conducted on selected river reaches in Victoria, including the Goulburn, Ovens, Loddon and Murray rivers [Fulton 2011]. Total Murray Cod catch within these river reaches was estimated at more than 98 000 fish, of which just over 6 500 were harvested. However, there is insufficient data available to determine the current biomass or fishing mortality on Murray Cod. In the absence of a State-wide recreational fishing survey and/or fishery-independent data, there is insufficient information available to confidently classify the status of this stock.

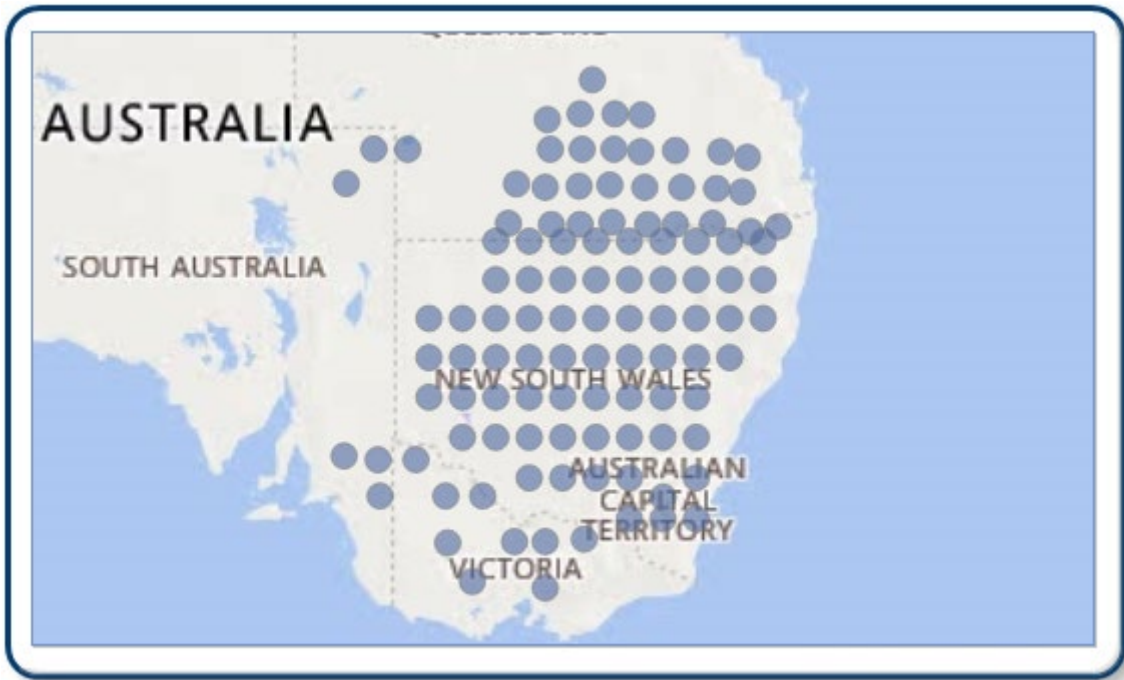
On the basis of the evidence provided above, Murray Cod in Victoria is classified as an **undefined stock**.

BIOLOGY

Murray Cod biology [Anderson et al. 1992, Butler et al. unpublished data, Gooley et al. 1995, King et al. 2009, Lake 1967, Pollard 1966, Rowland 1985, Rowland 1998a, Whitley 1955]

Species	Longevity / Maximum Size	Maturity (50 per cent)
Murray Cod	At least 48 years, ~1800 mm TL , 83 kg	First maturity at ~4–5 years, ~400–600 mm TL for both sexes. Variable across geographic regions

DISTRIBUTION



Distribution of Murray Cod based on reported catch

TABLES

Commercial Catch Methods	Australian Capital Territory	New South Wales	Queensland	South Australia	Victoria
N/A		✓			
Unspecified	✓		✓	✓	✓
Fishing methods					
	Australian Capital Territory	New South Wales	Queensland	South Australia	Victoria
Commercial					
Unspecified	✓		✓	✓	✓
Indigenous					
Hook and Line	✓	✓	✓	✓	✓
Traditional apparatus		✓	✓	✓	✓
Recreational					
Hook and Line	✓	✓	✓	✓	✓
Management Methods					
	Australian Capital Territory	New South Wales	Queensland	South Australia	Victoria
Charter					
Bag limits			✓		
Seasonal closures			✓		
Size limit			✓		

Indigenous					
Bag limits	✓	✓		✓	✓
Size limit	✓	✓		✓	✓
Recreational					
Area closures	✓	✓		✓	
Bag limits	✓	✓	✓		✓
Seasonal closures	✓	✓	✓	✓	✓
Size limit	✓	✓	✓		✓

Active Vessels

Catch					
	Australian Capital Territory	New South Wales	Queensland	South Australia	Victoria
Commercial					
Indigenous	Unknown	Unknown	Unknown	Unknown	Unknown
Recreational	Unknown	Unknown	Unknown	Unknown	Unknown

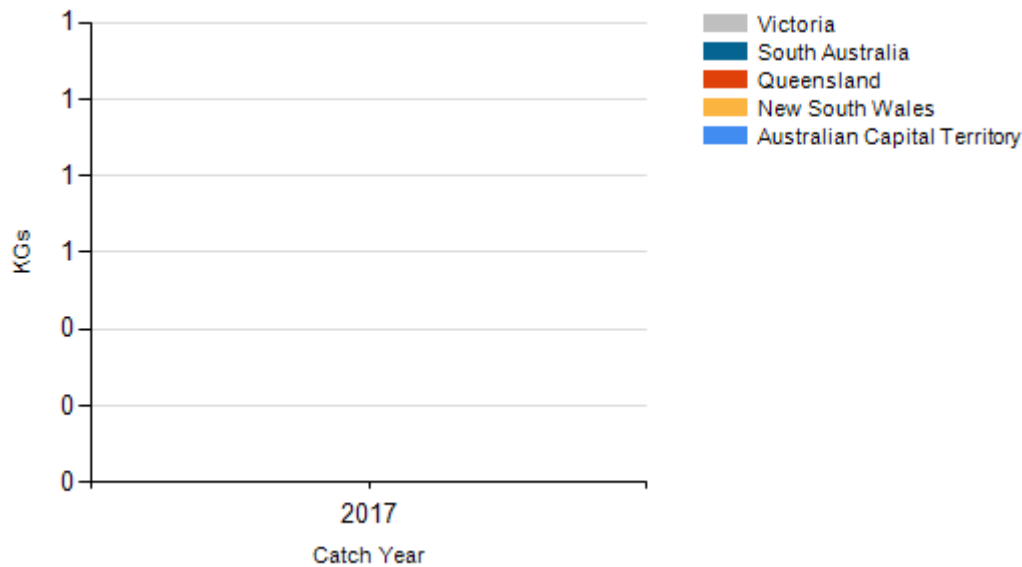
N/A Not Applicable (ACT), N/A Not Applicable (NSW), N/A Not Applicable (QLD), N/A Not Applicable (SA), N/A Not Applicable (VIC),

Commercial (management methods) Murray Cod captured by the Lakes and Coorong Fishery are currently protected under South Australian fishing regulations.

Indigenous (management methods) Indigenous fishers who can satisfy the requirements of the *Native Title Act 1993* (Cth) in relation to their connection to the specific area or waters may take sufficient Murray Cod to satisfy their customary, non-commercial domestic needs in South Australia and Queensland. Indigenous fishers who do not satisfy these requirements are subject to the standard recreational bag limits, size limits and closures.

Victoria – Indigenous fishing In Victoria, regulations for managing recreational fishing may not apply to fishing activities by Indigenous people. Victorian traditional owners may have rights under the Commonwealth's *Native Title Act 1993* to hunt, fish, gather and conduct other cultural activities for their personal, domestic or non-commercial communal needs, without the need to obtain a licence. Traditional Owners that have agreements under the *Traditional Owner Settlement Act 2010* (Vic) may also be authorised to fish without the requirement to hold a recreational fishing licence. Outside of these arrangements, Indigenous Victorians can apply for permits under the *Fisheries Act 1995* (Vic) that authorise customary fishing (for example, different catch and size limits or equipment).

CATCH CHART



Commercial catch of Murray Cod- note confidential catch not shown

EFFECTS OF FISHING ON THE MARINE ENVIRONMENT

ENVIRONMENTAL EFFECTS on Murray Cod

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