

Murray Cod (2016)

Maccullochella peelii



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STOCK STATUS OVERVIEW

Jurisdiction	Stock	Fisheries	Stock status	Indicators
Australian Capital Territory	Australian Capital Territory	N/A	Undefined	Catch, abundance surveys, recreational fishing surveys
Queensland	Queensland	N/A	Undefined	Catch, recreational fishing surveys
New South Wales	New South Wales	N/A	Undefined	Catch, <u>CPUE</u> , abundance surveys, recreational fishing surveys
Victoria	Victoria	N/A	Undefined	Catch, abundance surveys, recreational fishing surveys
South Australia	South Australia	N/A	Undefined	Catch, <u>CPUE</u> , age/size composition, abundance surveys, recreational fishing 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, where there is connectivity between catchments, one large genetically panmictic biological stock exists throughout most of its distribution[1]. However, genetically distinct populations have been identified in the more isolated Lachlan, Macquarie and Gwydir catchments[1]. This separation appears to be the result of restricted gene flow due to isolated catchments, but may also be influenced by stocking programs[1]. 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 a popular recreational target both in the Murrumbidgee and Molonglo Rivers and in the 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[13]. However, no obvious change in abundance of adult riverine populations has been seen since the 1990s. 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[14]. Boat electrofishing, employed 2002–present (alongside netting), found higher numbers of Murray Cod. There appear to be good numbers of juvenile Murray Cod captured in recent years, but there is little data to compare this with as juveniles were never targeted in pre-2008 monitoring programs.

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[15,16]. Approximately 723 000 fingerlings have been stocked since the program began in 1980[15], with an average of approximately 22 000 stocked annually since 2000. Stocking of native fish for recreational purposes is not conducted in riverine environments, and there have been no conservation stockings of the species[15]. Stocked populations in urban lakes continue to provide localised, but well-regarded recreational fisheries.

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[14]. These fish are possibly the result of stocking by the New South Wales Department of Primary Industries upstream of the Australian Capital Territory since 2008. Recent larval genetic investigations have identified hybridisation between Murray Cod and Trout Cod (*Maccullochella macquariensis*)[17]. 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.

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*)[18]. The National Recreational and Indigenous Fishing Survey[19] did not report harvest data for the Australian Capital Territory. In a recent survey, 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[20].

Because the majority of ecological knowledge of this species has been derived from studies in lowland habitats[21–23], and there was little knowledge of

ecology in upland regions, management arrangements and regulations have largely mirrored those in force in surrounding New South Wales. This arrangement has also minimised confusion for cross-border recreational fishers.

In view of the anecdotal and relatively sparse scientific data on abundance compared to historical levels, absence of regular or consistent creel or angler surveys on either the urban lakes or the Murrumbidgee River and uncertainty regarding recovery rates as a result of re-stocking programmes, there is insufficient information available to confidently classify the status of this stock.

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

New South Wales

The range and abundance of Murray Cod are considered to be much-reduced compared to that of pre-European settlement levels in New South Wales[11]. Concerns were raised as early as 1880 regarding declines in abundance, based largely on falling catch rates within the commercial fishery[5]. 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[5]. The annual catch remained below 35 t in the majority of years until the commercial fishery was closed in New South Wales in 2001[5].

The recreational fishery for Murray Cod has continued to grow in New South Wales. The 2000–01 national survey estimated that around 161 000 Murray Cod were caught annually by recreational anglers across New South Wales, with around 25 per cent of these fish harvested[19]. A more recent survey in 2013–14, found that angler effort had increased since 2000–01 and that total catch had also increased by around three per cent, to 165 557 fish[28]. 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, but even fewer were harvested, with only around five per cent retained[29]. The results of these more recent surveys suggest that the recreational sector are increasingly targeting the species, but are also more commonly practicing catch-and-release.

A number of management actions have been implemented to facilitate population recovery across New South Wales. This has included restocking, with over five million hatchery-reared fry and fingerlings released into many of the state's impoundments and rivers since the late-1970's. 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[30]. 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[30]. In contrast, stocked Murray Cod comprised almost the entire population in Copeton Dam (94 per cent)[30]. 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. Recently, in line with Victoria, new fisheries regulations have been implemented to manage the Murray Cod recreational fishery. In December 2014, a state-wide slot limit of 550–750 mm was introduced, with the daily bag limit of two and possession limit of four, remaining the same.

Anecdotal reports and scientific surveys suggest that Murray cod numbers are

increasing in at least some New South Wales rivers[8,31]. Based on a long-term monitoring program over 17 years at 27 sites across New South Wales, it has been suggested these increases could be as high as 740 per cent in some areas[31]. However, to-date there has been insufficient research undertaken to validate these estimates, and there has been no attempt to estimate total abundance or biomass 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[24]. 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[4]. 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[4].

Approximately 100 000 fingerlings have been stocked each year throughout their range in Queensland since the inception of the Recreational Fishing Enhancement Program in the mid-1980s. A large proportion of these fingerlings are stocked into impounded areas, where natural recruitment levels are low[24]. 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[24,25]. The audit and other fishery-independent monitoring have been undertaken in several other rivers and catchments in Queensland[4,24]. However, the lack of consistency in sampling methodologies and the low numbers of Murray Cod recorded during the monitoring makes accurate biomass estimates difficult. This data deficiency needs to be addressed for effective management.

The Queensland area of the Murray–Darling Basin has never supported a commercial fishery, although there is a considerable 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[24,26]. A survey of recreational participation and catch was conducted in 2014[27], 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 a couple of years of reaching legal size[25]. While this suggests that fishing pressure is high, data are presently too uncertain to use for status determination. 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[38,39]. 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 in 2010 under the *Fisheries Management Act 2007* [SA]) that prohibits commercial harvest. Unlike other states/jurisdictions, Murray Cod had not historically been stocked in the South Australian reaches of the Murray River[40]. In 2016, however, the Department of Primary Industries and Regions, South Australia, released 100 000 fingerlings into two river reaches in the South Australian lower Murray.

In the absence of a commercial fishery, or dedicated fishery-independent monitoring programs, the most recent assessment of the population dynamics was conducted using data from three long-term (8–11-year) fish assemblage monitoring projects in the lower Murray River from 2002–13[41]. During this period, catch per unit effort data from electrofishing and drum netting indicated that relative abundance was low, but reasonably constant. 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. 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)[41]. Additionally, in 2014–15, an age 0+ cohort was detected in the main channel of the lower Murray River[42]. Consistent recruitment was evident in the flowing water habitats of the Chowilla anabranch system in 2002–13[41]. These data provide some indication of a fairly stable adult population, and periodic successful recruitment, but there is insufficient information available to confidently determine the biomass of Murray Cod in the South Australian reaches of the Murray River.

The 2007–08 South Australian Recreational Fishing Survey estimated that 507 Murray Cod (around 2.1 t) were harvested from the lower Murray River[43]. 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[19], but release rates increased from 16 per cent in 2000–01 to 73 per cent in 2007–08, 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[44] did not report any catch of this species in the lower Murray River and there remains uncertainty regarding the catch, level of fishing effort and overall post-release mortality associated with the catch-and-release fishery. There is therefore insufficient information available to confidently classify the status of this stock.

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

Victoria

In Victoria, Murray Cod numbers are considered to be much lower than pre-European levels[32]. During the 19[th] century Murray Cod were considered abundant in the Loddon, Campaspe and Goulburn Rivers[33]. However, by the middle of the 20[th] century, populations of Murray Cod had declined in these rivers[34]. 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[35]. Management actions such as the prohibition of commercial netting, introduction of strict recreational bag and size limits, restrictions on fishing methods such as set lines and hatchery stocking have likely resulted in the recovery observed in some populations by the 1990s. However, no 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[36]. In 2015, approximately 580 000 Murray Cod were stocked into 28 waters 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. Surveys in 2014 of some stocked waters indicated that the contribution of Murray Cod from stocking was highly variable (11–100 per cent)[35]. Other surveys, such as the Murray–Darling Basin Authority Sustainable Rivers Audit[9], indicate that fish biomass appears to have increased in some catchments (Ovens, Goulburn and Loddon Rivers) and declined in others (Broken and Kiewa Rivers)[10].

The last state-wide estimate of recreational catch was measured as part of the National Recreational and Indigenous Fishing Survey in 2001–01[19]. This survey estimated that 11 943 Murray Cod were harvested by Victorian recreational fishers, equating to around 27 469 kg 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[37]. Total Murray Cod catch within these river reaches was estimated at more than 98 000 fish, of which just over 6500 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[22,45–51]

Species	Longevity / Maximum Size	Maturity (50 per cent)
Murray Cod	At least 48 years; ~1800 mm <u>TL</u> , 83 kg	First maturity at ~4–5 years; ~450–600 mm <u>TL</u> 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
Line	✓	✓	✓	✓	✓
Fishing methods					
	Australian Capital Territory	New South Wales	Queensland	South Australia	Victoria
Indigenous					
Hand Line, Hand Reel or Powered Reels	✓	✓	✓	✓	✓
Traditional apparatus		✓	✓	✓	✓
Recreational					
Hand Line, Hand Reel or Powered Reels	✓	✓	✓	✓	✓
Line	✓	✓	✓	✓	✓
Management Methods					
	Australian Capital Territory	New South Wales	Queensland	South Australia	Victoria

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

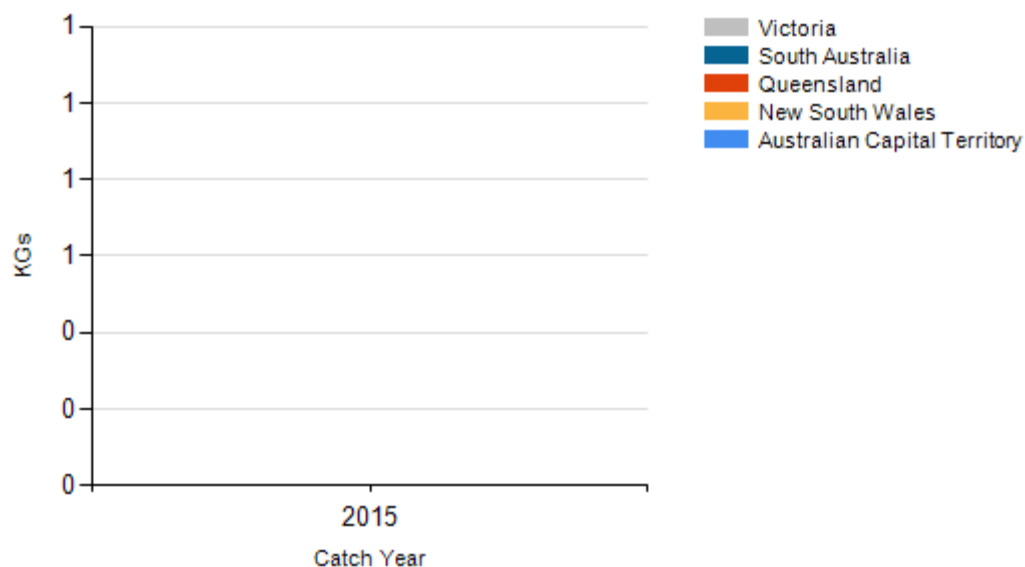
N/A Not Applicable (ACT), N/A Not Applicable (NSW), N/A Not Applicable (QLD), N/A Not Applicable (SA), N/A Not Applicable (VIC),

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

b 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.

c Victoria - Indigenous (management methods) In Victoria, regulations for managing recreational fishing are also applied to fishing activities by Indigenous people. Recognised Traditional Owners (groups that hold native title or have agreements under the Traditional Owner Settlement Act 2010 [Vic]) can apply for permits under the Fisheries Act 1995 (Vic) that authorise customary fishing (for example, different catch and size limits, or equipment). The Indigenous category in Table 3 refers to customary fishing undertaken by recognised Traditional Owners. In 2012–13, there were no applications for customary fishing permits to access Murray Cod.

CATCH CHART



N/A

EFFECTS OF FISHING ON THE MARINE ENVIRONMENT

- Although Murray Cod is no longer targeted by commercial fishing, it is a highly prized catch for recreational fishers. Release rates are very high for this species because of catch-and-release practices or specific fishing regulations[19], which differ considerably between jurisdictions. Studies have investigated the post-release mortality of Murray Cod and found it to be between two and 15 per cent[52,53].
- Recreational fishers targeting Murray Cod often make incidental catches of other native species, such as Golden Perch (*Macquaria ambigua*) and the threatened Trout Cod (*Maccullochella macquariensis*). The recreational catch of these other species is also controlled under state and territory recreational fishing regulations, but there may be post-release mortalities for these species.
- While the recreational fishing take and stocking of Murray Cod impacts their populations[6], the potential effects of changes in the abundance of this top order predator on the freshwater ecosystem (for example, trophic dynamics) are unknown. Implications of disease and other potential environmental risks also need to be considered[40]. In addition, use of live organisms as bait is considered risky because of its potential to introduce and spread disease or noxious species, and the negative impacts that this may have on ecosystems[54].

ENVIRONMENTAL EFFECTS on Murray Cod

- Like many freshwater fish in the Murray–Darling Basin, Murray Cod populations have declined in abundance since the early-1900s as a result of anthropogenic impacts, such as altered natural flow regimes, habitat loss, barriers to movement, cold-water releases from dams, interactions with alien species and overharvesting[3]. Murray Cod prefer structurally complex habitats (for example, coarse wood and overhanging vegetation) in the main channel of the river and anabranches around which they maintain home sites[55–58]. Habitat alteration, such as removal of snags from the main channel and anabranches, will decrease habitat availability and potentially reduce Murray Cod abundance. In addition, fast-flowing lotic habitats are considered to be important for survival of Murray Cod larvae, and as a habitat for juveniles and adults[41]. Alteration to these conditions through anthropogenic (river regulation and water extraction) or natural (floods and drought) factors are likely to affect stocks.
- Enhanced recruitment of Murray Cod in lowland areas has been linked to increased river flow or flooding[22,39]. The exact mechanism driving recruitment is unknown, but it is likely to be linked to an increase in food resources for larvae and juveniles following floodplain inundation[22].
- In lowland rivers, adult Murray Cod can undertake small- to large-scale movements (up to 120 km) from their home sites within the main river channel and anabranches, and between these habitats[58–60]. Lateral and longitudinal disconnection (for example, by

structures or reduced flow) will alter the movement patterns of the species. In upland rivers, movements are likely to be limited by natural barriers such as gorges and waterfalls.

- Cold-water pollution, due to low-level releases from dams, has been deemed responsible for the loss of Murray Cod populations downstream of a number of impoundments[61,62].
- Anoxic blackwater events in lowland environments that may occur as a result of flooding after prolonged periods of low flow, and other poor water quality events, can result in considerable mortality of Murray Cod[59,63].

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