

MUD CRABS (2020)

Scylla spp., *Scylla serrata*, *Scylla olivacea*



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STOCK STATUS OVERVIEW

Jurisdiction	Stock	Stock status	Indicators
Western Australia	Kimberley Crab Managed Fishery	Sustainable	Catch, effort, catch rate
Northern Territory	Arnhem-west Northern Territory Management Unit	Sustainable	Catch, effort, catch rate
Northern Territory	Western Gulf of Carpentaria	Sustainable	Catch, effort, catch rate, biomass, fishing mortality
Queensland	East Coast	Sustainable	Catch, effort, catch rate, biomass, fishing mortality
Queensland	Gulf of Carpentaria	Sustainable	Catch, effort, catch rate, biomass, fishing mortality
New South Wales	Estuary General Fishery	Sustainable	Catch, catch rate, biomass, fishing mortality

STOCK STRUCTURE

Two species of Mud Crabs are found in Australian waters: Giant Mud Crab (*Scylla serrata*) and Orange Mud Crab (*S. olivacea*). The former constitutes more than 99 per cent of the commercial catch of Mud Crabs in the Northern Territory and Queensland, and the entire commercial catch in New South Wales. The species composition in the Kimberley Developing Mud Crab Fishery (Western Australia) is uncertain but is known to vary considerably between

locations.

The life history and biology of Giant Mud Crab in the Northern Territory and Queensland are well documented [Heasman 1980, Hill et al. 1984, Hill 1994, Knuckey 1999, Alberts-Hubatsch 2015] but, with some exceptions [Butcher et al. 2003, Butcher 2004, Alberts-Hubatsch et al. 2014], corresponding information from Western Australia and New South Wales is scarce. There are no published accounts on the biology of Orange Mud Crab in Australian waters. Hence, all catch, and biological information presented here refers to the Giant Mud Crab (*S. serrata*), unless otherwise stated.

Genetic evidence suggests that there are at least two biological stocks of Giant Mud Crab in Australian waters: one to the west and another to the south east of the Torres Strait [Gopurenko and Hughes 2002], referred to as the Northern Australian and East Coast biological stocks, respectively.

Female Giant Mud Crab in northern Australia migrate up to 95 km offshore to release their eggs [Hill 1994], which average around 4.5 million per individual [Mann et al. 1999]. Coupled with a planktonic larval stage that can last for several weeks [Nurdiani and Zeng 2007], this reproductive strategy may facilitate significant gene flow between areas (depending on local oceanography). However, there have been significant changes in the relative performance of some fisheries operating across these stocks since 2014, suggesting that, despite larval connectivity, there are different exploitation rates on components of the adult stock in different areas. These changes, combined with different management arrangements for each of the four jurisdictions that harvest Giant Mud Crab, and (in some cases) the need for more information on local population dynamics, and fine-scale stock structure, have resulted in this status report providing status determinations for Giant Mud Crab at the level of fishery management units: Kimberley Developing Mud Crab Fishery (Western Australia); Arnhem-West Mud Crab Fishery (Northern Territory), Western Gulf of Carpentaria (Northern Territory); Gulf of Carpentaria (Queensland), East Coast (Queensland); and the Estuary General Fishery (New South Wales).

STOCK STATUS

Arnhem-west Northern Territory Management Unit

The Arnhem-West Northern Territory (AWNT) management unit encompasses all NT waters outside of the Gulf of Carpentaria. This unit includes the Darwin region that supports a substantial non-commercial harvest of Mud Crabs. The estimates of the harvest by recreational and Indigenous fishers within the AWNT indicate that their combined take accounted for around 40 per cent of the overall harvest within this management unit during 2000 - 2001 [Henry and Lyle 2003, Coleman 2004]. A more recent, non-Indigenous, resident-only angler survey confirmed the significance of the recreational harvest in this region (23 per cent) [West et al. 2012]. However, a lack of annual catch estimates for recreational and Indigenous fishers means that the assessment presented here is primarily based on data from commercial logbooks.

The most recent stock assessment based on the model used in Grubert et al. [2019] estimated the biomass in 2019 as a proportion of the biomass at Maximum Sustainable Yield (B_{2019}/B_{MSY}) was 1.23, indicating that the stock is currently above the target reference level. The above evidence indicates that the biomass of the stock is unlikely to be depleted and that recruitment is unlikely to be impaired.

The same stock assessment estimated that fishing mortality in 2019 as a proportion of that to achieve MSY (F_{2019}/F_{MSY}) was 0.8 indicating that overfishing is not occurring. Consequently, this level of fishing mortality is unlikely to cause the stock to become recruitment impaired.

On the basis of the evidence provided above, the Western Northern Territory management unit is classified as a **sustainable stock**.

East Coast

The only simultaneous estimates of the recreational and Indigenous harvest

within the East Coast (Queensland) Mud Crab Fishery (MCF) management unit are now more than a decade old but indicate that the combined take by these sectors once exceeded 50 per cent of the total catch within this management unit (using a regional weight multiplier of 1.00 kg per crab [Henry and Lyle 2003]). A recent stock assessment utilised recreational catch estimates of around 331 t based on 2013 survey data (Webley et al. 2015; Northrop et al. 2019), but noted the need for more up-to-date estimates. Note that this catch may include some harvest by Indigenous fishers (survey respondents were not asked about their heritage). These estimates confirm the ongoing significance of the non-commercial harvest, at around 27 per cent of the overall take [Northrop et al. 2019]. These recent annual catch estimates for recreational and Indigenous fishers are taken into consideration for stock status alongside data from commercial logbooks.

The male-only harvest policy in Queensland means that fishing mortality on female Giant Mud Crab is minimal. However, female crabs may be handled and released many times during their life and so some incidental damage and discard mortality is probable [Grubert and Lee 2013]. Nonetheless, this harvest policy maximises the number of females that survive to spawn. Protection of some sexually mature male crabs in Queensland is afforded by a minimum size limit of 150 mm CW (above the size at first maturity in this state [Heasman 1980]), recreational possession and boat limits, and restrictions on commercial licence numbers and fishing effort.

The East Coast (Queensland) MCF management unit accounts for approximately 86.6 per cent of the commercial harvest of the east coast Giant Mud Crab biological stock. The commercial catch in 2019 (687 tonnes (t)) was 32 per cent below the average catch for the previous 10 years (1 008 t). The nominal catch rate in 2019 was 23 kg per fishing day, 15 per cent below the 10-year average (27 kg per fishing day; range 23–33 kg per fishing day). The most recent stock assessment [Northrop et al. 2019] considered the use of catch rates to calculate biomass but inaccuracies in logbook effort data (i.e. pot lifts) meant that there were technical issues with this approach. Instead, a simplified catch-MSY model was adopted. This stock assessment indicated that east coast mud crabs are likely to be 62% of unfished levels (range: 37–69 per cent) with commercial catch estimated to be 685 t in the 2017–18 financial year (catch takes into consideration 30% over-reporting).

Several no-take zones (applying to all marine organisms) along the east coast of Queensland provide additional protection to Giant Mud Crab and result in higher crab densities and larger mean sizes within the protected areas, as well as spillover of crabs into adjacent fished areas [Pillans et al. 2005, Alberts-Hubatsch 2015]. However, the benefit of these closures, over and above the single-sex harvest policy (and the male size limit) on a fishery-wide scale has not been quantified. While the localised benefits of spatial closures can be significant, their cumulative benefit on Giant Mud Crab spawning biomass across the entire East Coast (Queensland) MCF management unit is unlikely to be great when considering the suite of protective measures already in place. All the above evidence indicates that the biomass of the management unit is unlikely to be depleted and that recruitment is unlikely to be impaired.

The most recent estimate of fishing mortality in the East Coast (Queensland) MCF management unit (based on commercial data to 2008) was around 1.5 [Brown 2010], 24 per cent above the estimate of natural mortality for *S. serrata* (1.2—derived from crabs in the Northern Territory [Knuckey 1999]). There are indications from the size distribution of male crabs that fishing mortality is not evenly spread across eastern Queensland, with localised depletion in some areas and low to moderate fishing mortality in others [Grubert and Lee 2013]. Annual fishing effort in 2019 (around 30 000 fishing days) was 9 per cent above the 2008 figure (33 000 fishing days) and the 2019 catch rate (23 kg per fishing day) was 8 per cent below the 2008 value. The effect of the increase in effort since 2008 on the fishing mortality rate of male crabs is not known. However, the proportional change in fishing effort and catch rate is minor when compared

to the variation seen in equivalent data for the Northern Territory. The above evidence indicates that the current level of fishing mortality is unlikely to cause the stock to become recruitment impaired.

On the basis of the evidence provided above, the East Coast (Queensland) Mud Crab Fishery management is classified as a **sustainable stock**.

Estuary General Fishery

The Estuary General Fishery (New South Wales) (EGF) accounts for approximately 17 per cent of the commercial harvest from the East Coast Giant Mud Crab biological stock, with the annual catch composition by sex being very close to 1:1 (49 per cent female, 51 per cent male). A recent survey of recreational fishing in New South Wales (which may include some harvest by Indigenous fishers) indicated that the non-commercial take accounts for around 20 per cent of the overall Giant Mud Crab harvest in this state [Murphy et al. 2020] (using a regional weight multiplier estimated at 0.70 kg per crab).

Part of the Giant Mud Crab population in New South Wales is protected through a minimum size limit (85 mm CL) although the effectiveness of this measure is uncertain because the size at maturity of *S. serrata* in this jurisdiction is not known. Studies on the reproductive biology of *S. serrata* from different catchments in northern Australia have reported regional differences in size at sexual maturity [Knuckey 1999]. The life history of *S. serrata* in New South Wales may differ from populations elsewhere as this jurisdiction represents the southern limit of the species' typical distribution on the eastern seaboard.

Several "no take" zones (applying to all marine organisms) along the New South Wales coast afford some protection to Giant Mud Crab and result in higher crab densities in the closed areas, size class distributions biased towards larger crabs, and spillover of crabs into adjacent fished areas [Butcher et al. 2003, Butcher et al. 2014]. However, these spatial closures are relatively small and fragmented, and their cumulative benefit on a fishery-wide scale has not been quantified.

Historically, the primary indicators for biomass and fishing mortality are commercial catch and standardised commercial catch rate (CPUE).

Standardised catch rates were predicted from generalised linear models (GLM). For recent data analysed as mean daily catch rates (available from 2009–10 to 2018–19), catch rates (zones combined) have remained stable and were above the 10-year average from 2013–14 to 2018–19 [Johnson 2020].

Catch-MSY model-assisted catch-only assessment [Martell and Froese 2013] was fitted to commercial catch from 1978–79 to 2018–19 using the 'simpleSA' package in R [Haddon et al. 2018]. Results of modified Catch-MSY modelling suggest that the current biomass of Giant Mud Crab in NSW waters is depleted to 53 per cent of the estimated maximum biomass with a 95 per cent confidence interval (CI) of 27–80 per cent [Johnson 2020]. Five-year stock projections at catch equal to the current total allowable commercial catch (~206 t) with recreational catches estimated at 20 per cent of total harvest, indicate that biomass is predicted to slowly decline [Johnson 2020].

In 2020, a Schaefer surplus production model (BSM) was fitted to commercial catch (1978–79 to 2018–19) and CPUE (1984–85 to 2018–19) using CMSY+ and BSM [Froese et al. 2019]. Based on BSM analysis, biomass in the last year (1 650 t, CI: 1 240–1 990 t) is estimated to be greater than Bmsy (1 390 t, CI: 910–2 130 t). Estimates of fishing mortality (F) and exploitation rate (F/Fmsy) in 2018–19 were 0.09 (CI: 0.07–0.12) and 0.95 (CI: 0.64–1.64), respectively [Johnson 2020]. All the above evidence indicates that the biomass of the management unit is unlikely to be depleted and that recruitment is unlikely to be impaired. The above evidence also indicates that the current level of fishing mortality is unlikely to cause the stock to become recruitment impaired.

On the basis of the evidence provided above, the Estuary General Fishery (New

South Wales) management unit is classified as a **sustainable stock**.

**Gulf of
Carpentaria**

The commercial sector takes 88 per cent of the Giant Mud Crab catch in the Gulf of Carpentaria (Queensland) Mud Crab Fishery (MCF) management unit [Northrop et al. 2019] and so the status determination for this management unit is primarily based on data from commercial logbooks.

Female Giant Mud Crab cannot be retained in Queensland and the minimum legal size for males (150 mm *CW*) ensures that 50 per cent of males attain sexual maturity before harvest (based on male size at maturity estimates from the WGOCMCF, [Knuckey 1999]). Although female Giant Mud Crab are not retained by the Gulf of Carpentaria (Queensland) MCF management unit, they are probably impacted by it to some degree, given that they may be handled and released many times. Indirect evidence of potential post-release mortality in Queensland comes from an analysis of female size frequency distributions inside and outside parts of the Moreton Bay Marine Park [Grubert and Lee 2013], with larger females being more prevalent in the catch in areas closed to fishing for 12 years compared to those where fishing is still allowed, even though female harvest is prohibited in both areas. Nonetheless, the male-only harvest policy maximises the number of female crabs that survive to spawn the next generation.

Catches in the Gulf of Carpentaria (Queensland) MCF management unit have historically been the most stable of any commercial *Scylla* fishery in Australia, averaging 160 t (range 100–199 t) between 2008 and 2018 [QFISH 2020]. As occurred in other areas, the catch and catch rate for this fishery in 2016 (100 t and 25 kg per fishing day, respectively) were the lowest in a decade, following several years of poor monsoon rainfall in the eastern Gulf of Carpentaria. By contrast, the catch in 2018 (157 t) was the highest in five years and the catch rate (39 kg per fishing day) was 23 per cent greater than the 10 year average (30 kg per fishing day). While catch in 2019 declined again, the catch rate (34 kg per fishing day) remained higher than this average, showing that the Giant Mud Crab population within this management unit rebuilds rapidly and is resilient to the above environmental impacts. The above evidence indicates that the biomass of the management unit is unlikely to be recruitment depleted and that recruitment is unlikely to be impaired.

A recent stock assessment estimated biomass to be around 61% of unfished levels (range 31–72%) and recommended a total allowable commercial catch for the region to be set at 97 t; slightly less than what was harvested by the commercial sector in the 2017–18 financial year. While this fishery still operates under a non-quota based management regime, historical commercial catch levels and the smaller impact of the recreational sector will mean that Gulf of Carpentaria stocks are likely to maintain sustainable biomass levels.

There has been a history of comparatively light exploitation of male crabs (as indicated by the relatively low fishing mortality rate), female Giant Mud Crab are completely protected, and the species exhibits rapid growth and high fecundity [Knuckey 1999, Mann et al. 1999]. The above evidence indicates that the current level of fishing mortality is unlikely to cause this management unit to become recruitment impaired.

On the basis of the evidence provided above, the Gulf of Carpentaria (Queensland) Mud Crab Fishery management unit is classified as a **sustainable stock**.

**Kimberley
Crab
Managed
Fishery**

The Kimberley Crab Managed Fishery (Western Australia) (KCMF) operates in a remote part of Western Australia and commercial harvests are a mixture of Giant Mud Crab and Orange Mud Crab in relatively small quantities. Estimates of the harvest of Mud Crabs by recreational and Indigenous fishers in the Kimberley zone of the North Coast bioregion of Western Australia (the section

of the tropical Western Australian coastline east of 120°00' east) indicate that the non-commercial harvest is around two-thirds of the commercial catch. The catch is calculated from the estimated number of crabs kept, multiplied by a regional average weight of 0.67 kg per crab (across both species) [Henry and Lyle 2003, Ryan et al. 2019], a method employed in this assessment of individual management units.

Western Australia is the only Australian jurisdiction to impose separate minimum size limits for Giant Mud Crab (150 mm CW) and Orange Mud Crab (120 mm CW). Although size at maturity estimates are not available for either species within this state, studies of their reproductive biology in other places (the Northern Territory and Malaysia, respectively) suggest that the two size limits allow a large proportion of each species to reach sexual maturity before harvest. In the case of Giant Mud Crab, approximately 50 per cent of males and 98 per cent of females attain sexually maturity at a size of 150 mm CW [Knuckey 1999]. Reproductive development of the Orange Mud Crab begins at a much smaller size, with around 98 per cent of both sexes mature at 120 mm CW [Ikhwanuddin et al. 2011].

Commercial fishing activity in the KCMF over the past decade has been sporadic, with annual effort ranging widely from around 300 to 30 000 pot-lifts. Confidentiality provisions preclude the disclosure of exact catch figures for 2019 as they are based on data from less than three operators but annual catches by the KCMF have yet to exceed 20 t. The annual standardised catch rate from the KCMF provides an index of abundance that can be used to assess this fishery's performance. The fishery recorded a standardised catch rate of 0.92 kg/traplift in 2017 that was significantly above the (draft) harvest strategy threshold [Johnston et al. 2020]. The 2018 catch rate of 0.5 kg/traplift represented a 46% decrease from 2017, but was still above the threshold. However, the catch rate in 2019 (0.33 kg/traplift) fell below the threshold, but remained above the limit. Consequently, catch and effort in this fishery will be closely monitored in the near future. Note that minimal fishing occurred in 2019 which may have adversely impacted the catch rate. The relatively small catch by commercial and recreational fishers, the wide distribution of the species throughout the region, and minimum legal sizes set well above size at first maturity indicate that the crab stock in this management unit is sustainable. The above evidence indicates that the biomass of this stock is unlikely to be depleted and that recruitment is unlikely to be impaired.

There are no estimates of the fishing mortality rate in the KCMF. However, the small and sporadic commercial catch by the fishery is considered to have little impact on the resource, given the harvest rates. The above evidence indicates that the current level of fishing mortality is unlikely to cause the stock to become recruitment impaired.

On the basis of the evidence provided above, the Kimberley Crab Managed Fishery (Western Australia) management unit is classified as a **sustainable stock**.

Western Gulf of Carpentaria

The Western Gulf of Carpentaria management unit (WGOC) has accounted for more than 70 per cent of the commercial harvest of Mud Crabs in the Northern Territory over the past 20 years. There are no records indicating the presence of Orange Mud Crab within this management unit [Keenan et al. 1998, Atlas of Living Australia 2021] so the catch of Mud Crabs in this region is assumed to consist entirely of Giant Mud Crab. A survey of Northern Territory anglers in 2009–2010 estimated that the harvest of Giant Mud Crab by resident anglers within the WGOC is less than five per cent of the overall harvest of *Scylla* spp. by this sector across the Northern Territory [West et al. 2012]. However, the sporadic collection of recreational harvest data for this species within this management unit means that the assessment presented here is based on data from commercial logbooks.

In addition to fisheries impacts, the GOC has a unique environment that has had a recent period of drought Duke et al. [2017] and a series of extreme ocean warming events [Benthuisen et al. 2018]. The culmination of these factors probably contributed significantly to the commercial catch in 2016 declining to a low level (51 t) [NTG 2018]. However, this historical low catch was followed by a substantial increase in 2017 (185 t). This increase is attributed to above average rainfall during the 2016–17 monsoon season, recovery of juvenile nursery areas and a return to average sea surface temperatures that year [COA BOM 2017, IMOS 2018] highlighting the resilience of this species.

The most recent stock assessment based on the model used in Grubert et al. [2019] estimated the biomass in 2019 as a proportion of the biomass at Maximum Sustainable Yield (B_{2019}/B_{MSY}) was 0.6. While this value would be low for many species, the biomass in this management unit has increased substantially from the low levels in 2016 ($B_{2016}/B_{MSY} = 0.32$) demonstrating that Mud Crab stocks can rebuild very quickly under favourable environmental conditions. The above evidence indicates that the biomass of this stock is unlikely to be depleted and that recruitment is unlikely to be impaired.

Moreover, the same stock assessment estimated that fishing mortality in 2019 as a proportion of that to achieve MSY (F_{2019}/F_{MSY}) was 0.73 indicating that overfishing is not occurring. Consequently, this level of fishing mortality is unlikely to cause the stock to become recruitment impaired.

On the basis of the evidence provided above, the Western Gulf of Carpentaria management unit is classified as a **sustainable stock**.

BIOLOGY

Giant Mud Crab biology [Heasman 1980, Knuckey 1999, Butcher et al. 2003, Jebreen et al. 2008, Grubert and Lee 2013]

Species	Longevity / Maximum Size	Maturity (50 per cent)
MUD CRABS	3–4 years, 230 mm CW, but rarely exceeds 200 mm CW in most areas	Varies by sex and location but generally 120–150 mm CW

DISTRIBUTION



Distribution of reported commercial catch of Mud Crabs

TABLES

Fishing methods				
	New South Wales	Northern Territory	Queensland	Western Australia
Charter				
Rod and reel				✓
Traps and Pots	✓	✓	✓	
Commercial				
Crab Trap		✓		✓
Mesh Net	✓			
Mud Crab Trap			✓	
Traps and Pots	✓			
Various	✓			
Recreational				
Coastal, Estuary and River Set Nets				✓
Dip Net	✓			✓
Hand collection	✓	✓	✓	✓
Hook and Line	✓	✓		✓
Hoop Net	✓			
Spearfishing		✓		
Traps and Pots	✓	✓	✓	
Management Methods				

	New South Wales	Northern Territory	Queensland	Western Australia
Charter				
Effort limits			✓	
Gear restrictions	✓		✓	✓
License				✓
Male-only harvest			✓	
Possession limit	✓		✓	✓
Size limit			✓	✓
Size limits	✓			
Spatial closures	✓		✓	✓
Commercial				
Catch limits	✓			
Effort limits	✓	✓		✓
Gear restrictions	✓	✓	✓	✓
Limited entry	✓	✓	✓	✓
Male-only harvest			✓	
Protection of berried females	✓	✓		✓
Protection of soft-shelled crabs		✓		
Size limit	✓	✓	✓	✓
Spatial closures	✓	✓	✓	✓
Spatial zoning	✓	✓		✓
Recreational				
Bag limits				✓
Effort limits			✓	
Gear restrictions	✓	✓	✓	✓
Male-only harvest			✓	
Possession limit	✓	✓	✓	
Protection of berried females	✓	✓		✓
Size limit	✓	✓	✓	✓
Spatial closures	✓	✓	✓	✓
Spatial zoning	✓	✓		✓

Vessel limits		✓	✓	✓
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Catch				
	New South Wales	Northern Territory	Queensland	Western Australia
Charter		1.1 t		< 1 t
Commercial	119.382 t	125.54 t	912.36 t	5.962 t
Indigenous	Unknown	69 t (2000–01)	13 t (2000–01)	6 t (2000–01)
Recreational	37.9 t (2017–18)	29 t (2015)	331 t in East Coast MCF (2013–14), 15 t in Gulf of Carpentaria MCF (2013–14)	3 t (2017/18)

Western Australia – Indigenous (catch) The estimate of the Indigenous harvest tonnage of Mud Crabs in Western Australia has been revised down as the weight multiplier previously used to calculate this value (1.34 kg per crab) is now considered unrealistically high given that the average weight of harvested Mud Crabs in Western Australia was recently estimated at 0.65 kg.

Northern Territory – Charter (management methods) In the Northern Territory, charter operators are regulated through the same management methods as the recreational sector but are subject to additional limits on license and passenger numbers.

Northern Territory – Indigenous (management methods) The *Fisheries Act 1988* (NT), specifies that “...without derogating from any other law in force in the Territory, nothing in a provision of this Act or an instrument of a judicial or administrative character made under it limits the right of Aboriginals who have traditionally used the resources of an area of land or water in a traditional manner from continuing to use those resources in that area in that manner”.

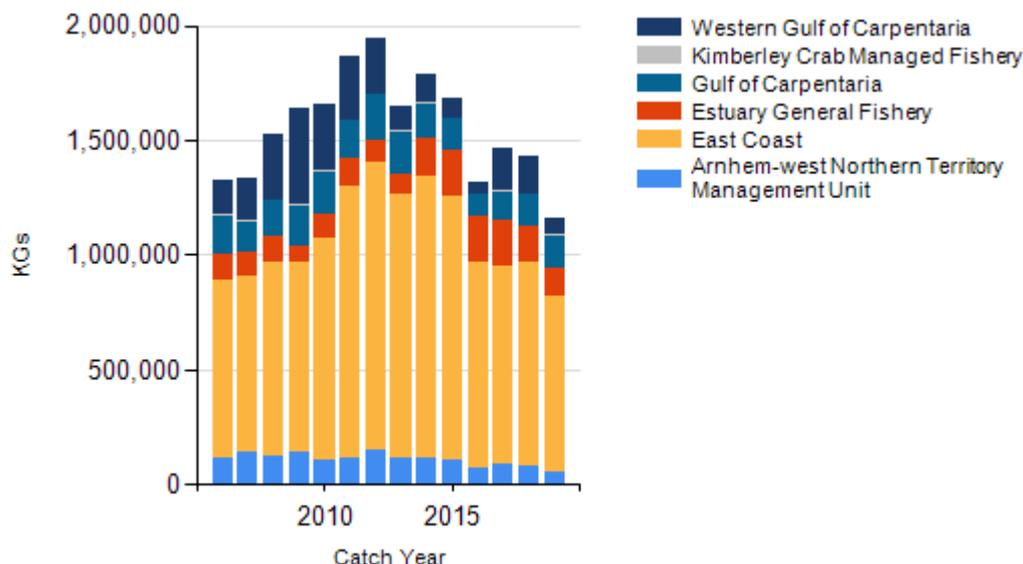
Queensland – Indigenous (management methods) for more information see <https://www.daf.qld.gov.au/business-priorities/fisheries/traditional-fishing>

New South Wales – Indigenous (management methods)<https://www.dpi.nsw.gov.au/fishing/aboriginal-fishing>

New South Wales – Recreational (Catch) Murphy et al. [2020].

Active Vessels The number of active exemption holders (for Western Australia), licences (for the Northern Territory and Queensland) or businesses (for New South Wales) are shown here because the number of active vessels is not an appropriate measure of effort in Australian Mud Crab fisheries. Licensing arrangements also vary significantly between jurisdictions.

CATCH CHART



Commercial catch of Mud Crabs - note confidential catch not shown

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