

# Gould's Squid (2016)

*Nototodarus gouldi*



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## STOCK STATUS OVERVIEW

Jurisdiction	Stock	Fisheries	Stock status	Indicators
Commonwealth, New South Wales, Tasmania	South-Eastern Australia	OTF, SESSF (CTS), SESSF (GABTS), SF, SSJF	Sustainable	Catch rates, total catch

SESSF (CTS) Southern and Eastern Scalefish and Shark Fishery (Commonwealth Trawl Sector) (CTH), SESSF (GABTS) Southern and Eastern Scalefish and Shark Fishery (Great Australian Bight Trawl Sector) (CTH), SSJF Southern Squid Jig Fishery (CTH), OTF Ocean Trawl Fishery (NSW), SF Scalefish Fishery (TAS)

## STOCK STRUCTURE

Genetic studies support the hypothesis of a single biological stock of Gould's Squid throughout south-eastern Australian waters[1]. Two techniques, statolith shape and statolith elemental composition, have also been used to determine dispersal patterns of Gould's Squid and evidence of separate stocks[2,3]. Samples were collected from Victoria and the Great Australian Bight. Adult statolith shape provided evidence that adults caught in the two locations belonged to different stocks. However, statolith elemental composition suggested that Gould's Squid caught at each location had hatched throughout their distribution[3]. Hence, genetic homogeneity of the species is suspected to be a function of egg mass and juvenile drift resulting from seasonal longitudinal ocean currents rather than large-scale migration between the two regions[3]. Also, this drift appears to provide more juvenile squid from Victoria to the Great Australian Bight than occurs in the opposite direction. The current dominance of Victorian and Tasmanian regions in terms of fishing effort means that a single stock approach to management is appropriate at this time[3].

Here, assessment of stock status is presented at the biological stock level—South-eastern Australia.

## STOCK STATUS

**South-Eastern** The South-eastern Australian Gould's Squid biological stock is fished in the jurisdictions of the Commonwealth, New South Wales and Tasmania.

**Australia** Assessment of stock status is primarily based on information from the Commonwealth, which takes the great majority of catch.

No formal stock assessment is available for the Gould's Squid biological stock in Australia. Gould's Squid is short lived (less than 1 year), spawns multiple times during its life, and displays highly variable growth rates, and size and age at maturity[1]. These characteristics mean that the population can rapidly increase in biomass during favourable environmental conditions; it is therefore less susceptible to becoming recruitment overfished than longer-lived species. The high historical catches taken by foreign vessels in the late 1970s and 1980s indicate that a high annual harvest can be taken from the stock in years of high abundance without greatly reducing recruitment and biomass for subsequent seasons. However, because the fishery targets a single year class, there is potential for the population to be recruitment overfished if insufficient animals survive long enough to reproduce. In the case of Gould's squid, spawning occurs throughout the year[1] so this feature of the species reduces the risk of recruitment overfishing in seasonal and localised fisheries such as those in south-eastern Australia.

The majority of catch is taken by bottom trawling and squid jigging. The total fishing effort in the Southern Squid Jig Fishery (Commonwealth) (SSJF) decreased from the peak fishing effort of 15 600 jig hours in 1997, to 617 jig hours in 2010. Despite greater fishing effort in 2011–12, subsequent annual fishing effort has been less than 2000 jig hours. Fishing effort in 2015 was 1304 jig hours. Changes in fishing effort largely reflect economic factors, rather than changes in Gould's Squid catch rates; high operating costs and low prices are the main drivers of the contraction of the SSJF[4]. Fishing effort in the Commonwealth Trawl Sector and Great Australian Bight Trawl Sector has also substantially decreased since 2001[5,6].

Gould's Squid is taken in small quantities as byproduct of the New South Wales Ocean Trawl Fishery (OTF)[7]. Annual landings from New South Wales have steadily decreased since 1998 from 45 tonnes (t) to just 5 t in the last 3 years. Most of the decline has been in catches from the northern zones of the prawn trawl sector in response to a concurrent decrease in nominal fishing effort from 10 500 to 1 500 fisher days.

Gould's Squid are present sporadically in high abundances in Tasmanian State waters in late summer/early autumn, especially off the south-east coast (for example 2000, 2012, 2013)[8]. In 2013, the reported Tasmanian catch of 1025 t exceeded the total of all Commonwealth fisheries. In years of high local abundance, dual endorsed automatic squid-jig vessels have concentrated fishing effort in Tasmanian State waters before moving back to more traditional fishing grounds in Commonwealth waters. As a consequence, Tasmanian catches of Gould's Squid have been highly variable through time and strongly influenced by the level of automatic jig activity. The reported catch of Gould's Squid from Tasmanian waters was 14.4 t in 2015.

The above evidence indicates that the current level of fishing pressure is unlikely to cause the stock to become recruitment overfished[9].

Combined total catch from the Commonwealth, New South Wales and Tasmania since 2000 has been below 3000 t (Figure 2), which is below the historical peak of 7914 t taken by foreign jig fishing vessels in 1979–80. The nominal catch rates from the Commonwealth Trawl Sector, the Tasmanian Scalefish Fishery and OTF have been stable over time[8,9]. Depletion analysis also suggests that the stock has not become recruitment overfished as a result of jigging or demersal trawling pressure in past seasons[4]. The above evidence indicates that the biomass of this stock is unlikely to be recruitment overfished[9].

On the basis of the evidence provided above, the South-eastern Australian

biological stock is classified as a **sustainable stock**.

## BIOLOGY

Gould's Squid biology[1]

Species	Longevity / Maximum Size	Maturity (50 per cent)
Gould's Squid	<1 year; 350–400 mm <u>ML</u>	6–9 months; 170–300 mm <u>ML</u>

## DISTRIBUTION



Distribution of reported commercial catch of Gould's Squid

## TABLES

Commercial Catch Methods	Commonwealth	New South Wales	Tasmania
Danish Seine	✓		
Demersal Pair Trawl	✓		
Gillnet			✓
Hand Line, Hand Reel or Powered Reels			✓
Midwater Trawl	✓		
Otter Trawl	✓	✓	
Squid Jigging	✓		✓
Various			✓
<b>Fishing methods</b>			

	Commonwealth	New South Wales	Tasmania
<b>Commercial</b>			
Danish Seine	✓		
Midwater Trawl	✓		
Otter Trawl	✓	✓	
Squid Jigging	✓		✓
Various			✓
<b>Recreational</b>			
Hand Line, Hand Reel or Powered Reels		✓	✓
<b>Management Methods</b>			
	Commonwealth	New South Wales	Tasmania
<b>Commercial</b>			
Effort limits	✓		
Limited entry	✓	✓	✓
Spatial closures		✓	✓
Temporal closures			✓
Trigger limits	✓		
Vessel restrictions	✓	✓	✓
<b>Indigenous</b>			
Bag limits		✓	✓
Gear restrictions		✓	✓
Section 31 (1)(c1), Aboriginal cultural fishing authority		✓	
Spatial closures		✓	✓
<b>Recreational</b>			
Bag limits		✓	✓
Gear restrictions		✓	✓
Spatial closures		✓	
Temporal			✓

closures			
Active Vessels	Commonwealth	New South Wales	Tasmania
	54 Vessel in SESSF (CTS), 4 Vessel in SESSF (GABTS), 7 Vessel in SSJF, 0 Vessel in WDTF,	44 Vessel in OTF,	12 Vessel in SF,

**SESSF (CTS)** Southern and Eastern Scalefish and Shark Fishery (Commonwealth Trawl Sector)(CTH)

**SESSF (GABTS)** Southern and Eastern Scalefish and Shark Fishery (Great Australian Bight Trawl Sector)(CTH)

**SSJF** Southern Squid Jig Fishery(CTH)

**WDTF** Western Deepwater Trawl Fishery(CTH)

**OTF** Ocean Trawl Fishery(NSW)

**SF** Scalefish Fishery(TAS)

Catch	Commonwealth	New South Wales	Tasmania
<b>Commercial</b>	450.369t in SESSF (CTS), 44.089t in SESSF (GABTS), 329.811t in SSJF,	5.1589t in OTF,	14.432t in SF,
<b>Recreational</b>		Unknown	21 t in 2012–13

SESSF (CTS) Southern and Eastern Scalefish and Shark Fishery (Commonwealth Trawl Sector) (CTH), SESSF (GABTS) Southern and Eastern Scalefish and Shark Fishery (Great Australian Bight Trawl Sector) (CTH), SSJF Southern Squid Jig Fishery (CTH), OTF Ocean Trawl Fishery (NSW), SF Scalefish Fishery (TAS),

**a Commonwealth – Recreational** The Australian Government does not manage recreational fishing in Commonwealth waters. Recreational fishing in Commonwealth waters is managed by the state or territory immediately adjacent to those waters, under its management regulations.

**b Commonwealth – Indigenous** The Australian Government does not manage non-commercial Indigenous fishing in Commonwealth waters, with the exception of the Torres Strait. In general, non-commercial Indigenous fishing in Commonwealth waters is managed by the state or territory immediately adjacent to those waters.

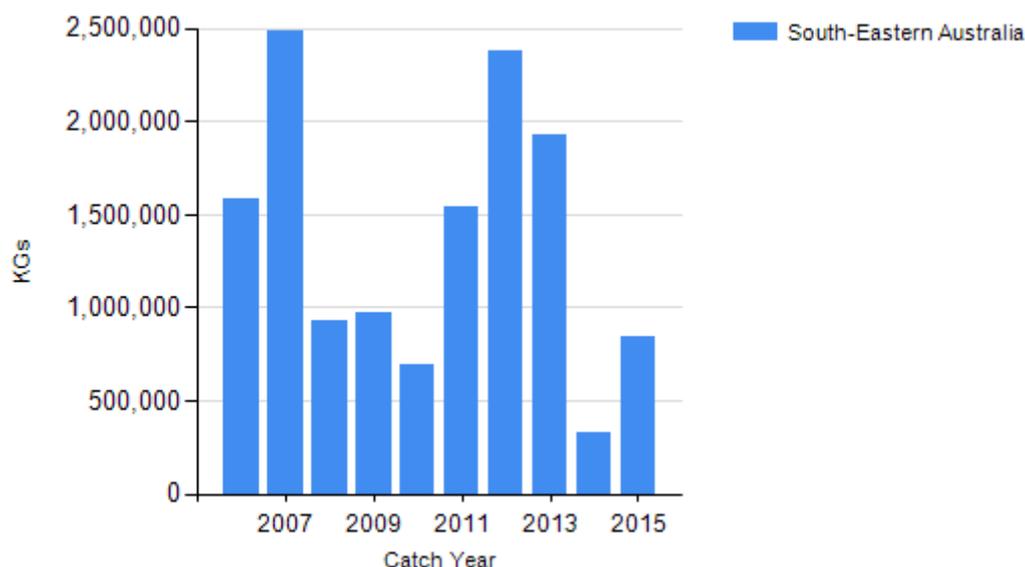
**c Tasmania – Indigenous (management methods)** In Tasmania, aborigines engaged in aboriginal fishing activities in marine waters are exempt from holding recreational fishing licences, but must comply with all other fisheries rules as if they were licensed. Additionally, recreational bag and possession limits also apply. If using pots, rings, set lines or gillnets, Aborigines must obtain a unique identifying code (UIC). The policy document Recognition of Aboriginal Fishing Activities for issuing a Unique Identifying Code (UIC) to a person for Aboriginal Fishing activity explains the steps to take in making an application for a UIC.

**d New South Wales – Indigenous (management methods)** Aboriginal Cultural Fishing Interim Access Arrangement - allows an Indigenous fisher in New South Wales to take in excess of a recreational bag limit in certain circumstances, for example, if they are doing so to provide fish to other community members who cannot harvest themselves.

**e New South Wales – Indigenous (management methods)** Aboriginal cultural fishing authority - the authority that Indigenous persons can apply to take catches outside the recreational limits under the Fisheries Management Act 1994 (NSW), Section 37(1)(c1) (Aboriginal cultural fishing authority). **f Tasmania – Active vessels** Vessels allowed to operate in the Tasmanian Scalefish Fishery need an automatic squid jig licence to operate more than

four automatic jig machines.

## CATCH CHART



Commercial catch of Gould's Squid - note confidential catch not shown

## EFFECTS OF FISHING ON THE MARINE ENVIRONMENT

- Jig fishing methods are highly selective of target species. The current ecological risk assessment for the Southern Squid Jig Fishery (Commonwealth) (SSJF), which assesses the effect of jig fishing methods against five ecological components—target species; by-product and by-catch species; threatened, endangered and protected species; habitats and (ecological) communities, was completed in 2006. The ecological risk assessment identified low levels of risk from jig fishing methods on the five ecological components[12]. A new ecological risk assessment for the SSJF is scheduled for the end of 2016 (AFMA, 2016, pers. Comm., September).
- An ecological risk assessment for the Scalefish Fishery (Tasmania) over the 2012–13 season identified automatic squid jigging as a low risk activity for target species, non-retained species and the general ecosystem[13].
- There is bycatch in the fish trawl sector. In 2006, mandatory requirements for otter trawls to use 90 mm square-mesh codend panels were introduced in an effort to reduce the bycatch of small species and juvenile fish[14].
- The Australian Fisheries Management Authority mandated individual vessel seabird management plans[15]. The seabird action plans are used in the Southern and Eastern Scalefish and Shark Fishery (Commonwealth Trawl Sector) (SESSF [CTS]) to mitigate the impacts of trawling on seabirds. From 1 May 2017, all vessels in the SESSF (CTS) and Southern and Eastern Scalefish and Shark Fishery (Great Australian Bight Trawl Sector) (SESSF [GABTS]) fisheries must use one of the following mitigation devices: sprayers; bird bafflers; or pinkies with zero discharge of fish waste[16].
- The effects of trawl fishing on the marine environment are assessed through an environmental risk assessment and risk management framework and mitigated through spatial closures, and the implementation of bycatch and discard workplans[17,18] in the SESSF (CTS) and SESSF (GABTS) fisheries.
- The New South Wales Ocean Trawl Fishery (OTF) mandates otter trawl nets must be fitted with a bycatch reduction device of an approved design to reduce the bycatch of small prawns and juvenile fish. Mesh size and gear restrictions are regulated to increase the target species selectivity of otter trawl and Danish-seine nets and codends.
- Trawling, used in the Commonwealth Trawl Sector and the OTF, has potential for interactions with threatened, endangered and protected species. These fisheries have

in place bycatch and discarding workplans[17,18] or bycatch catch triggers to reduce these interactions and environmental impacts.

- Interactions also occur with animals protected under the *Environment Protection and Biodiversity Conservation Act 1999*, including marine mammals (dolphins, seals and sea lions), seabirds, some shark species and seahorses and pipefish (syngnathids). These interactions are reported quarterly by the Australian Fisheries Management Authority[19] and on-board observer programs are used to validate the reporting in commercial logbooks.
- In 2007, the South East Trawl Fishing Industry Association released an industry code of practice that aims to minimise interactions with fur seals, as well as addressing the environmental impacts of the fishery more generally[20]. Operators have developed other mitigation protocols that have further reduced seal mortalities, including: using breakaway ties that keep the net closed until it is below depths that seals regularly inhabit; adopting techniques to close the trawl opening during recovery to minimise opportunities for seals to enter the net; switching off gantry lights that are not required during night trawling to avoid attracting bait species and seals; and dumping offal only when the boat is not engaged in deploying or hauling gear[20].

### ENVIRONMENTAL EFFECTS on Gould's Squid

- The Gould's Squid biological stock can vary significantly in abundance between years, and environmental conditions are widely acknowledged as influences on larval and juvenile survival[2]. Environmental factors such as sea temperature and nutrient concentrations have been linked to growth rate, particularly for females[1]. Gould's Squid is a fast-growing species with a short life span[1], and the stock is able to respond rapidly when conditions are favourable. However, at any given time, the southern Australian stock comprises a single population of less than 1 year of age. This means that prolonged detrimental environmental conditions have the potential to reduce abundance for more than a year. Therefore, any detrimental environmental impact on recruitment has the potential to cause drastic impacts on abundance.

References	
1	Jackson, GD and McGrath-Steer, BL 2003, <i>Arrow squid in southern Australian waters—supplying management needs through biological investigations</i> , final report to the Fisheries Research and Development Corporation, project 1999/112, Institute of Antarctic and Southern Ocean Studies, University of Tasmania, Hobart.
2	Virtue, P, Green, C, Pethybridge, H, Moltschaniwskyj, N, Wotherspoon, S and Jackson, G 2011, <i>Arrow squid: stock variability, fishing techniques, trophic linkages—facing the challenges</i> , final report to the Fisheries Research and Development Corporation, project 2006/12, Institute for Marine and Antarctic Studies, Hobart.
3	Green, C, Robertson, S, Hamer, P, Virtue, P, Jackson, G and Moltschaniwskyj, N 2015, Combining statolith element composition and Fourier shape data allows discrimination of spatial and temporal stock structure of arrow squid ( <i>Nototodarus gouldi</i> ). <i>Canadian Journal of Fisheries and Aquatic Sciences</i> DOI: 10.1139/cjfas-2014-0559.
4	Sahlqvist, P and Skirtun, M 2011, Southern Squid Jig Fishery, in J Woodhams, I Stobutzki, S Vieira, R Curtotti and GA Begg (ed.s), <i>Fishery status reports 2010: status of fish stocks and fisheries managed by the Australian Government</i> , Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra, pp 233–241.
5	Georgeson, L, Nicol, S, Moore, A and Green, R 2016, Commonwealth Trawl and Scalefish Hook sectors, in H Patterson, R Noriega, L Georgeson, I Stobutzki and R Curtotti (ed.s), <i>Fishery status reports 2016</i> , Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra, pp 135–230.
6	Moore, A, Georgeson, L and Savage, J 2016, Great Australian Bight Trawl Sector, in H Patterson, R Noriega, L Georgeson, I Stobutzki and R Curtotti (ed.s), <i>Fishery status reports 2016</i> , Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra, pp 238–256.
7	Hall, KC 2015, Gould's Squid ( <i>Nototodarus gouldi</i> ), in Stewart, J, Hegarty, A, Young, C, Fowler, AM and Craig, J (ed.s), <i>Status of fisheries resources in NSW 2013–14</i> , NSW Department of Primary Industries, Mosman, pp 157–160.

8	Emery, T, Bell, J, Lyle, J and Hartmann, K 2015, <i>Tasmanian scalefish fishery assessment 2013/14</i> , Institute for Marine and Antarctic Studies, University of Tasmania, Hobart.
9	Hansen, S and Bath, A 2016, Southern Squid Jig Fishery, H Patterson, R Noriega, L Georgeson, I Stobutzki and R Curtotti (ed.s), <i>Fishery status reports 2016</i> , Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra, pp 281–292.
10	Australian Fisheries Management Authority 2007, <i>Southern Squid Jig Fishery harvest strategy</i> , AFMA, Canberra.
11	Lyle, JM, Stark, KE and Tracey, SR 2014, <i>2012–13 survey of recreational fishing in Tasmania</i> , Institute for Marine and Antarctic Studies, University of Tasmania, Hobart.
12	Furlani, D, Hobday, A, Ling, S, Dowdney, J, Bulman, C, Sporcic, M and Fuller, M 2007, <i>Ecological risk assessment for the effects of fishing: report for the Southern Squid Jig sub-Fishery</i> , report to the Australian Fisheries Management Authority, Canberra.
13	Bell, JD, Lyle, JM, Andre, J and Hartmann, K 2016, <i>Tasmanian scalefish fishery: ecological risk assessment</i> , Institute for Marine and Antarctic Studies, University of Tasmania, Hobart.
14	Australian Fisheries Management Authority 2005, <i>SESSF direction no. 05: gear requirements for the Commonwealth Trawl Sector</i> , AFMA, Canberra.
15	Australian Fisheries Management Authority, <i>Seabirds</i> , AFMA, Canberra.
16	Australian Fisheries Management Authority 2016, <i>AFMA moves to strengthen seabird safety</i> , AFMA media release 15 July 2016.
17	Australian Fisheries Management Authority 2014, <i>Commonwealth Trawl Sector (Otter Board Trawl and Danish Seine) bycatch and discarding workplan 2014–2016</i> , AFMA, Canberra.
18	Australian Fisheries Management Authority 2014, <i>Great Australian Bight Trawl Sector bycatch and discarding workplan 2014–2016</i> , AFMA, Canberra.
19	Australian Fisheries Management Authority, <i>Protected species interaction reports</i> , AFMA, Canberra.
20	South East Trawl Fishing Industry Association 2007, <i>Industry code of practice to minimise interactions with seals</i> , SETFIA, Shearwater, Tasmania.