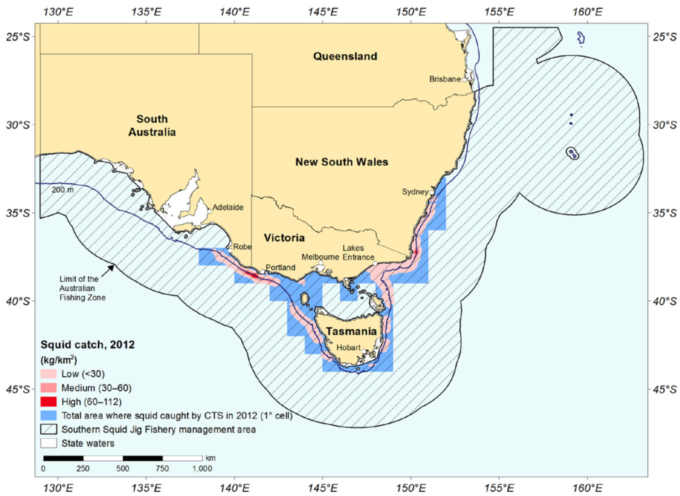
Chapter 13
Southern Squid Jig Fishery

P Sahlqvist, M Skirtun and S Vieira

FIGURE 13.1 Commonwealth Trawl Sector squid catch (a) and (b) the relative fishing intensity in the Southern Squid Jig Fishery, 2012

(a)



(b)

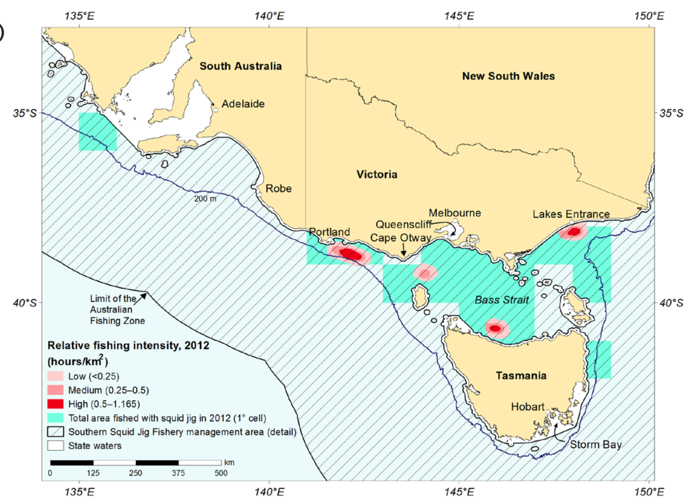


TABLE 13.1 Status of the Southern Squid Jig Fishery

Status	2011		2012		Comments
Biological status	**Fishing mortality**	**Biomass**	**Fishing mortality**	**Biomass**	
Gould's squid (*Nototodarus gouldi*)					No formal stock assessment. Jig fishing effort in recent seasons has been lower than long-term average because of low profitability. Catch rates from CTS are stable.
Economic status	NER are likely to have improved in the 2012 season, given an increase in GVP and a relatively small decrease in effort.				

Notes: **CTS** Commonwealth Trawl Sector. **GVP** Gross value of production. **NER** Net economic returns.

Fishing mortality	Not subject to overfishing	Subject to overfishing	Uncertain
Biomass	Not overfished	Overfished	Uncertain

13.1 Description of the fishery

The Southern Squid Jig Fishery (SSJF) is a single-method (jigging), single-species fishery, targeting Gould's squid. The fishery is located off New South Wales, Victoria, Tasmania and South Australia, and in a small area of oceanic water off southern Queensland, with most fishing taking place in the areas of Queenscliff and Portland (Figure 13.1).

The SSJF is managed by the Australian Government, although jigging operations within coastal waters (inside the 3 nautical mile limit) are managed by the adjacent state government. Before the commencement of the SSJF, Japanese commercial jig vessels fished in southern Australian waters in the summers of 1978–79 and 1979–80 under joint-venture partnerships with Australian companies. The peak historical catch of Gould's squid from south-eastern Australian waters (7914 t) was taken by foreign (Japanese) jig vessels in 1979–80. Commercially viable jig catch rates were achieved in south-east waters, particularly in western Bass Strait, proving the feasibility of a fishery for Gould's squid. Taiwanese and Korean vessels were also licensed to fish in Bass Strait until 1988, with annual catches ranging from 13 t to 2309 t.

Current Australian jig vessels operate at night in continental-shelf waters between 60 m and 120 m in depth. Up to 10 automatic jig machines are used on each vessel; each machine has two spools of heavy line, with 20–25 jigs attached to each line. High-powered lamps are used to attract squid. These are smaller vessels than the foreign vessels previously operating in this fishery.

Gould's squid is also caught in other Commonwealth fisheries, mostly by demersal otter trawling, and particularly in the Southern and Eastern Scalefish and Shark Fishery (SESSF). In the Commonwealth Trawl Sector (CTS) of the SESSF, the annual catch of squid has ranged between 440 t and 956 t over the past 10 years. In the Great Australian Bight Trawl Sector (GABTS), the annual catch peaked in 2006 at 262 t, but has been much less in recent years. The main trawl catches are taken near the seabed in depths of 100–200 m. The total annual catch of Gould's squid in state government–managed waters is usually less than 100 t. However, in some years, Gould's squid is abundant in eastern Tasmanian waters, particularly in Storm Bay, where 687 t were harvested in 2007 by the Tasmanian Scalefish Fishery.

Squid's short lifespan, fast growth and sensitivity to environmental conditions result in highly variable squid recruitment, making it extremely difficult to estimate biomass before a fishing season. As a result, no biomass or economic targets or limits are used in the squid harvest strategy. Instead, the SSJF harvest strategy (AFMA 2007) uses a system of within-season monitoring against catch triggers for the jig and trawl sectors. It includes catch, effort and catch-per-unit-effort triggers that signal the need for assessment and review of management arrangements if the triggers are exceeded. The current harvest strategy also does not set escapement targets to limit the percentage of biomass removed in a season. The feasibility of conducting in-season depletion analysis when triggers are reached and the data needs for such analysis (such as real-time catch-and-effort data, current size monitoring and growth estimates) are a limitation of the current harvest strategy structure; this may warrant further consideration by the Southern Squid Jig Fishery Resource Assessment Group (SquidRAG).

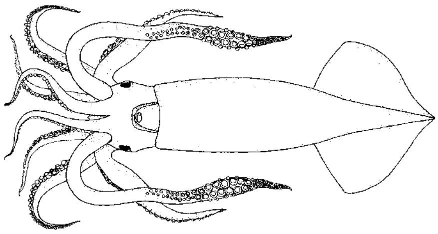
TABLE 13.2 Main features and statistics for the SSJF

Fishery statistics a	2011 fishing season			2012 fishing season		
Fishery/sector	**TAE**	**Catch (t)**	**Real value (2010–11)**	**TAE**	**Catch (t)**	**Real value (2011–12)**
SSJF	560 standard jigging machines b	650	$1.69 million	560 standard jigging machines b	832	$2.07 million
CTS	–	735	$1.42 million	–	956	$1.32 million
GABTS	–	14	$0.03 million	–	30	$0.03 million
Fishery-level statistics						
Effort (hours of jigging)	4 122 jig hours			4 111 jig hours		
Fishing permits	56 (5 600 gear SFRs)			56 (5 600 gear SFRs)		
Active vessels	15			18		
Observer coverage	0			0		
Fishing methods	Squid jig, otter trawl					
Primary landing ports	Portland, Queenscliff, Hobart					
Management methods	Input controls: gear SFRs, number of jig machines					
Primary markets	Domestic: Melbourne—fresh International: China, Hong Kong, Canada					
Management plan	*Southern Squid Jig Fishery management plan 2005* (DAFF 2005)					

a Fishery statistics are provided by fishing season, unless otherwise indicated. Fishing season is 1 January to 31 December. Real-value statistics are by financial year and are in 2011–12 dollars. **b** Defined in the *Southern Squid Jig Fishery management plan 2005* as a squid jigging machine that has two elliptical spools with one jig line on each spool.
Notes: **CTS** Commonwealth Trawl Sector. **GABTS** Great Australian Bight Trawl Sector. **SFR** Statutory fishing right. **SSJF** Southern Squid Jig Fishery. **TAE** Total allowable effort. – Not applicable.

13.2 Biological status

13.2.1 Gould's squid



Line drawing: FAO

Stock assessment

Gould's squid is short lived, with a maximum life span of 12 months. The fishery is therefore entirely dependent on annual recruitment. The species spawns several times during its life and displays highly variable growth, and size and age at maturity (Jackson & McGrath-Steer 2003; Virtue et al. 2011). These characteristics mean that the stock can rapidly increase its numbers during favourable environmental conditions, and that stock biomass can fluctuate substantially between years.

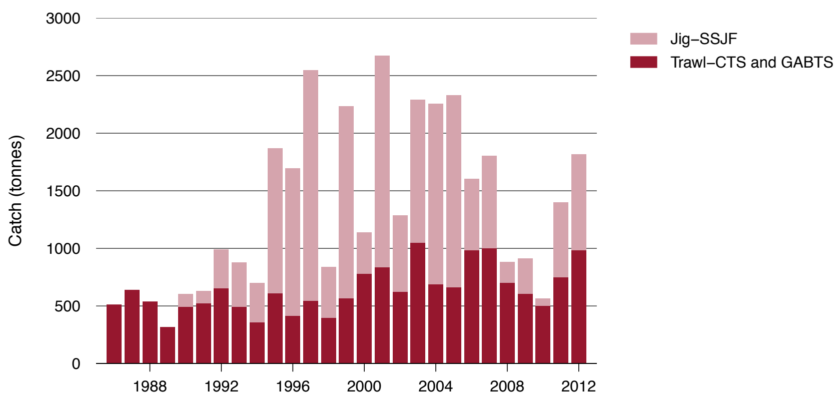
In 2008, SquidRAG analysed catch, effort and catch rates since 2000 for four regions in the SSJF. Only one region (the central region from Cape Otway in Victoria to Robe in South Australia) was found to have had levels of fishing that could cause depletion. A preliminary depletion analysis was conducted for the central region using jig catch-and-effort data for the 2001 fishing season, during which high catch rates were reported and the total jig fishery catch was the second highest on record (Figure 13.2). Results indicated that, despite the high catches, the stock was not overfished in that region in that year.

ABARES has conducted further depletion analyses for the central region of the SSJF for 1995 to 2006 (Barnes et al., in preparation). The initial depletion curve results show declines in stock during most of the seasons analysed, with escapement in five seasons estimated to be between 30 and 40 per cent. However, these results are for only one region of the fishery and do not indicate exploitation rates for the stock as a whole. Limited data are available on squid growth in this region. Interpretation of the depletion estimates is further complicated by the lack of an agreed estimate of natural mortality, the possible presence of multiple cohorts each year (as a result of multiple spawning events) and a lack of knowledge about squid movement in the region. Application of a depletion analysis to guide within-season management decisions under the harvest strategy will require improved real-time fishery monitoring throughout the fishing season.

Total annual reported catches of Gould's squid by all methods were less than 1000 t between 2008 and 2010 (Figure 13.2). In 2011, total jig catch increased significantly to 650 t, from 62 t in 2010; the CTS catch was 735 t, up from 483 t. The jig catch increased again in 2012 to 832 t, and the CTS catch increased to 956 t. The 2011 and 2012 jig catches were lower than those recorded in many seasons before 2006, mainly due to lower levels of fishing effort (Figure 13.3). High costs and low revenues as a result of poor prices paid by processors, combined with reduced availability of squid, were the main reasons for the contraction of the jig fishery between 2008 and 2010, although annual jig fishing effort has been below the long-term average since 2006. The nominal annual average catch rate from the jig fishery was very low in 2010 (100 kg/hour) compared with previous seasons (203 kg/hour in 2008, 251 kg/hour in 2009). The catch rate improved to an average of 158 kg/hour in 2011 and improved further to 202 kg/hour in 2012 (Figure 13.4). Squid are visual predators, and poor jig catch rates in some seasons (1998 and 2000) have been attributed to poor environmental conditions (e.g. rough seas, reduced water clarity) that reduce squid catchability on jigs. However, there is some doubt about the utility of jig catch rates as an index of abundance for squid, given the aggregating effect of lights used during the operation.

Trawl catch rates from the CTS have been stable over the past 15 years, suggesting long-term stability in the biomass of Gould's squid across the stock's wider geographic range (Figure 13.4). The 2012 average trawl catch rate for Gould's squid in the CTS was the highest reported in the past 20 years; it is not known whether increased targeting of squid on trawl grounds contributed to these increased catches. The high historical catches taken by foreign vessels in the 1980s confirm that, as a result of the high variability in abundance of this species, a much higher annual harvest can be taken from the stock in some years without depleting the biomass for subsequent seasons.

FIGURE 13.2 Squid catch in the SSJF, CTS and GABTS, 1986 to 2012



Notes: **CTS** Commonwealth Trawl Sector. **GABTS** Great Australian Bight Trawl Sector. **SSJF** Southern Squid Jig Fishery.

FIGURE 13.3 Effort, number of permits and number of active vessels in the SSJF, 1996 to 2012

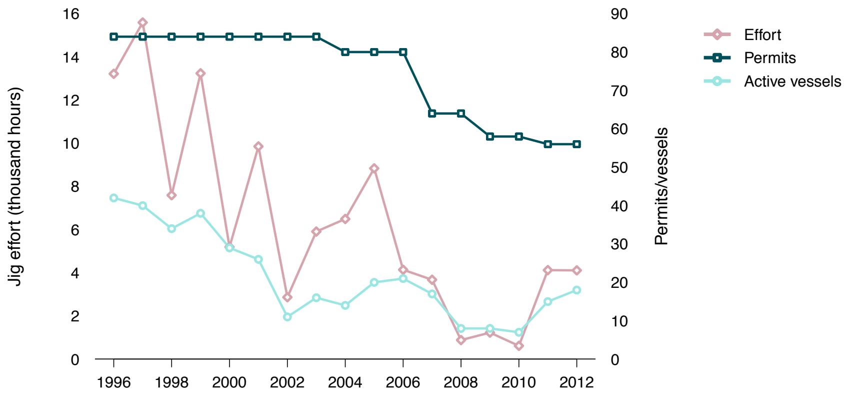


FIGURE 13.4 Nominal catch rate of Gould's squid in the SSJF and CTS, 1996 to 2012

Notes: **CTS** Commonwealth Trawl Sector. **SSJF** Southern Squid Jig Fishery.

Stock status determination

The low SSJF catches in the past five years appear to have resulted from the short time for which squid were available to the jig fishery, combined with economic factors that have discouraged fishing effort. The results of preliminary depletion analysis in the fishery for seasons back to 1996, stable catch rates in the trawl fishery over an extended period and higher average catch rates over the past season support the conclusion that the stock has not been overfished in any season to date. As a result, the Gould's squid stock is classified as **not overfished**. Since recent jig fishing effort has been low and trawl catches have been relatively stable, the stock is classified as **not subject to overfishing**.

13.3 Economic status

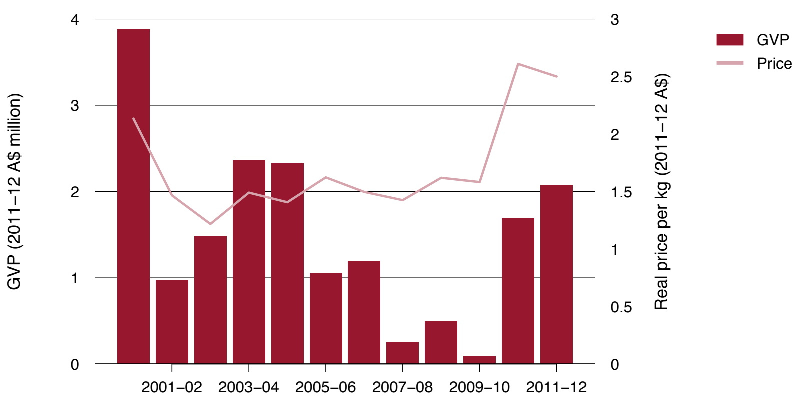
13.3.1 Key economic trends

Catch levels and catch rates have increased substantially since the 2010 jig season, which recorded the lowest landed catch in 10 years (62 t) as a result of exceptionally low catch rates (Figure 13.2). Total catch increased to 650 t in the 2011 season and 832 t in the 2012 season. It is likely that this increase has been driven by higher catch rates and favourable prices resulting from reduced supply on international markets. The reduced supply on international markets in 2009–10 (largely due to declines in squid catches in the South Atlantic Ocean) significantly increased international and domestic prices for squid in 2010–11 (SEMAC 2011). In 2010–11, average beach prices (2011–12 dollars) in the SSJF were the highest for 10 years, at $2.61 per kilogram (Figure 13.5). Domestic squid prices fell slightly in 2011–12 to $2.50 per kilogram, but remain high in comparison with previous years.

Low catch, coupled with low squid prices, significantly undermined the fishery's gross value of production (GVP) in 2009–10. Despite the small decline in prices between 2010–11 and 2011–12, the increase in catch resulted in an increase in the fishery's real GVP from $1.69 million to $2.07 million (Figure 13.5).

The recent increase in effort levels in the fishery suggests that it has become more profitable to operate in the fishery. Management costs in the fishery were $0.11 million in 2011–12 (5 per cent of the fishery's GVP), leaving a sizable margin for net economic returns. However, catch volume and value are still low relative to other Commonwealth fisheries. Therefore, net economic returns are also likely to be comparatively low, in absolute terms.

FIGURE 13.5 Real GVP and average unit prices in the SSJF, 2000–01 to 2011–12



Notes: **GVP** Gross value of production.

Factors that have contributed to the low participation and investment levels in the fishery in recent years include relatively high set-up and running costs for squid jigging operations, rising fuel prices, variable catch rates and low availability (in some years). The lack of a reliable supply for the domestic market has resulted in limited development of processing facilities. Currently, most vessels operating in the fishery do not have onboard refrigeration or processing facilities. The catch is chilled on board but must be returned to port each morning for processing or freezing. Most of the vessels are also not equipped to operate in extreme weather conditions. This can limit the volume of catch that can be taken in a given trip and overall profit margins (L Triantafillos, Department of Primary Industries and Resources of South Australia, pers. comm., 2013). In particular, during winter months, heavy winds and swells in Bass Strait often halt activity in the fishery.

13.3.2 Management arrangements

Given the biology of this species, and the fact that profitability is heavily influenced by stock availability in the fishery, the use of input controls (effort limits) in the form of tradeable gear statutory fishing rights (SFRs) is considered appropriate. In the absence of formal stock assessments, total allowable effort (TAE) levels in the fishery are determined based on consultation with SquidRAG and the South East Management Advisory Committee. To date, TAEs have simply been set at levels matching the number of SFRs held by fishers, and there has been no economic basis for setting the fishery's TAE (AFMA 2007).

Although effort has increased in the past two seasons, the number of unused gear SFRs in the SSJF remains high. Boats tend to use up to 10 jigging machines, with each machine requiring 10 gear SFRs. In 2009–10, 5800 SFRs were present in the fishery. This could enable 58 vessels (each with 10 jigging machines) to operate in the fishery, but only 7 vessels operated in that season. In 2010–11, the number of active vessels increased to 15, with 5600 gear SFRs available. In 2011–12, the same number of gear SFRs existed, and the number of active vessels increased to 18. This still leaves a large number of gear SFRs inactive.

A fishery with such high interannual variability in available biomass would also be expected to vary in the proportion of fishing rights that are active in any given year. However, although gear SFR latency has been variable in the SSJF, it has persisted at high levels in all years since 1996—management arrangements have never constrained effort (Figure 13.3). Normally, this would create the potential for a rapid increase in capital invested in the fishery in response to favourable stock availability or market conditions. This could lead to entry of vessels and an increase in fixed costs beyond the optimal level for the fishery. If entry does occur, another problem for highly variable fisheries is that disinvestment is typically slow relative to declines in abundance (Freon et al. 2008), leading to the possibility of overcapacity and fishery-level inefficiency.

13.3.3 Performance against economic objective

The short lifespan of squid, a weak relationship between recruitment and stock abundance, and high interannual variability in squid abundance or availability mean that a biomass target such as B_{MEY} (the biomass producing maximum economic yield) is likely to be inappropriate for the SSJF. Instead of a biomass target, the fishery's harvest strategy currently has a 3000 t catch trigger for formal stock assessments to be undertaken. This is aimed at preventing depletion, by allowing catches above the trigger level only if they are justified by assessment results (AFMA 2007). The trigger has not been reached since the harvest strategy was implemented in 2007. The catch trigger is not linked to economic performance, and so it is difficult to determine how the fishery's harvest strategy complies with the economic objective of the Commonwealth Fisheries Harvest Strategy Policy (DAFF 2007).

Fluctuations in squid availability and prices have meant that effort has fluctuated in the fishery. However, high levels of latent effort have persisted. Reducing this latent effort might be beneficial for the fishery by preventing the entry of excess capacity in profitable years when prices rise. However, the ability to deploy extra fishing effort in years of increased abundance is also important in optimising exploitation of a variable stock. Further research would be required to confirm the potential economic benefits of reducing latent effort, and to determine the optimal level of effort. This would need to take into account the fishery's highly variable nature and the adjustment costs associated with reducing effort.

Squid
Steve Hall, AFMA

13.4 Environmental status

The SSJF was accredited under Parts 13 and 13A of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) on 22 April 2010 for a period of five years. Recommendations that accompanied this accreditation include that operations of the fishery are carried out in accordance with the management plan; that the Australian Fisheries Management Authority (AFMA) informs the Australian Government Department of the Environment of any amendments to management measures that could affect approval under the EPBC Act; that AFMA produces reports addressing the *Guidelines for the ecologically sustainable management of fisheries* (DSEWPaC 2007); and that AFMA continues to cooperate with relevant jurisdictions to improve understanding of stock status and depletion rates, and to encourage complementary management arrangements.

The ecological risk assessment of the fishery, completed in 2006, did not identify any threats to the environment from jig fishing (AFMA 2009; Furlani et al. 2007). The SSJF is a highly selective fishery with little bycatch. Occasionally, schools of pelagic sharks, especially blue shark (*Prionace glauca*), are attracted by the schooling squid, and barracouta (*Thyrsites atun*) frequently attack squid jigs and cause loss of jigs and lines. However, the main effect of these interactions is damage to, or loss of, fishing gear, and these species are not landed in large quantities. Operators usually move to another area when such interactions occur. There is some loss of gear at times, but this sinks to the seabed as a result of line weights.

AFMA publishes quarterly reports of logbook interactions with threatened, endangered and protected species on its website. No interactions were reported for the squid jig fishery in 2012. The occurrence of seals in the vicinity of working jig vessels has been raised as a possible concern in the past. However, observers on jig vessels in 2002 (Arnould 2002) found no evidence of negative effects on seals from jig fishing. Similarly, observer records in 2005 and 2007 did not identify any effects on seals.

Lights on a squid jig boat
AFMA

13.5 Literature cited

AFMA (Australian Fisheries Management Authority) 2007, *Southern Squid Jig Fishery harvest strategy,* AFMA, Canberra.

——2009, *Ecological risk management, report for the Southern Squid Jig Fishery*, AFMA, Canberra.

Arnould, JPY 2002, *Southern Squid Jig Fishery—seal interaction project, report on observations of interactions between fur seals and fishing vessels,* report to AFMA, Canberra.

Barnes, B, Ward, P & Boero, V in preparation, *Depletion analyses of Gould's squid in Bass Strait,* ABARES, Canberra.

DAFF (Australian Government Department of Agriculture, Fisheries and Forestry) 2005, *Southern Squid Jig Fishery managemnet plan 2005*, ammended 2011, Federal Register of Legislative Instruments F2005L00964, DAFF, Canberra.

——2007, *Commonwealth Fisheries Harvest Strategy: policy and guidelines*, DAFF, Canberra.

DSEWPaC (Australian Government Department of Sustainability, Environment, Water, Population and Communities) 2007, *Guidelines for the ecologically sustainable management of fisheries—2007,* 2nd edn, DSEWPaC, Canberra.

Freon, P, Bouchon, M, Mullon, C, Garcia, C & Niquen, M 2008, 'Interdecadal variability of anchoveta abundance and overcapacity of the fishery in Peru', *Progress in Oceanography,* vol. 79, no. 2–4, pp. 401–12.

Furlani, D, Ling, S, Hobday, A, Dowdney, J, Bulman, C, Sporcic, M & Fuller, M 2007, *Ecological risk assessment for the effects of fishing: Southern Squid Jig Sub-fishery,* report to AFMA, Canberra.

Jackson, GD & McGrath-Steer, BL 2003, *Arrow squid in southern Australian waters—supplying management needs through biological investigations*, final report to FRDC, project 1999/112, Institute of Antarctic and Southern Ocean Studies, University of Tasmania, Hobart.

SEMAC (South East Management Advisory Committee) 2011, Meeting 5: Preliminaries, 27–28 January 2011, <www.afma.gov.au/managing-our-fisheries/consultation/management-advisory-committees/south-east-mac/archive/south-east-mac-meeting-5>.

Virtue, P, Green, C, Pethybridge, H, Moltschaniwskyj, N, Wotherspoon, S & Jackson, G 2011*, Arrow squid: stock variability, fishing techniques, trophic linkages—facing the challenges,* final report to FRDC, project 2006/12, Institute for Marine and Antarctic Studies, University of Tasmania, Hobart.