Australian Government

Department of the Environment and Heritage

Assessment of the
Southern Squid Jig Fishery

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Disclaimer

This document is an assessment carried out by the Department of the Environment and Heritage of a commercial fishery against the Australian Government *Guidelines for the Ecologically Sustainable Management of Fisheries*. It forms part of the advice provided to the Minister for the Environment and Heritage on the fishery in relation to decisions under Parts 10, 13 and 13A of the *Environment Protection and Biodiversity Conservation Act 1999*. The views expressed do not necessarily reflect those of the Minister for the Environment and Heritage or the Australian Government.

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Assessment of the ecological sustainability of management arrangements for the Southern Squid Jig Fishery

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EXECUTIVE SUMMARY

Background

The Australian Fisheries Management Authority (AFMA) has submitted documents for assessment of the Southern Squid Jig Fishery (SSJF) under Parts 10, 13 and 13A of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

On 25 August 2003 the delegate for the Minister for the Environment and Heritage (the delegate) signed an Agreement with AFMA to initiate the strategic assessment of the fishery. Following public consultation, *Terms of Reference for the Environmental Assessment of the Southern Squid Jig Fishery* were adopted. The document: *Assessment Report – Southern Squid Jig Fishery* (the submission*);* was received by the Department of the Environment and Heritage (DEH) in June 2004. The documents were released for a thirty-day public comment period that expired on 2 August 2004. Three public comments were received. AFMA provided a response to the issues raised and amended the submission where necessary. A final submission for assessment was received in November 2004.

The submission reports on the SSJF against the Terms of Reference, including the Australian Government *Guidelines for the Ecologically Sustainable Management of Fisheries*. The DEH assessment considers the submission, associated documents, public comments and AFMA's response to the comments.

Table 1: Summary of the Southern Squid Jig Fishery

Area	Commonwealth waters from Fraser Island to the South Australian / Western Australian border, including waters around Tasmania. Majority of fishing occurs off Portland, Queenscliff and Lakes Entrance in Victoria.
Fishery status	The target species is considered underfished
Target Species	Arrow Squid (*Nototodarus gouldi*)
By-product Species	Mainly squid species (southern calamari, red ocean squid and southern arrow squid). Up to 100 kg of fish (Superclass Pisces) may be retained per trip.
Gear	Squid jigging. A device with barbless lures attached to 1 or more jig lines that are rotated by elliptical spools.
Season	Most fishing occurs between February and July, however fishing can occur all year.
Commercial harvest 2002-03	1,236 t
Value of commercial harvest 2002-03	$1,158,300
Recreational harvest	Negligible
Commercial licences issued in 2002-03	82 fishing permits, 16 active boats.
Management arrangements	Management measures include: • limited entry; • Total Allowable Effort (TAE) proportioned between permit holders in the form of gear units; • Trigger catch limit for squid of 4000 t; • Gear limited to squid jigging.

Export	Overseas markets in Japan, Korea, Taiwan, Spain and Italy are likely to hold the most potential for high quality squid from Australian producers.
Bycatch	Bycatch is low. Small amounts of blue shark, barracouta and octopus reported.
Interaction with Threatened Species	Considered low. Possible interactions with seals, dolphins, seabirds and sharks.

The area of the fishery includes Commonwealth waters from Fraser Island in Queensland, south to the South Australian (SA) and Western Australian (WA) border, including waters around Tasmania. The majority of squid jigging occurs in fishing grounds off Portland, Queenscliff and Lakes Entrance in Victoria.

The fishery targets arrow squid (*Nototodarus gouldi*). Less than 1% of catch consists of byproduct species including southern calamari (*Sepioteuthis australis*), Southern Ocean arrow squid (*Todarodes filippovae*) and red ocean squid (*Omnastrephes bartrami*). Up to 100 kg of fish (Superclass Pisces) can also be retained per trip.

Arrow squid is found in northern waters of New Zealand and southern Australian waters from southern Queensland to Geraldton in WA, including Tasmania[1]. The target species is most abundant in waters between 50 m and 200 m deep and favours a sea surface temperature of 11°C to above 25°C. Research to date has been unable to distinguish differences in stock structure within the fishery, so the fishery is considered to consist of one stock for management purposes.

The target species is fast growing and completes its lifecycle in less than one year. Size, growth and maturity vary largely between sites, however in general female arrow squid reach larger sizes than males. Spawning and hatching take place throughout the year in southeastern Australia[2].

Arrow squid are found in schools near the seabed during the day and disperse through the water column at night to feed. Squid are voracious feeders that prey on pelagic crustaceans, fish and other squid. The most important fish species in the squid diet in Bass Strait are pilchards and barracouta. Arrow squid are eaten by a number of species of fish, sharks, seabirds, whales and seals[3].

The domestic SSJF started in 1986, however large amounts of squid were harvested in southeast Australian waters from 1977 through to 1988 by foreign vessels. The squid catch taken by foreign vessels varied widely, with a maximum catch of 7,914 t.

Over 1,236 t of squid was taken in the 2002-03 season at a value of $1,158,300. The maximum catch recorded in the domestic fishery has been just under 2,000 t in 1996-97. Harvest in the SSJF is subject to considerable inter-annual variability, which may be caused by variations in abundance, catchability or availability to vessels, or changes in effort. 83 fishing permits were issued in the fishery in 2003 and with only 16 active vessels in 2002-03, there is considerable potential for further development of the SSJF.

Most arrow squid taken in the SSJF is traded on the domestic market and local markets are continuing to expand, however the majority of squid consumed in Australia is imported. There is some potential for high quality squid from Australia to be exported to overseas markets including Japan, Korea, Taiwan, Spain and Italy.

The fishery harvests squid using squid jigging machines, which consist of 1 or more lines with barbless hooks attached, pulled through the water on rotating elliptical spools, creating a 'jigging' effect. Jigging is typically carried out at night in boats with large lights mounted on top. The squid

[1] Norman & Reid, 2000.
[2] Jackson *et al,* 2003.
[3] Winstanley *et al,* 1983.

tend to aggregate in the shadow below the boat, and dash out into the light to feed on marine organisms that have been attracted to the light[4]. Squid jigging has a high level of specificity for the target species and is considered to have low levels of byproduct and bycatch associated with it.

Management of the fishery is based on limited entry, a TAE proportioned to licence holders in gear units and a 4000 t catch trigger for the catch of squid species. A Bycatch Action Plan (BAP), containing objectives, strategies and actions related to the management of bycatch in the SSJF, has been developed and implemented and is reviewed biennially.

Data on bycatch and interactions with protected species in the fishery is limited to that collected from logbooks and occasional observer placements. Bycatch levels are considered low, due to the specificity of the gear. Small amounts of shark, barracouta and octopus were recorded as taken as bycatch in 2002-03. Some species that may be affected by this fishery are currently listed protected species under the EPBC Act. Possible protected species interactions in this fishery include seals, sharks, dolphins and seabirds. Limited evidence to date suggests that interaction with any protected species group is low. These interactions are assessed under Principle Two of this report.

Arrow squid are taken by a number of commercial fisheries in both State and Commonwealth waters. Trawling operations in the South East Trawl (SET) and Great Australian Bight Trawl (GABT) sectors of the Southern and Eastern Scalefish and Shark Fishery (SESSF) take arrow squid as byproduct. The levels of harvest are reported in the SSJF data summary and AFMA is introducing a 6000 t catch trigger of squid harvest for the SSJF, GABT and SET. In 2001-02 and 2002-03 the take of squid in trawls has constituted approximately 45% of the total arrow squid take in all three fisheries. The harvest of squid in the GABT and SET is considered in the assessment of the SESSF. Arrow squid is taken in small amounts by fisheries targeting southern calamari in Victorian, Tasmanian and SA fisheries. The Tasmanian fishery targeting southern calamari, which is the largest dedicated squid fishery in State waters, took less that 2 t of arrow squid in 2002-03, making up less than 8% of the fishery's annual catch.

The recreational and indigenous harvest of arrow squid is considered to be negligible.

The fishery is managed under the *Southern Squid Jig Fishery Management Plan 2004* (the Management Plan), which obtains its authority from the *Fisheries Management Act 1991*. The Management Plan is supported by a BAP for the SSJF which was revised in 2004.

Overall assessment

The material submitted by AFMA indicates that the SSJF operates in accordance with the Australian Government *Guidelines for the Ecologically Sustainable Management of Fisheries*. DEH considers that the SSJF is a well managed fishery that is unlikely to have an unacceptable or unsustainable impact on the environment in the short to mid term. Recommendations have been developed to ensure that the risk of impact is minimised in the longer term. Overall, the management regime of limited effort and selective gear suggests that the fishery is being managed in an ecologically sustainable way.

In making its assessment, DEH considers that the management regime, including monitoring arrangements and management objectives, are sufficient to ensure the fishery is conducted in a manner that does not lead to over-fishing and that stocks are not currently overfished. Considering the management arrangements in place and the selective characteristic of the fishery operations, DEH considers that fishing operations are managed to minimise their impact on the structure, productivity, function and biological diversity of the ecosystem.

The assessment finds that the fishery is managed in an ecologically sustainable way and its operation is consistent with the objects of Part 13A of the EPBC Act. DEH recommends that the export of species taken in the fishery should be exempt from the export requirements of Part 13A of

[4] Kailola *et al,* 1993.

the EPBC Act, with that exemption to be reviewed in 5 years. DEH considers that the fishery, as managed in accordance with the management regime is not likely to cause serious or irreversible ecological damage over this period.

As the official fishery area encompasses Commonwealth as well as State waters, consideration under Part 13 of the EPBC Act is required regarding the impact of the fishery on listed threatened species, listed migratory species, cetaceans and listed marine species.

Protected species occurring in the fishery area include seals, cetaceans, sharks and seabirds. Limited information indicates that there is a low level of interaction with these groups. The actual and potential impact on Part 13 species under the management arrangements is considered low and adequate protection is provided. There are no listed threatened ecological communities in the fishery area.

DEH recommends that the Management Plan be declared an accredited Management Plan under Sections 208A, 222A, 245 and 265 of the EPBC Act. In making this judgement, DEH considers that the fishery to which the Management Plan relates does not, or is not likely to, adversely affect the survival in nature of listed threatened species or population of that species, or the conservation status of a listed migratory species, cetacean species or listed marine species or a population of any of those species. DEH also considers that the Management Plan requires that all reasonable steps are taken to avoid the killing or injuring of protected species, and the level of interaction under current fishing operations is low. On this basis, DEH considers that an action taken by an individual fisher, acting in accordance with the Management Plan, would not be expected to have a significant impact on a listed threatened species or listed migratory species protected by the EPBC Act.

Part 10 of the EPBC Act requires that Commonwealth managed fisheries undergo strategic assessment to determine whether actions taken in the fishery have a significant impact on the environment in Commonwealth Marine Areas. Under this Part, the Minister may accredit a Management Plan to exempt actions taken in accordance with the management plan from further impact assessment approval.

DEH considers, *inter alia*, that there has been adequate assessment of the impacts that actions approved in accordance with the Management Plan have, will have or are likely to have on the marine environment. DEH also considers that actions approved or taken in accordance with the Management Plan will not have unacceptable or unsustainable impacts on the marine environment in a Commonwealth area. DEH therefore recommends that, in accordance with Part 10 of the EPBC Act, the Management Plan be accredited under section 33 of the EPBC Act for the matter of national environmental significance "the marine environment".

To further strengthen the effectiveness of the management arrangements for the SSJF, and to contain the environmental risks in the medium to long term, DEH has developed a series of recommendations. The implementation of these and other commitments made by AFMA in the submission will be monitored and reviewed as part of the next DEH review of the fishery in 5 years time.

Recommendations

1. AFMA to inform DEH of any proposed amendment to the management regime for the SSJF, to enable DEH to evaluate any impact on the ecological sustainability of the fishery.

2. AFMA to continue to cooperate with other relevant jurisdictions to pursue complementary management and research of shared stocks for squid target and by-product species, which may be affected by cross-jurisdictional issues.

3. Within 2 years of completion of the Ecological Risk Assessment project, AFMA to identify and implement appropriate management strategies to address/mitigate impacts identified through the ecological risk assesment of the Southern Squid Jig Fishery.

4. AFMA to continue to encourage and facilitate further research on arrow squid that will assist with the development of ecologically sustainable yield estimates.

5. AFMA to develop, within 2 years, interim performance measures sufficient to detect significant declines in the abundance of squid.

6. AFMA to ensure that adequate validation of logbook data on bycatch and protected species interactions is undertaken.

PART I - MANAGEMENT ARRANGEMENTS

The SSJF is managed by AFMA. The management regime is described in the following documents, all of which are, or will be publicly available:

- The *Fisheries Management Act 1991;*
- The *Fisheries Administration Act 1991;*
- The *Southern Squid Jig Management Plan 2004* (the Management Plan);
- The *Southern Squid Jig Fishery Bycatch Action Plan 2004* (the BAP); and
- Directions and licence conditions made under the Management Plan.

A number of other documents, including research reports, scientific literature and discussion papers are integral to the management of the fishery.

DEH considers it important that management arrangements remain flexible to ensure timely and appropriate managerial decisions. Because of the importance of the Management Plan and documents referred to above to DEH's assessment of the fishery, an amendment could change the outcomes of the assessment and decisions stemming from it. Export decisions relate to the arrangements in force at the time of the decision. In order to ensure that these decisions remain valid, DEH needs to be advised of any changes that are made to the management regime and make an assessment that the new arrangements are equivalent or better, in terms of ecological sustainability, than those in place at the time of the original decision.

Recommendation 1: *AFMA to inform DEH of any proposed amendment to the management regime for the SSJF to enable DEH to evaluate any impact on the ecological sustainability of the fishery.*

Advice on management of the SSJF is provided by the Southern Squid Jig Fishery Management Advisory Committee (SquidMAC), which consists of an independent chair, AFMA representatives, a research scientist, commercial fishers, a State government member, and an environment / conservation member. Members of SquidMAC are appointed by the AFMA Chair and the executive officer is provided by AFMA. DEH is a permanent observer to the committee. The Southern Squid Jig Fisheries Assessment Group (SquidFAG), has been formed to provide advice to SquidMAC and the AFMA Chair on stock, environmental and economic assessments.

Management of the fishery incorporates a sound range of consultative mechanisms and a clear commitment to effective consultation with a variety of stakeholders. DEH considers the level of consultation to be adequate and is confident that AFMA will continue to ensure interested parties are consulted appropriately.

The fishery is managed according to the regime described in the Management Plan. This document contains a number of objectives relating to harvest of the target species and the ecologically sustainable development of the fishery, including the need to have regard to impacts on bycatch species and the long-term sustainability of the marine environment. Objectives are underpinned by a number of management measures and performance criteria against which measures taken may be assessed. An assessment of the effectiveness of these measures is included in Part Two of this report.

Management of the SSJF is based on a mixture of input and output controls, including:

- Limited entry to 83 permit holders;
- Gear restrictions;
- A TAE, annually proportioned between permit holders in the form of gear units;
- A 4000 t trigger limit for the take of squid (all species).

Compliance with catch and effort controls is monitored by AFMA through logbooks. Under the Management Plan, catch disposal records are being introduced in 2004 which will assist with validation of logbook data. Field compliance is undertaken by State fishery management agencies, who conduct unloading inspections and offshore inspections. Squid vessels are rarely inspected due to the low level of effort in the fishery. DEH considers that these compliance measures contain the means of enforcing critical aspects of the management arrangements for the fishery.

Periodic reviews of management are provided for in the management regime. The effectiveness of the Management Plan must be reviewed by AFMA and SquidMAC at least every 5 years. The BAP and data plan must be reviewed every 2 years, and the performance of the fishery against the performance criteria in the Management Plan must be reviewed and reported on annually. An annual analysis of data collected in the fishery is undertaken and made publicly available through the Southern Squid Fishery Data Summary. DEH considers that a five year review of the entire fishery management framework is suitable while critical aspects are reviewed annually. The annual reviews are discussed more fully in Part Two of this report.

Fishery dependent data relating to target, byproduct and bycatch species is collected on a regular basis in the fishery. Some fishery independent projects have been undertaken in the past, however fishery independent data is not collected on a regular basis in the SSJF. Discussion of the information collection system can be found in Part Two of this report.

An analysis of the fishery's capacity for assessing, monitoring and avoiding, remedying or mitigating any adverse impacts on the wider marine ecosystem in which the target species lives and the fishery operates is contained under Principle Two of this report.

Squid is a valuable and increasingly important byproduct of the SET and GABT sectors of the SESSF. The annual harvest of squid in these fisheries is reported in the SSJF data summary and subject to a 6000 t catch trigger for squid harvest in the SSJF, GABT and SET. The harvest of squid in the GABT and SET is considered in the assessment of the SESSF, and will therefore not be discussed in this report.

Arrow squid is harvested in small amounts throughout its distribution by State fisheries targeting southern calamari. The greatest harvest of arrow squid occurs in the Tasmanian dedicated squid fishery which took 110 t of squid in 2002-03, including 1.9 t of arrow squid. AFMA informally communicates with states regarding the annual harvest of squid in their fisheries.

Ideally, management arrangements affecting a single stock should be under a single jurisdiction, or at least complementary across jurisdictions. Although the harvest is relatively small, DEH recommends that AFMA continue to liaise with all other jurisdictions where arrow squid is harvested to ensure that management is complementary. The management of byproduct species, including southern calamari, red ocean squid and southern ocean arrow squid, would also benefit from a cross-jurisdictional management approach. This is discussed further in Part Two.

Recommendation 2: *AFMA to continue to cooperate with other relevant jurisdictions to pursue complementary management and research of shared stocks for squid target and by-product species, which may be affected by cross-jurisdictional issues.*

DEH considers that the current management arrangements comply with all relevant threat abatement plans and recovery plans. The *Commonwealth Policy on Fisheries Bycatch* requires the development of bycatch action strategies for Commonwealth fisheries. The SSJF developed and implemented a BAP in 2001 and most recently revised this document in 2004. DEH expects that AFMA will also ensure compliance with any future plans or policies as they are developed.

No regional or international management regimes, to which Australia is a party, are of direct relevance to the fishery. The prime international regime affecting the fishery is the United Nations Convention on the Law of the Sea (UNCLOS). The management regime essentially complies with this. Other international regimes are applicable to fisheries management but do not explicitly

involve this fishery, for example the 1992 Convention on Biological Diversity and in particular the 1995 Jakarta Mandate requiring that, in relation to the sustainable use of marine and coastal biological diversity, the precautionary principle should apply in efforts to address threats to biodiversity. While these agreements are not specifically addressed in the Submission, the fishery's compliance with their requirements can be assessed by examination of Part Two of this report. The application of the International Convention for the Prevention of Pollution from Ships (MARPOL) to vessels operating in the fishery is explicitly discussed under Principle 2, Objective 3.

DEH considers it is incumbent on all authorities to develop a thorough understanding of the framework of national, regional and international agreements and their applicability to export-based fisheries for which they are responsible.

Conclusion

DEH considers that the SSJF management regime is documented, publicly available and transparent, and is developed through a consultative process. The management arrangements are adaptable and underpinned by appropriate objectives and performance criteria by which the effectiveness of the management arrangements can be measured, enforced and reviewed.

The management arrangements are capable of controlling the harvest through a combination of input and output controls appropriate to the size of the fishery. Periodic review of the fishery is provided for, as are the means of enforcing critical aspects of the management arrangements.

The management regime takes into account arrangements in other jurisdictions, and adheres to arrangements established under Australian laws and international agreements.

DEH considers that there is scope to further refine the management arrangements and has provided recommendations for improvements in the longer term.

PART II – GUIDELINES FOR THE ECOLOGICALLY SUSTAINABLE MANAGEMENT OF FISHERIES

Stock Status and Recovery

Principle 1: *'A fishery must be conducted in a manner that does not lead to over-fishing, or for those stocks that are over-fished, the fishery must be conducted such that there is a high degree of probability the stock(s) will recover'*

Maintain ecologically viable stocks

Objective 1: *'The fishery shall be conducted at catch levels that maintain ecologically viable stock levels at an agreed point or range, with acceptable levels of probability'*

Information requirements

From 1981 to 1995 domestic operators were not required to submit logbook information and therefore data from this time is unreliable. Since 1995, fishery dependent data have been obtained through compulsory daily logbooks that are submitted on a monthly basis. Logbooks collect information on amounts of target, byproduct and bycatch species harvested, in addition to number of jigging machines used, location of fishing, time spent fishing and depth fished. Returns are generally high, with 98% of logbooks completed and returned in 2002-03. A catch disposal recording system is to be introduced in the SSJF in 2004 to allow monitoring of catch levels and verification of logbook data.

AFMA and industry have committed to develop and implement a data plan for the fishery to increase the efficiency and effectiveness of data collection requirements. The data plan will be developed in the next 6-12 months and will be reviewed every 2 years. Verification of logbooks using catch disposal records and observer data is also provided for in the data plan. DEH believes that data reliability for target species catch and effort information is reasonable and that there is a commitment to continual improvement in the collection of fishery dependent data. The introduction of catch disposal recording will allow for the verification of logbook data, however DEH is concerned that this relates only to target and byproduct species. This issue is discussed further in Principle 2.

Fishery independent data collection in the SSJF is limited. Management draws on research undertaken in larger international squid fisheries, however a number of gaps still exist in knowledge of squid biology and ecology relevant to the sustainable management of the fishery. The lack of knowledge was also raised as a concern during public comment on the fishery. Key areas requiring attention include arrow squid biology and life cycle, population biology, age structure, recruitment, the influence of environmental conditions on populations and ecological role. In recognising the need for fishery independent data collection to feed into research and management, AFMA and SquidFAG have developed a 5 year strategic research plan identifying priority research areas.

A research project being funded by the Fisheries Research and Development Corporation (FRDC) is currently undertaking research into the biology and life cycle of arrow squid, which should provide further information for management of the species. However additional research will be needed to inform ecologically sustainable management of the fishery, particularly in gaining a greater understanding of the ecological role of arrow squid in southern Australian waters and for the development of ecologically sustainable yield estimates in the SSJF. DEH recommends that AFMA continue to encourage and facilitate research into the biology and ecology of arrow squid in southern Australian waters.

Recommendation 3: *AFMA to continue to encourage and facilitate further research on arrow squid that will assist with the development of ecologically sustainable yield estimates.*

The Management Plan contains a measure to ensure that management practices of the fishery take into account the results of any research conducted in relation to the fishery, as a result DEH is confident that further research on arrow squid will be incorporated in the management of the fishery.

The data needs of the fishery and existing fisheries data is to be analysed as part of the ecological risk assessment process (ERA) for this fishery, which is likely to be finished in early-mid 2005.

Overall, given the reliability of fishery dependent data gathered by AFMA and the mechanisms for regularly reviewing the data requirements as part of the data plan, DEH considers that the information collection system in place is appropriate to the scale of the fishery. Continuation of existing data collections and research programs, combined with some extension and refinement of such activities will be important for the future management of the fishery.

Assessment

Data collected through fishery dependent means in the SSJF is analysed annually and published in the Southern Squid Fishery Data Summary. The document summarises the previous year's catch and effort in the SSJF and the catch of squid and associated effort in the SET and GABT. Spatial data and catch per unit effort (CPUE) information for all three fisheries is presented in the document.

The 2002-03 data summary for the SSJF showed a total annual squid catch of 1,236 t, nearly double the catch in 2001-02. This continues a trend since 1995-96 of higher catches every second year. Effort was also significantly higher than in the previous year and as a result CPUE was essentially unchanged. In 2002-03 the SET and GABT also reported higher catches of squid, suggesting that the resource was more abundant during this season. The short-lived fast-growing nature of the species allows for rapid regeneration and large variations in stock abundance from year to year. An analysis of logbook data by Sharp *et al* (1999), found that the large variations in catch may be caused by variations in abundance, catchability or availability of squid and that a more detailed analysis would be required to determine which of those factors is most important[5].

The short time series of catch and effort, short lifespan of squid, highly variable population and lack of knowledge about squid biology make it difficult to conduct stock assessments or produce accurate sustainable yield estimates for the fishery. As a result, reliable estimates of potential stock production and sustainable yields have not been produced and it is unlikely that anything but preliminary assessments could be done in the next 5 years. Concern regarding the lack of stock assessments was raised during public comment. Egg and larval surveys can be undertaken to predict stock sizes in squid fisheries, however they are expensive and therefore not practical in a low production and relatively low value fishery. The current research being undertaken on squid should provide further information to guide development of stock assessment and sustainable yield estimates, however further research will still need to be undertaken before robust methods are developed (see Recommendation 3). DEH encourages AFMA to pursue the development of stock assessments or sustainable yield estimates for the squid stock.

An ERA, being conducted for the SSJF, will include a qualitative risk assessment to identify broad categories of risk and a full quantitative risk assessment considering target, byproduct, bycatch and broader ecological impacts where possible. The ERA process is analysing the existing data to identify risks that the fishery poses to the ecosystem. The Management Plan commits AFMA to taking appropriate action to manage the identified risks, however there are no timeframes associated with this commitment.

[5] Sharp *et al,* 1999

Recommendation 4: *Within 2 years of completion of the ERA, AFMA to identify and implement appropriate management strategies to address/mitigate impacts identified through the ecological risk assesment of the SSJF.*

Arrow squid are distributed from southern Queensland to Geraldton in WA, including Tasmania and northern waters of New Zealand. Limited research has been unable to distinguish differences in stock structure and it is therefore assumed for management purposes that the fishery consists of one stock. Arrow squid is harvested throughout its distribution in southern calamari and trawl fisheries. Consideration of this harvest in the management of the SSJF is discussed in Part I, recommendation 2.

Non-commercial take of arrow squid is considered to be negligible due to the offshore nature of the fishery and lack of indigenous or recreational interest in the species. As a result the catch data from the SSJF and the two trawl fisheries in the area, the SET and GABT, covers the majority of removals of arrow squid. The take of squid from the three fisheries are analysed and presented in the annual data summary. Although there is no quantitative stock assessment implemented in the fishery at this time, AFMA has committed to considering all removals of arrow squid in any stock assessment developed in the future.

The take of squid as byproduct in other Commonwealth fisheries is reported annually in the data summary and a 6000 t trigger limit applies to the take of squid in the SET, GABT and SSJF. This harvest is considered in the assessments of those fisheries.

Management response

The management regime for the SSJF aims to maintain ecologically viable stock levels through a range of input and output controls. These measures are outlined in Table 1 and Part I of this report. DEH considers that the combination of controls should ensure adequate protection of the target stocks, but notes that this is contingent upon monitoring of the fishery in relation to precautionary performance measures.

The Management Plan contains objectives, measures and performance criteria against which the measures taken may be assessed. Objectives of the Management Plan explicitly address ecological sustainability of squid and having regard to the impact of fishing activities on bycatch species and the marine environment. Included under 'specific ecosystem requirements' is the requirement to develop reference points for squid appropriate for maintaining ecologically viable stocks of squid and an ecologically sustainable fishery. DEH commends the commitment to develop reference points to maintain ecological sustainability, which will require consideration of the important role of squid in the ecosystem and the harvest of the species in other Commonwealth and State fisheries.

The Management Plan requires the reference points to be developed as soon as practicable after the Management Plan comes into force and within 5 years. DEH acknowledge that the development of precautionary and biologically meaningful reference points will require further research and may take some time. As an interim performance measure, AFMA is implementing an annual trigger limit of 4000 t for all squid species in the SSJF, nearly all of which is likely to be arrow squid. This limit is based on historical levels of harvest in the fishery during which time foreign vessels were participating in the fishery. DEH is concerned that this interim performance measure does not allow the detection and response to declines in the abundance of arrow squid. While the biological characteristics of arrow squid result in a highly variable stock, DEH recommends that in the absence of biologically meaningful reference points for the fishery, AFMA implement an interim precautionary performance measure that will ensure any significant decline in the arrow squid stock is detected and appropriately responded to.

Recommendation 5: *AFMA to develop, within 2 years, interim performance measures sufficient to detect significant declines in the abundance of squid.*

AFMA annually reports on the performance of the fishery against performance criteria, including identification of key risks to the ecologically sustainable development of the fishery and any action taken to manage the risks.

Squid jigging gear is considered to be a highly selective method of harvesting that results in low levels of byproduct and bycatch. The amount and type of byproduct is recorded in the daily logbook for the fishery which can be validated using the catch disposal records or occasional observers. Making up less than 1% of the total catch, byproduct species include offshore red ocean squid, Southern Ocean arrow squid and southern calamari. Fishing permit conditions also allow the take of up to 100 kg of fish (Superclass Pisces) per trip, excluding blue eye trevalla, pink ling, blue warehou and gemfish. DEH is satisfied that byproduct in the fishery is low, and is likely to remain so, and that AFMA will detect changes in levels and composition of byproduct harvest through logbooks and will publicly report it in the annual data summary. In addition, the ERA will identify any impacts of jigging on byproduct species, and the implementation of recommendation 3 will ensure that impacts are appropriately responded to.

DEH recognises that there is a high level of latent effort in the fishery. Despite an anticipated increase in profitability in the fishery and new interest, AFMA is not considering the removal of this latent effort. As the species is currently underfished, DEH considers that an increase in effort to activate those authorities currently not utilised is not likely to threaten the stocks due to the strategic management arrangements in place, including monitoring change in the fishery, reviewing the performance of the fishery against the performance measures and appropriately responding to any significant changes in the fishery.

Conclusion

DEH considers that the management regime in the SSJF is appropriately precautionary and provides for the fishery to be conducted in a manner that does not lead to over-fishing. DEH considers that management arrangements in the SSJF are sufficient to ensure that the fishery is conducted at catch levels that maintain ecologically viable stock levels with acceptable levels of probability.

DEH considers that there is scope to further refine some of the existing information collection, assessment and management responses and has provided a number of recommendations for improvements in the longer term.

Promote recovery to ecologically viable stock levels

Objective 2: *'Where the fished stock(s) are below a defined reference point, the fishery will be managed to promote recovery to ecologically viable stock levels within nominated timeframes'*

This objective is not applicable to the fishery at present as the fishery is considered underfished. The Management Plan requires the development of precautionary reference points to avoid the risk of overfishing the arrow squid stock in the future. If the squid stock falls below reference points AFMA will develop a recovery strategy for the squid stock, specifying management actions linked to defined reference points. The recovery strategy will also identify time periods appropriate to the biology of the stock.

Conclusion

DEH considers that the squid stock is not below a defined reference point but should that occur in the future, the fishery is conducted such that there is a high degree of probability the stock would recover to ecologically viable stock levels within nominated timeframes.

Ecosystem impacts

Principle 2: *'Fishing operations should be managed to minimise their impact on the structure, productivity, function and biological diversity of the ecosystem'*

Bycatch protection

Objective 1: *'The fishery is conducted in a manner that does not threaten bycatch species'*

Information requirements

Since 2001, the daily logbook in the SSJF has allowed for the identification and recording of bycatch and protected species interactions. The SSJF BAP commits to implement, within 1 year, a strategy to communicate to industry the importance of reporting and quality of reporting bycatch and wildlife interactions. This strategy, to be implemented within the next 12 months, should further improve the quality of logbook data.

Validation of logbook data on bycatch and protected species interactions is limited, as observer coverage is limited to opportunistic placement of observers on board when scientific studies are taking place. Currently no scientific studies are taking place in the fishery.

In addition, the revised BAP has removed the commitment to include a trigger in the management plan to implement a follow-up observer program to ensure sustainability of bycatch and wildlife species. Public comment raised the issue of inadequacies in data collection on bycatch and protected species impacts in the SSJF. While DEH is satisfied that the implementation of Recommendation 3 will ensure that risks identified in the ERA process are responded to, bycatch and protected species data obtained from the logbooks should be verified to ensure robust data is available to inform future management and risk assessments. DEH recognises that a number of opportunities for funding and research are being pursued by AFMA, however at this time there are no confirmed validation opportunities. DEH therefore recommends that AFMA ensure that adequate validation of logbook data on bycatch and protected species interactions is undertaken within the period of the DEH approval.

Recommendation 6: *AFMA to ensure that adequate validation of logbook data on bycatch and protected species interactions is undertaken.*

Assessment

Logbooks in 2002-03 reported minor amounts of blue shark (20 kg), barracouta (5 kg) and octopus (5 kg) taken as bycatch in the fishery. The data summary for 2001-02 reported no bycatch taken in the fishery. Due to the highly selective gear used in the fishery, bycatch is expected to be low, however validation of logbook data should be undertaken in order to verify this assumption.

Using existing data, the ERA will assess the impact the SSJF is having on bycatch species by considering a mix of biological parameters and susceptibility of the species to capture. SquidFAG will undertake a comparison of levels of bycatch reporting and discarded species after the industry communication strategy has been implemented.

Management response

The Management Plan contains an objective to have regard to the impact of fishing activities on bycatch species and requires that all reasonable steps are taken to minimise bycatch. To assist management achieve this, a BAP was developed and implemented in 2001 and was reviewed and updated in 2003 and 2004.

Squid-jigging is a highly selective gear type that is used at depths where the target species is dominant and the proportion of non-target species is low. As a result, low levels of bycatch are taken. AFMA and SquidFAG have committed to implement targeted management and mitigation regimes should any high risk species be identified as part of the ERA process. Although the impact on bycatch species is considered to be low, if it were to increase as a result of expansion of the fishery or other influences, DEH considers the BAP and Management Plan provides a strategic management framework that should ensure impacts are maintained within sustainable levels. DEH also commends the commitment in the BAP for industry to develop and implement a code of practice to address bycatch handling in the fishery, and encourages AFMA to facilitate its timely implementation.

While no specific group of indicator species is being monitored, management and mitigation measures will be implemented if high risk species are identified in the ERA process. In the light of the outcomes of the ERA process, SquidFAG will also consider the monitoring of an indicator group of species.

Conclusion

DEH considers that there is a high likelihood the fishery is conducted in a manner that does not threaten bycatch species. Should this situation change, or the ERA indicate otherwise, DEH expects that AFMA would undertake appropriate actions to ensure that bycatch species are not threatened by this fishery.

A recommendation has been developed to ensure that the risk of unacceptable impact on bycatch species is detected and minimised in the longer term.

Protected species and threatened ecological community protection

Objective 2: *'The fishery is conducted in a manner that avoids mortality of, or injuries to, endangered, threatened or protected species and avoids or minimises impacts on threatened ecological communities'*

Information requirements

Information on protected species interactions in the SSJF is collected in the daily logbooks and by occasional observers. Information collected in the logbooks includes species type, condition of captured species upon release and number caught. This data is published in the annual squid fishery data summary. Capture, injury or death of a seabird or marine mammal must also be reported to AFMA. A coordinated research program collected information on seal interactions in the SSJF by placing independent observers on a number of boats during 2002. Interactions with other species were also recorded during these trips.

The Management Plan and BAP require that data on protected species is collected for the fishery and the ERA will assess the type and level of bycatch data needed to produce a valid data set that is scientifically robust and assessable. DEH is concerned that fishery dependent data on bycatch and interactions with protected species is currently not validated and that robust data is not available on the level of interactions of the fishery with seals, sharks, dolphins and seabirds. DEH has therefore recommended that AFMA periodically validate the logbook data collected on bycatch and protected species interactions (see Recommendation 6).

Assessment

Protected species that may interact with the fishery include seals, sharks, dolphins and seabirds, however to date there have been no interactions reported by fishery dependent means. Data from observers placed on board vessels in 2002 to observe seal interactions in the fishery concluded that interactions with fur seals are minor. The study showed that 3.6% of seals observed targeted squid caught on lures and no observed seals became entangled or caught on gear. The study also observed a number of species of seabirds interacting with operations during observations[6].

A qualitative risk assessment using anecdotal information and logbook data identified a medium risk of interactions with seals in jigging operations. The ERA being undertaken for the fishery will conduct a quantitative assessment of the level of impact the fishery is likely to have on different protected species. DEH has recommended the implementation of mitigation measures if the ERA identifies impacts on protected species (see Recommendation 4).

There are no listed ecological communities in the fishery area.

Management response

The Management Plan requires that all reasonable steps are taken to avoid interactions with listed threatened species, cetaceans, listed migratory species, threatened ecological communities and listed marine species under the EPBC Act. In order to achieve this, the BAP requires that levels of impacts are monitored and mitigation measures are taken if needed.

Due to the highly selective nature of the fishing gear, interactions with protected species in the SSJF are considered to be low, and as a result no mitigation measures are in place. However, as a precautionary measure the BAP includes a commitment for industry, in association with SeaNet, to develop and implement a code of practice for the fishery to address bycatch handling, particularly for large marine wildlife. DEH supports the development of the code of practice and encourages AFMA to monitor its implementation and adopt complementary management measures.

Conclusion

DEH notes that interactions with protected species in this fishery are negligible and considers that the fishery is conducted in a manner that avoids mortality of, or injuries to, endangered, threatened or protected species and avoids or minimises impacts on threatened ecological communities. Should this situation change, or a risk assessment process indicate otherwise, DEH expects that appropriate actions will be undertaken to ensure that the fishery avoids mortality of, or injury to, these species and avoids or minimises impacts on threatened ecological communities.

Recommendations have been developed to ensure that the risk of unacceptable impact on protected species is minimised in the longer term.

Minimising ecological impacts of fishing operations

Objective 3: *'The fishery is conducted, in a manner that minimises the impact of fishing operations on the ecosystem generally'*

Information requirements

Information related to the fishery's impact on the ecosystem is not collected. Data available to inform the ecologically sustainable management of the SSJF is limited to research undertaken in

[6] Arnould *et al* 2003.

international squid jigging fisheries and data on the SSJF harvest of target species, byproduct and bycatch, and interactions with protected species. The 5 year strategic research plan for the fishery has ranked research on squid predator-prey relationships as high priority, however there are no projects currently being undertaken on this topic.

DEH is concerned at the lack of information collection and research covering the fishery's impact on the ecosystem and environment generally. However, DEH understands that this lack of information is the case across a range of Australian and International fisheries and until appropriate research techniques and programs are developed and implemented this will continue to be the case. DEH strongly supports research in this area.

Assessment

As a highly selective fishing method that has minimal impact on the benthos, the potential of the SSJF to impact unacceptably and unsustainably on the environment generally is considered to be low.

Squid are thought to play an important ecosystem role as they are prey to a number of organisms including sharks, fish, seals, whales and seabirds. Research suggests that squid is not a major component of any commercial fish species diet, and it is assumed that species are unlikely to rely on squid as a food source due to its highly variable abundance. Squid prey on a range of organisms including crustaceans, fish and other cephalopods. It is therefore likely that removal of the species is likely to have some impact on the pelagic food web, however the level of impact has not yet been quantified.

The fishery may also have the potential to impact on the ecosystem through changing the target and byproduct species behaviour by attracting them to the boats, however again the level of impact has not been quantified. The ERA will examine the ecological impacts and potential risks of the fishery. DEH expects that any significant risks identified will be responded to in a timely manner (see Recommendation 4).

Management response

Squid jigging is a highly specific fishing gear that has low levels of byproduct, bycatch and benthic interactions. The ecosystem impact is therefore considered to be low. Potential risks include the impact of target species removal on marine food chains and interactions with protected species. Although no specific management measures are in place to mitigate these risks, increased validation of data on protected species interactions should allow better understanding of ecosystem impacts of the fishery. In addition, the maintenance of precautionary harvest levels of target species should ensure that appropriate amounts of squid remain for ecosystem purposes.

The Management Plan for the SSJF requires that management have regard to the impact of fishing activities on the long term sustainability of the marine environment and that all reasonable steps are taken to minimise impacts on the ecosystem. The Management Plan also allows for the introduction of spatial closures to ensure that fishing does not have a high impact on an area of particular sensitivity. DEH considers that the strategic management framework in the Management Plan provides the basis for responding to any ecosystem impacts identified in the ERA or through other mechanisms.

Impacts on water quality through the discharge of plastic wastes and pollution from vessels are controlled under MARPOL legislation. Operators are required to comply with the legislation and must retain any plastic waste and dispose of it only when the vessel returns to port.

The National Oceans Office is currently leading a regional marine planning process in the area of the fishery. The planning process aims to ensure the ecologically sustainable use of the resources in the planning area and will help to integrate management across jurisdictions and sectors. It will also

identify potential candidate areas for the National Representative System of Marine Protected Areas (NRSMPA). The regional marine planning process is a potential vehicle for pursuing sustainable fisheries objectives, particularly where cross sectoral or cross jurisdictional approaches are required. AFMA should continue to engage in the process as far as practical. More information is available at www.oceans.gov.au.

Conclusion

DEH considers that the fishery is conducted in a sufficiently precautionary manner to minimise the impact of fishing operations on the ecosystem generally. AFMA should endeavour to gain a greater understanding of the role of the target species in the ecosystem to ensure ecologically sustainable management of the fishery into the future.

REFERENCES

Arnould JPY, Trinder DM, McKinley CP (2003) Interactions between fur seals and squid jig fishery in southern Australia. *Australian Journal of Marine and Freshwater Research* **54**: 979-984.

Jackson GD, McGrath-Steer B, Wotherspoon S, Hobday AJ (2003) Variation in age, growth and maturity in the Australian arrow squid *Nototodarus gouldi* over time and space: what is the pattern? *Marine Ecology Progress Series* **264**: 57-71.

Kailola PJ, Williams MJ, Stewart PC, McNee A, Grieve C (1993) *Australian Fisheries Resources*. Bureau of Resource Sciences: Canberra.

Norman M & Reid A (2000) *A Guide to Squid, Cuttlefish and Octopuses of Australasia*. CSIRO Publishing, Collingwood.

Sharp A, Scott M, Sahlqvist PP (1999) *Southern Squid Jig – 1998 data summary*. Draft report presented to Squid MAC.

Winstanley RH, Potter MA, Caton AE (1983). Australian Cephalopod Resources. *Memoirs of the National Museum of Victoria* **22**: 243-253.

LIST OF ACRONYMS

AFMA	Australian Fisheries Management Authority
BAP	Bycatch Action Plan
CPUE	Catch per unit effort
DEH	Department of the Environment and Heritage
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
ERA	Ecological Risk Assessment
FRDC	Fisheries Research and Development Corporation
GABT	Great Australian Bight Trawl Fishery
MARPOL	International Convention for the Prevention of Pollution from Ships
NRSMPA	National Representative System of Marine Protected Areas
SA	South Australia
SESSF	Southern and Eastern Scalefish and Shark Fishery
SET	South East Trawl Fishery
SquidFAG	Southern Squid Jig Fisheries Assessment Group
SquidMAC	Southern Squid Jig Fishery Management Advisory Committee
SSJF	Southern Squid Jig Fishery
TAE	Total Allowable Effort
UNCLOS	United Nations Convention on the Law of the Sea
WA	Western Australia