

Management Plan for the South Australian Pilchard Fishery



Paper No 47
November 2005

South Australian
Fisheries Management Series



Government of South Australia
Primary Industries and Resources SA

Management Plan for the South Australian Pilchard Fishery

Steve Shanks

November 2005

**South Australian Fisheries Management Series
Paper Number 47**

Prepared by the Fisheries Division of Primary Industries and Resources, South Australia in association with the Pilchard Fishery Working Group.



Government of South Australia
Primary Industries and Resources SA

Management Plan for the South Australian Pilchard Fishery

Prepared for the purposes of Section 14 of the *Fisheries (Management Committees) Regulations 1995* and consistent with section 20 of the *Fisheries Act 1982*.

November 2005

Steve Shanks
Fisheries Manager

PIRSA Fisheries
GPO Box 1625
Adelaide SA 5001
www.pir.sa.gov.au

ph (08) 8226 0364
fax (08) 8226 0434
shanks.steve@saugov.sa.gov.au

© Primary Industries and Resources South Australia 2005

Disclaimer:

This Management Plan has been prepared as a policy document. The information contained in this document is current at the time of publication. However, government policy may change at any time. Persons should not act in reliance on the information contained in this document when making business decisions without seeking independent advice first.

This document also contains information in relation to the *Fisheries Act 1982* and associated regulations. This information has been prepared as a summary of the fisheries management arrangements that are in place at the time of publication, and does not replace the legislation. Legislation will change from time to time. It is the responsibility of each individual to ensure that they are aware of the law that applies and to comply with it.

ISBN: 0759013683
ISSN: 1322 - 8072

FOREWORD

The marine and freshwater fisheries resources of South Australia are community owned resources. The role of the Government, as custodian of these resources on behalf of the broader community and future generations, is to ensure that they are used in an ecologically sustainable and economically efficient manner, while at the same time maximising returns to the community.

Experience worldwide has demonstrated that where unrestricted use of fishery resources is allowed, there is little incentive for individuals harvesting the resource to conserve fish stocks. Left unmanaged, the increase in fishing effort that results from competition is reflected in over-capitalisation and reduced financial returns in the commercial fishing sector. Loss of these resources to the community can result in significant regional economic failure.

In managing fisheries resources, governments have the primary responsibility of ensuring long-term sustainability. Governments must also ensure that the basis for sharing fisheries resources among all users is clearly understood and accepted as equitable, and that the allocation of fisheries resources and their level of utilisation are consistent with the needs of present and future generations.

To assist decision-making by the Government in managing South Australia's fisheries resources, numerous fishery-specific stakeholder-based fishery management committees were established to provide expertise-based advice to the Minister for Agriculture, Food and Fisheries. These committees are comprised of Government managers, research scientists, commercial and recreational fishers, fish processors and members of the general community. An independent chairperson convenes meetings. Appointment of members and the terms of reference of the committees are embodied in the *Fisheries (Management Committees) Regulations 1995*.

I am pleased to release this Management Plan for the South Australian Pilchard Fishery that has been prepared by Primary Industries and Resources South Australia in association with the South Australian Research and Development Institute and the commercial pilchard industry, in accordance with the *Fisheries Act 1982*. The purpose of the Plan is to ensure that the fishery continues to be managed on a sustainable basis while allowing for continued development of the commercial industry.



Hon Rory McEwen MP
MINISTER FOR AGRICULTURE, FOOD AND FISHERIES
MINISTER FOR STATE/LOCAL GOVERNMENT RELATIONS
MINISTER FOR FORESTS

/ /2005

ACKNOWLEDGMENTS

The author is grateful for the invaluable advice and support of the Pilchard Fishery Working Group (PFWG), the Marine Scalefish Pilchard Fishermens Association and Mr Matthew Jeffrey for his editorial comments, in particular the information and comments on draft documents provided by the late Mr Norm Craig, Dr Keith Jones, Mr Jon Presser, Dr Tim Ward and Mr Will Zacharin.

TABLE OF CONTENTS

FOREWORD	3
ACKNOWLEDGMENTS	4
1. PURPOSE OF THE MANAGEMENT PLAN	8
2. SCOPE OF THE MANAGEMENT PLAN	9
2.1 GENERAL	9
2.2 OPERATION OF THE MANAGEMENT PLAN.....	10
2.3 REVIEW OF THE MANAGEMENT PLAN	11
2.4 KEY POLICY DRIVERS.....	11
2.4.1 <i>National Strategy for Ecological Sustainable Development</i>	11
2.4.2 <i>The Precautionary Approach</i>	12
2.4.3 <i>Commonwealth Environment Legislation</i>	14
2.4.4 <i>National Policy on Fisheries Bycatch</i>	15
3. DESCRIPTION OF THE FISHERY	15
3.1 OVERVIEW OF THE FISHERY	15
3.2 HISTORY OF THE DEVELOPMENT OF THE FISHERY	16
3.3 CURRENT MANAGEMENT ARRANGEMENTS	17
3.4 CONSULTATION AND CO-MANAGEMENT	18
3.5 CONSULTATIVE PROCESS FOR DEVELOPING A MANAGEMENT PLAN.....	19
3.6 COST RECOVERY	19
4. THE MANAGEMENT PLAN	19
4.1 INTRODUCTION	19
4.2 MANAGEMENT GOALS AND OBJECTIVES	20
4.2.1 <i>Goal 1</i>	21
4.2.2 <i>Goal 2</i>	21
4.2.3 <i>Goal 3</i>	21
4.2.4 <i>Goal 4</i>	22
4.3 MANAGEMENT STRATEGIES.....	22
4.3.1 <i>Performance Indicators</i>	22
4.3.2 <i>Reference/ Trigger Points</i>	23
4.4 MONITORING PROGRAMS.....	28
4.5 REPORTING ON THE PERFORMANCE OF THE MANAGEMENT PLAN.....	28
4.6 MANAGEMENT RESPONSES	28
4.7 SETTING THE TOTAL ALLOWABLE COMMERCIAL CATCH (TACC)	29
5 RESEARCH	31
5.1 BACKGROUND	31
5.2 INDEPENDENT STOCK ASSESSMENT	31
5.3 ANNUAL STOCK ASSESSMENT.....	33
5.3.1 <i>Catch and Effort data</i>	33
5.3.2 <i>Reproductive parameters</i>	35
5.3.3 <i>Spatial Patterns</i>	36
5.4 OTHER BAIT SPECIES.....	37
5.5 ENDANGERED AND PROTECTED SPECIES	38
5.5.1 <i>Code of Practice Endangered and Protected Species</i>	38

6	ECOLOGICAL IMPACTS OF FISHING	39
6.1	FISH AND CEPHALOPODS	39
6.2	SEABIRDS.....	40
6.3	MAMMALS	40
6.4	IMPACTS ON THE PHYSICAL ENVIRONMENT	41
6.5	WATER QUALITY	41
7	COMPLIANCE AND MONITORING	41
7.1	COMPLIANCE RISK ASSESSMENT MODEL.....	42
8	REFERENCES	43
	APPENDIX 1: CATCH DISPOSAL RECORD FORM	47
	APPENDIX 2: GLOSSARY	48
	APPENDIX 3: ACRONYMS	54

LIST OF FIGURES

FIGURE 1: AREA OF JURISDICTION OF THE SOUTH AUSTRALIAN PILCHARD FISHERY.	10
FIGURE 2: THE TACC FOR THE SOUTH AUSTRALIAN PILCHARD FISHERY BETWEEN 1991 AND 2003 AND SPAWNING BIOMASS ESTIMATES UNDERTAKEN BY SARDI AQUATIC SCIENCES BETWEEN 1995 AND 2003.	33
FIGURE 3: TRENDS IN ANNUAL CATCH, EFFORT AND CPUE BETWEEN 1991 AND 2003.	34
FIGURE 4: TRENDS IN MONTHLY CATCH, EFFORT AND CPUE BETWEEN 1991 AND 2003.	35
FIGURE 5: SPATIAL PATTERN OF PILCHARD CATCHES OVER THE PERIOD 2001 TO 2003.	37

LIST OF TABLES

TABLE 1: ANNUAL LANDED COMMERCIAL CATCH RECORDED IN THE SOUTH AUSTRALIAN RESEARCH DEVELOPMENT INSTITUTE (SARDI) RESEARCH LOGBOOKS FROM 1992 TO 2004.....	17
TABLE 2: SUMMARY OF CURRENT MANAGEMENT ARRANGEMENTS IN THE SOUTH AUSTRALIAN PILCHARD FISHERY. ..	18
TABLE 3: MANAGEMENT OBJECTIVES, STRATEGIES AND PERFORMANCE INDICATORS.	24
TABLE 4 : MANAGEMENT ACTIONS BASED ON BIOLOGICAL PERFORMANCEINDICATORS.....	27
TABLE 5 : PERFORMANCE INDICATORS USED TO SET THE ANNUAL TACC FOR THEFISHERY.....	28
TABLE 6: CATCHES OF BAIT SPECIES RECORDED IN THE COMMERCIAL FISHING LOGBOOK FROM 1999 TO 2002.	38

1. PURPOSE OF THE MANAGEMENT PLAN

The purpose of this Management Plan is to provide a detailed strategic policy framework that aims to ensure the ecological sustainable management of the South Australian Pilchard Fishery. It sets out a formal harvest strategy for the fishery and provides direction for the formulation of regulations contained within the *Fisheries (Scheme of Management – Marine Scalefish Fisheries) Regulations 1991* and the *Fisheries (General) Regulations 2000*. This Management Plan is intended to provide greater certainty in the day-to-day and long-term management and decision-making processes for all stakeholders.

Access to fisheries resources, which are managed by the Government on behalf of the broader community and future generations, comes with certain obligations for commercial licence holders, recreational participants and traditional fishers regarding the proper management and care of fisheries resources. These obligations are set out in this Management Plan. Information herein provides a reference for the broader community in relation to the management measures that have been introduced to ensure the long-term sustainability and optimal utilisation of the pilchard fishery resources.

The *Fisheries Act 1982* (the Act) provides a broad statutory framework to ensure the ecologically sustainable management of South Australia's marine, estuarine and freshwater fisheries resources. In administering the *Fisheries Act 1982*, the Minister for Agriculture, Food and Fisheries, the Director of Fisheries and the fisheries management committees must operate in accordance with the following objectives (*Fisheries Act 1982*, Section 20):

- (a) *ensuring, through proper conservation, preservation and fisheries management measures, that the living resources of the waters to which this Act applies are not endangered or overexploited; and*
- (b) *achieving the optimum utilisation and equitable distribution of those resources.*

This Management Plan sets out management strategies and key performance measures to allow for assessment of the degree to which these objectives are being achieved. It formalises a long-standing, informal, ecosystem-based approach to the management of the Pilchard Fishery. It also aims to provide a foundation for management of the fishery to continue moving towards a more integrated management framework, incorporating environmental management principles with standard species quota and gear-based fisheries management.

The powers contained within Section 14 of the *Fisheries (Management Committees) Regulations 1995* provide the legal basis for the establishment of this Management Plan.

2. SCOPE OF THE MANAGEMENT PLAN

2.1 General

This Management Plan provides a statement of the policy, objectives and strategies to be employed for the sustainable management of the Pilchard Fishery in South Australian waters.

The Plan primarily addresses the principal target species, pilchards (*Sardinops sagax*). However, all other species from the families Engraulididae and Clupeidae, that licence holders in the fishery are able to harvest, are also covered within the scope of the plan.

At present, the fishery is managed pursuant to the following legislation.

- *Fisheries Act 1982*
- *Fisheries (Scheme of Management - Marine Scalefish Fisheries) Regulations 1991*
- *Fisheries (General) Regulations 2000*

Pursuant to section (37) (1) of the *Fisheries Act 1982*, the Director of Fisheries and the Minister have the authority to prescribe conditions on licences relating to the take of a particular species and/or the use of fishing devices to take species. Under this section of the *Fisheries Act 1982*, 14 marine scalefish licences have had fine-mesh purse seine nets (or pilchard nets) listed as registered devices. In addition, licence conditions providing exclusive access have been listed permitting these 14 licence holders to harvest species from the families Engraulididae and Clupeidae. Licence conditions define species from the families Clupeidae and Engraulididae as pilchards.

The regulation defining a purse seine net or pilchard net is contained in part 1 of the *Fisheries (General) Regulations 2000*. A purse seine or pilchard net is defined as a purse seine net that -

- (a) is no more than 1000 metres in length; and
- (b) is no more than 200 metres in depth; and
- (c) has a minimum mesh size of 14 millimetres; and
- (d) has a maximum mesh size of 22 millimetres.

It is envisaged in the future that a set of regulations will be established specifically for the Pilchard Fishery (i.e. scheme of management), which will encompass all current legislation defining the management of the fishery in one document. The establishment of a scheme of management will remove much of the regulation that is currently contained in licence conditions and the *Fisheries (Scheme of Management – Marine Scalefish Fisheries) Regulations 1991*, pertaining to the Pilchard Fishery.

The area of jurisdiction of the fishery includes all the waters adjacent to the State of South Australia out to the edge of the 200nm Australian Fishing Zone (see Figure 1), with the exception of closed areas. The legislative instrument defining the area of jurisdiction for the Pilchard Fishery is the 1996 Offshore Constitutional Settlement (OCS) arrangements for scalefish species between South Australia and the Commonwealth of Australia.



Figure 1: Area of jurisdiction of the South Australian Pilchard Fishery within the 200 nautical mile Australian Fishing Zone (AFZ).

2.2 Operation of the Management Plan

This Management Plan will operate for a five-year period from 2005 to 2009 inclusive, subject to annual review and amendments that are considered necessary by the Pilchard Fishery Working Group (PFWG), the Director of Fisheries or the Minister for Agriculture, Food and Fisheries. The PFWG will use the Management Plan to guide annual processes for providing advice to the Minister and to the Director of Fisheries on management and research for the fishery. Specifically, the PFWG will use the reporting framework established in the Management Plan to prepare an annual report on the performance of the fishery against all performance indicators and reference/trigger points. An annual stock status report will provide the basis for this annual assessment of fishery performance. All stock assessment reports for the fishery will address key performance indicators outlined in the Management Plan. This process has been designed to deliver improved public accountability on the management of the fishery.

2.3 Review of the Management Plan

This Management Plan is a working document that reflects the current understanding of the Pilchard Fishery and, as such, is expected to change over time. This Management Plan will be periodically reviewed and improved as advancements in knowledge and management are made. However, no major departure from the stated management arrangements, performance indicators or reference/trigger points will occur unless the PFWG is otherwise directed by the Minister for Agriculture, Food and Fisheries during the life of this Management Plan. In 2009, Primary Industries and Resources South Australia (PIRSA), in association with the PFWG and key stakeholders, will undertake a major review of this Management Plan, including the strategic research and monitoring plan.

PIRSA Fisheries, in consultation with key stakeholder groups and the broader community, is currently undertaking a comprehensive review of the *Fisheries Act 1982*. This review, which is expected to be completed in 2006, may result in changes to the broad framework for administering and managing South Australia's fisheries resources. If necessary, this Management Plan will be updated to ensure that it is consistent with the requirements of the new legislation.

2.4 Key Policy Drivers

This Management Plan aims to achieve outcomes that are consistent with broader Government objectives for the management of marine resources. Key policy drivers identified for the development of this Management Plan include:

- The National Strategy for Ecological Sustainable Development;
- The Precautionary Principle, as set out in the Intergovernmental Agreement on the Environment;
- The Commonwealth Government 'Guidelines for the Ecologically Sustainable Management of Fisheries,' as set out in the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999*; and
- The National Policy on Fisheries Bycatch.

2.4.1 National Strategy for Ecological Sustainable Development

The principles of Ecological Sustainable Development (ESD) have been incorporated into fisheries legislation and management frameworks throughout Australia in recent years. The Australian Government suggested the following definition for ESD in Australia:

'using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased' (Commonwealth of Australia, 1992).

The goal of the National Strategy for ESD (Commonwealth of Australia 1992) is:

'Development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends.'

To achieve this goal, the following core objectives were developed:

- To enhance individual and community wellbeing and welfare by following a path of economic development that safeguards the welfare of future generations;
- To provide for equity within and between generations; and

- To protect biological diversity and maintain essential ecological processes within life-support systems.

In addition to the core objectives, the following guiding principles need to be considered for a balanced approach in pursuing the goal of ESD (Commonwealth of Australia 1992):

- Decision-making processes should effectively integrate both long and short-term economic, environmental, social and equity considerations;
- Where there are threats of serious irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation (i.e. a precautionary approach needs to be adopted);
- The global dimension of environmental impacts of actions and policies should be recognised and considered;
- The need to develop a strong, growing and diversified economy that can enhance the capacity for environmental protection should be recognised;
- The need to maintain and enhance international competitiveness in an environmentally sound manner should be recognised;
- Cost-effective and flexible policy instruments should be adopted, such as improved valuation, pricing and incentive mechanisms; and
- Decisions and actions should provide for broad community involvement on issues that affect them.

The goal, core objectives and guiding principles for the National Strategy for ESD have shaped the way in which natural resources are currently being managed throughout Australia. In 2000, the Australian Standing Committee on Fisheries and Aquaculture initiated a process to develop a National ESD Reporting Framework for all Australian fisheries (Fletcher et al. 2002). This National ESD Reporting Framework provides for a consistent national approach to reporting on fishery performance against all elements of ESD.

National ESD Reporting Framework highlights that implementing ESD in the day-to-day management of fisheries requires consideration of not only the impacts of fishing on target species, but also the impacts of fishing on non-target species and the wider ecosystem. Linked to this is a recognition that the economic health of a fishery also relies on maintaining essential ecological processes. In addition, Governments and key stakeholder groups must be able to satisfy the wider community that the management systems in place are adequate and that fisheries are providing sufficient socio-economic benefits to justify any negative impacts they may have (Fletcher et al. 2002).

This Management Plan takes into account the approach suggested in the National ESD Reporting Framework and aims to provide for regular assessment of fishery performance against all aspects of ESD.

2.4.2 The Precautionary Approach

There is no international consensus on the definition of a precautionary approach, but it is generally understood that it is applied as a risk management tool. A well-known approach to precaution is Principle 15 of the Rio Declaration of the United Nations Conference on Environment and Development:

‘In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full

scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.’ (FAO 2000).

The FAO International Code of Conduct for Responsible Fisheries prescribes a precautionary approach to the management of all fisheries, in all aquatic ecosystems, and regardless of their jurisdictional nature, recognises that most problems affecting the management of fisheries results from a lack of precaution in management regimes when faced with high levels of uncertainty (FAO 2000).

The precautionary approach to fisheries management recognises that changes in fisheries systems are only slowly reversible, difficult to control, not well understood and subject to changing environmental and human values (FAO 2000). The implications of adopting a precautionary approach to fisheries management are summarised as follows (FAO 2000):

‘The precautionary approach involves the application of prudent foresight. Taking account of the uncertainties in fisheries systems and the need to take action with incomplete knowledge, it requires inter-alia:

- *Consideration of the needs of future generations and avoidance of changes that are not potentially reversible*
- *Prior identification of undesirable outcomes and of measures that will avoid them or correct them promptly*
- *That any necessary corrective measures are initiated without delay, and that they should achieve their purpose promptly, on a time scale not exceeding two or three decades*
- *That where the likely impact of resource use is uncertain, priority should be given to conserving the productive capacity of the resource*
- *That harvesting and processing capacity should be commensurate with estimated sustainable levels of resource, and that increases in capacity should be further contained when resource productivity is highly uncertain*
- *All fishing activities must have prior management authorisation and be subject to periodic review*
- *An established legal and institutional framework for fishery management within which management plans implement the above points are instituted for each fishery*
- *Appropriate placement of the burden of proof by adhering to the requirements above.’*

The Commonwealth and State Governments of Australia formed an agreement in 1992 to implement a precautionary approach to all facets of policy development and decision-making concerning the environment. This agreement, known as the Intergovernmental Agreement on the Environment, is embodied in the resultant *National Environment Protection Council Act 1994*. Section 3.5.1 (precautionary principle) of the Intergovernmental Agreement on the Environment states that:

‘Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing measures to prevent environmental degradation. In the application of the precautionary principle, public and private decisions should be guided by:

- *careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment; and*
- *an assessment of the risk-weighted consequences of various options.’*

This Management Plan seeks to promote a precautionary approach to the management of the South Australian Pilchard Fishery. For the purposes of this Management Plan, the precautionary principle has the same meaning as in Section 3.5.1 of the Intergovernmental Agreement on the Environment.

2.4.3 Commonwealth Environment Legislation

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (the EPBC Act) establishes reporting requirements against the '*Guidelines for the Ecologically Sustainable Management of Fisheries*.' All State and Commonwealth fisheries must undergo a comprehensive independent ecological assessment process, which is subject to public consultation, prior to fishery products being considered for export approval under Parts 13 and 13A of the EPBC Act.

The two key principles of the EPBC Act '*Guidelines for the Ecologically Sustainable Management of Fisheries*' are as follows:

- A fishery must be conducted in a manner that does not lead to overfishing, 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.
- Fishing operations should be managed to minimise their impact on the structure, productivity, function and biological diversity of the ecosystem.

In 2004, the South Australian Pilchard Fishery was assessed against the guidelines and principles of ecological sustainable management, and was approved by the Commonwealth Minister for the Environment and Heritage for a period of five years.

As part of the approval, the Commonwealth Minister has made recommendations to further strengthen the effectiveness of the management arrangements for the fishery and minimise the environmental risks in the medium to longer term. The State Minister for Agriculture, Food and Fisheries has accepted that PIRSA Fisheries should action these recommendations prior to the next Australian Government review of the fishery in 2009. The recommendations are as follows:

Recommendation 1. That PIRSA advise the Commonwealth Department of Environment and Heritage (DEH) of any material change to the South Australian Pilchard Fishery's management arrangements that could affect the criteria on which the EPBC decisions are based, within 3 months of that change being made.

Recommendation 2. Within 3 months of becoming aware of the breaching of a performance measure, PIRSA will finalise a clear timeframe for the implementation of appropriate management responses.

Recommendation 3. That PIRSA develop within 2 years a performance indicator and performance measure to ensure that by-catch is minimised in the South Australian Pilchard Fishery.

Recommendation 4. That PIRSA provide a mechanism, which allows fishers to record interactions with protected/ listed species at a species level. PIRSA to implement an education program to ensure that industry has the capacity to make these reports at an appropriate level of accuracy.

Recommendation 5. Should new information determine that the fishery is having significant interactions with any endangered, threatened or protected species, PIRSA will develop appropriate measures to mitigate those interactions. Measures should be implemented within 12 months of the information becoming available.

Recommendation 6. Should the ecological effects survey determine that the fishery is having significant ecosystem impacts, PIRSA will develop and implement appropriate measures to mitigate those impacts in a timely manner.

2.4.4 National Policy on Fisheries Bycatch

The Ministerial Council on Forestry, Fisheries and Aquaculture endorsed the National Policy on Fisheries By-catch in 1999 to ensure a unified national response to the problem of bycatch across all Australian fisheries. The overall goal of the policy is to ensure that the direct and indirect fishery impacts on ecosystems are taken into account in the development and implementation of fisheries management regimes. An overarching objective of the policy is to ensure that bycatch species and populations are maintained at sustainable levels. Supporting this are the following sub-objectives (DAFF 1999):

- To reduce bycatch.
- To improve protection for vulnerable/threatened species.
- To minimise adverse impacts of fishing on the aquatic environment.

The National Policy defines bycatch at its broadest level to include all material, living and non-living, other than target species which are caught while fishing. However, for practical purposes, the National Policy defines bycatch to include discards (that part of the catch returned to the water) and also that part of the catch that is not landed but is killed as a result of interactions with fishing gear. By-product is defined as non-target catch that is commercially valuable and therefore retained by fishers. For the purposes of this Management Plan, bycatch and by-product have the same meaning as the definitions set out in the National Policy on Fisheries Bycatch.

3. DESCRIPTION OF THE FISHERY

3.1 Overview of the Fishery

Historically, the principal species harvested in the fishery has been *Sardinops sagax* (pilchards), comprising more than 98% of the catch (Ward et al. 2004a). As such, research and management of the fishery is primarily directed at this species.

These fish are caught over 12 months of the year using a small (14 to 22 millimetres) mesh purse seine or pilchard net. Commercial fishing activities are predominately undertaken at night, although some fish are captured in daylight. Schools of pilchards are located by sonar generally, and then the net is deployed around the school usually with the aid of a net dinghy. The net is then pursed and encircled into a small area adjacent to the vessel. The fish are then removed from the net with a pump that extracts the catch from the water, removing the water before placing the catch in the hold of the boat.

Prior to 1993, the fishery was seasonal with the majority of the catch taken during the summer months by tuna fishers in the Southern Bluefin Tuna (SBT) fishery for live bait. Interest in establishing a commercial fishery for pilchards began in the mid 1980s, with product being supplied to the recreational bait and pet food markets. Following the development of tuna farming in the Port Lincoln region, there has been an increased demand for pilchards for use as tuna feed. This situation resulted in an increased emphasis on research in the fishery that has subsequently enabled higher levels of exploitation to be achieved.

3.2 History of the Development of the Fishery

In February 1991, the Government wrote to marine scalefish fishery licence holders who held a net endorsement seeking expressions of interest in establishing a fishery for pilchards using a small mesh purse seine net. As a result of this call, 20 licence holders were successful in gaining access to take pilchards using this method (Mackie 1991).

Catches amongst the 20 licence holders were low, as very few took up pilchard fishing on a full-time basis, or made the commitment to purchase purpose built fishing gear. Consequently, those in the fishery were unable to supply the newly established tuna farms with their required supply of pilchards for feedstock.

The access entitlement was subsequently reviewed and the (then) Scalefish Management Committee (SMC) decided to provide continued access to the following groups:

- Australian Tuna Boat Owners Association;
- A special permit holder (a WA pilchard fisher); and
- Marine Scalefish Fishery (MSF) licence holders endorsed by permit who had supplied pilchard catch and effort data to PIRSA Fisheries.

In June 1993, these arrangements were reviewed as a result of the following new access arrangements being established:

- That permit holders endorsed in the developmental Pilchard Fishery during the 1992/93 season be considered as eligible to apply for entry into the fishery if they had a proven significant catch history of at least 30 tonnes during the period 1 July 1992 to 30 June 1993; or
- If the permit holder had proven significant financial investment in a specific pilchard purse seine fishing vessel during the period 1 July 1992 to 2 April 1993.

As a result of the establishment of these new access arrangements, 7 MSF licence holders and 7 fishers previously nominated by the Australian Tuna Boat Owners Association (ATBOA) were granted access to pilchards. Access was administered by Ministerial exemptions.

In March 2000, a Pilchard Fishery Independent Advisory Allocation Panel was established to provide advice to the Minister in regard to future access to the pilchard resource. The advice of the Panel (that was subsequently adopted by the Minister), was that the current 14 fishers should maintain their access to the pilchard resource in waters adjacent to South Australia; 7 by virtue of holding a commercial licence in the marine scalefish fishery and 7 by virtue of being nominees of the Australian Tuna Boat Owners Association (ATBOA).

Access was also granted in 1996 to licence holders with a Commonwealth Southern Bluefin Tuna Permit to take the following genera/species *Emmelichthyes*, *Trachurus*, *Sardinops*, *Clupea*, *Scomber australasicus* and *Engraulis* for bait purposes. These management arrangements were legislated pursuant to the 1996 Offshore Constitutional Settlement (OCS) arrangements for scalefish species between South Australia and the Commonwealth.

In addition to the actual historical development of management arrangements in the fishery, the most significant events in the short history of the fishery were the 1995 and 1998 mass mortality events. These events have been attributed to a Herpes like virus of unknown origin (Ward et al. 2001). The fishery was closed for a period of time following each mass mortality event until such time as scientific evidence illustrated that the stock had recovered to a point where harvesting could continue.

Table 1 illustrates the changes in commercial catches and the subsequent introduction of a Total Allowable Commercial Catch (TACC) for the fishery in 1995.

Table 1: Annual landed commercial catch recorded in the South Australian Research Development Institute (SARDI) research logbooks from 1992 to 2004

		Commercial catch (tonnes)
1992	N/A	464.91
1993	N/A	1,463.02
1994	N/A	3,241.34
*1995	3,500	2,459.93
1996	3,500	3,532.28
1997	3,500	3,025.86
*1998	9,000	6,436.31
1999	4,700	3,548.56
2000	3,800	3,502.48
2001	9,100	4,547.87
2002	17,750	13,323.58
2003	36,000	26,161.14
2004	40,000	37,340
2005	51,100	N/A

(* denotes years in which mass mortality events occurred).

3.3 Current Management Arrangements

The fishery is managed primarily by an Individual Transferable Quota (ITQ) management regime, with complementary input controls to restrict interactions with non-target species.

The TACC set annually for the fishery is divided equally amongst the licence holders. The individual allocations of quota are endorsed on licences at the beginning of the calendar year and are valid for that year. Table 2 provides a summary of the management arrangements in the fishery.

PIRSA Fisheries Compliance monitors the catch and transfer of quota in the fishery through the Catch Disposal Record (CDR) form that enables all landings of pilchards to be monitored. These forms are used to verify the volumes of pilchards landed, with licence holders required to complete and forward the CDR form to PIRSA Fisheries Compliance.

In addition to completing the CDR form, each licence holder is required to complete a research logbook, with one record per net set. Information contained in the research logbook is used to enhance research assessments by the South Australian Research Development Institute (SARDI).

Table 2: Summary of current management arrangements in the South Australian Pilchard Fishery.

	MANAGEMENT ARRANGEMENTS
Licensing year	1 July – 30 June
Limited entry (no. of licence holders)	Yes (14)
Principal target species	Pilchard (<i>Sardinops sagax</i>)
Permitted species	Species from the families Engraulididae and Clupeidae
Max. No. of boats to be used at one time	2
Licence Transferability	Yes
Quota scheme (ITQ)	Yes
Quota year	1 January – 31 December
Quota amounts (2005)	3,650 tonnes for each of the 14 licence holders. Total Allowable Commercial Catch (TACC) 51,100 tonnes.
Quota transferability (within a quota year and between licence holders)	Yes
Method of capture	pilchard net (purse seine) (max length 1,000m)

3.4 Consultation and co-management

Marine resources in South Australia are recognised as common property resources. The role of the Government, as custodian of the marine resources on behalf of the general community, is to ensure that marine resources are used in an ecologically sustainable manner and as efficiently as possible, while yielding a reasonable return to the community. This ensures that the benefits of the use of marine resources are maximised within the community.

In carrying out this role, Government has the responsibility of ensuring that the basis for sharing of the resource amongst all users is clearly understood and accepted as equitable, and that the allocation of fisheries resources and their level of utilisation are consistent with the needs of present and future generations.

To facilitate this consultation with stakeholders a Pilchard Fishery Working Group (PFWG) has been established.

The PFWG comprises of the following members.

- Chairperson (1)
- Commercial licence holders (4)
- Conservation/ Environment (1)
- Community representative (1)
- Principal pilchard scientist (SARDI) (1)
- Fisheries manager (PIRSA) (1)
- South Australian Fishing Industry Council (SAFIC) (1)
- South Australian Recreational Fishing Advisory Council (SARFAC) (1)

These members have been appointed to the Working Group by the Director of Fisheries on the basis of their direct and/or indirect interest in the resource.

3.5 Consultative process for developing a Management Plan

Legislation in South Australia does not prescribe a consultation process for the development or review of a fishery Management Plan. However, the following steps have been employed when developing a Management Plan for the Pilchard Fishery.

- Review of the proposed Plan by the PFWG.
- Submission of draft Plan to the Minister seeking approval for public release of the document.
- A public comment period of at least 30 days.
- Distribution of the Plan to stakeholder groups (all relevant licence holders, fish processors, recreational and commercial representative bodies, local councils and community, conservation, and indigenous groups, as well as government agencies).
- Publicising to the wider community the release of the Plan.
- A summary report submitted to the PFWG and subsequently the Minister on issues raised during the public comment period.
- Finalisation of the Plan by the PFWG and submission to the Minister for final approval.
- Distribution of the Plan (including posting on relevant website).

This consultation process has been employed to ensure the Management Plan is accurate and representative of all stakeholder groups.

3.6 Cost Recovery

In 1995, the South Australian Government introduced a process to recover the full attributed costs of the management of commercial fisheries from licence holders.

The recovery of these attributed costs is negotiated on an annual basis through the PFWG. Traditionally for commercial fisheries, these negotiations are undertaken through the Fishery Management Committee (FMC). However, the Pilchard Fishery is yet to establish an FMC and until such time as an FMC is established negotiations for the full attributed costs of the annual management of the fishery will be undertaken through the PFWG.

The attributed costs of management for the commercial sector are recovered through licence fees. The specific services for which costs are recovered are research, management, compliance, licensing, legislation, directorate and the Fisheries Research and Development Corporation (FRDC) levy (0.25% of the Gross Value of Production).

4. THE MANAGEMENT PLAN

4.1 Introduction

In a practical sense, the Management Plan describes the linkages between management goals and objectives, strategies, performance indicators, reference points and management actions to be undertaken when limit reference points are triggered.

The priority for management of the Pilchard Fishery is to meet the requirements of ESD by ensuring that annual harvest levels are sustainable, so current and future generations may benefit from marine resources harvested in the fishery. In achieving the ESD requirements

for the fishery the various biological, ecological, social and economic objectives of the *Fisheries Act 1982* (Section 20) and relevant Commonwealth legislation have been taken into account.

In order to meet the challenge of maintaining the ESD requirements in the fishery, a management strategy addressing all aspects of the fishery has been developed. The management strategy for the fishery is based on the following processes:

- Key goals relating to management, sustainability of fish stocks, impacts of fishing operations on the ecosystem and governance of the fishery.
- A set of agreed objectives that are both understood by stakeholders, are measurable and relate to the goals of the Management Plan.
- A set of cost-effective management performance indicators aligned with the objectives.
- Assessment and evaluation of each objective through reference points.
- Monitoring of the performance of the fishery.
- Assessment and evaluation of the primary species pilchards through the use of biological reference points.
- Agreed management responses or decision rules to outcomes of assessment and evaluation.

Details of management goals and objectives, strategies, performance indicators, monitoring programs/schedules and limit reference points are provided in tables 3 to 6.

4.2 Management Goals and Objectives

The *Fisheries Act 1982* provides an over-arching framework to ensure long-term sustainability of South Australia's marine, estuarine and freshwater fisheries resources. The following management goals and objectives provide a focus for the long-term sustainable management of the Pilchard Fishery and are complementary to the objectives outlined in the Act.

Consistent with the objectives of the Act, a key goal of this Management Plan is to ensure that an appropriate balance exists between the need to ensure the long-term sustainability of resources and the optimum utilisation of these resources between stakeholders. For this reason, the stock sustainability and environmental management objectives set out in this Management Plan provide the baseline against which all other objectives will be pursued. Economic and social objectives will be pursued to the extent possible where stock sustainability imperatives have been demonstrably achieved.

The management objectives in the plan relate specifically to pilchards, as this is the primary species caught in the fishery. However, these objectives can also be extended to all species that may be retained in the fishery (i.e. species from the families Clupeidae and Engraulididae).

The following management goals aim to address key challenges facing the fishery and take into account key policy drivers set out in section 2.4, such as the principles of ESD, the

precautionary approach, and ‘*Guidelines for the Ecologically Sustainable Management of Fisheries.*’ A series of objectives have been established to ensure management goals are actively pursued.

4.2.1 Goal 1

Sustainable harvest of resources in the Pilchard Fishery.

- a. *Manage the total catch of pilchards and by-product species in the fishery by commercial licence holders to ensure the fishery remains sustainable in the long – term.*
- b. *Develop set biological performance indicators to ensure the resource is harvested within sustainable levels.*

Achieving this goal is the principal requirement in ensuring the long-term biological sustainability of the fishery. Current scientific information, through research programs established for the fishery, demonstrates that the pilchard stock is harvested at conservative levels (i.e. TACC). Conservative exploitation rates have been applied in the fishery due to the significant fluctuations in the abundance of the stock, as illustrated by the mass mortality events in the fishery in 1995 and 1998.

4.2.2 Goal 2

Minimise adverse impacts of fishing operations on the ecosystem.

- a. *Minimise impacts of fishing operations on the structure of the ecosystem.*
- b. *Minimise impacts of all fishing operations on bycatch and catches of endangered and protected species.*

As the principal target species pilchard is a low order predator, an ecosystem approach to the management of the fishery is an integral strategy in the protection and conservation of species within the ecosystem. This approach is being incorporated as part of current ecosystem research being undertaken and through the development of performance indicators to monitor impacts on the ecosystem (see Chapter 6).

4.2.3 Goal 3

Optimal utilisation of Pilchard Fishery resources within the constraints of sustainability imperatives.

- a. *Improve economic efficiencies in the commercial fishery.*
- b. *Maximise the social and economic benefit from the fishery to the broader community.*

The Pilchard Fishery operates from the regional city of Port Lincoln where the ongoing maintenance of the fishery, through the continuation of commercial fishing at sustainable levels, generates significant economic activity in the community. An essential requirement of the fishery is to ensure the resource is harvested in the most efficient manner to enable returns to the community to be maximised. This objective is achieved primarily by providing

commercial licence holders with the means to maximise the economic efficiency of their individual operations.

4.2.4 Goal 4

Good governance of the Pilchard Fishery.

- a. Promote cost-effective management of the fishery.*
- b. Promote co-management of the fishery.*
- c. Ensure compliance with management measures.*

The cost effective management of the Pilchard Fishery relates to the provision of effective stakeholder participation in the management of the fishery. To facilitate this approach, the Government has established a co-management committee, the PFWG, with stakeholder membership that provides advice to the Minister for Agriculture, Food and Fisheries and Director of Fisheries on the management strategy for the fishery. The co-management model is supported by management services providing information and facilitation related to scientific research, committee support, policy and management planning, industry extension and compliance services. Cost recovery through licence fees is the basis for funding these services.

4.3 Management Strategies

The management strategies outlined in Table 3 have been designed to ensure the management objectives are effectively pursued. Collectively, these strategies are aimed at management of the whole fishery; however, a number of strategies have been directed specifically at the principal target species pilchard, which comprises more than 98% of the catch.

An important element of the Pilchard Fishery harvest strategy is the flexibility that commercial fishers have to harvest pilchards. Management strategies to provide and promote flexibility enable licence holders to harvest pilchards in the most economic efficient manner and maximise the value of the resource.

The range of strategies outlined in Table 3 provides the necessary scope and flexibility required to manage the fishery and its impacts on fish stocks and the broader ecosystem.

4.3.1 Performance Indicators

The extent to which this Management Plan is achieving the range of established management objectives will be assessed using a combination of performance indicators, designed to measure the performance of the fishery, the stock status of the primary target species pilchards, the ecosystem effects of harvesting pilchards and the overall condition of the environment. Additional or further refined performance indicators may be developed over time as advances in knowledge are made and/or stock assessment methods are improved.

Biological performance indicator values are estimated using fishery independent sampling methods, which are outlined in Chapter 6.

4.3.2 Reference/ Trigger Points

A reference/ trigger point specifies the level at which a performance indicator suggests there is an uncertain situation within the fishery and that a review may be required depending on the nature of the problem. Reference/ trigger points are precautionary and are set relative to known levels of variation of the performance indicators spawning biomass and percentage presence of age-classes within the population (see table 4).

The annual level of exploitation for the fishery, set through the TACC, is reviewed against the reference/ trigger points which are the guidelines or decision-making rules that determine the setting of the TACC (see section 4.7). These reference/ trigger points are reviewed on an ongoing basis and should scientific information demonstrate that these points should be changed to reflect the status of the stock, a review of the measure of these points will be undertaken (see section 4.7).

Table 3: Management objectives, strategies and performance indicators.

Management Objectives	Management Strategies	Performance Indicators	Monitoring Program/Schedule	Limit Reference Points
Goal 1: Sustainable harvest of resources in the Pilchard Fishery				
a. Manage the total catch of pilchards and by-product species in the fishery by commercial licence holders to ensure the fishery remains sustainable over the long-term.	<ol style="list-style-type: none"> Limit the number of licences in the fishery to the existing 14 licences. Ensure an equal allocation of the TACC set at the beginning of the calendar year is allocated to each licence holder in the fishery. Set an annual TACC for pilchards. 	<ol style="list-style-type: none"> Annual compliance risk assessment in the fishery illustrates the effectiveness of compliance measures in containing the annually set TACC. Ensure the annual TACC for pilchards is not exceeded. Ensure catches of by-product species are retained within the TCLs set. s 	<ol style="list-style-type: none"> Monitoring of the total catches taken by individual commercial licence holders in a calendar year through Catch Disposal Record (CDR) forms. Monitoring of by-product species through the research logbook catch and effort data. 	<ol style="list-style-type: none"> Individual quota allocations held by licence holders The annual TACC of pilchards. The annual TCLs for by-product species. Anchovies – 150,000 kg's Bluesprats – 30,000 kg s Marays – 50,000 kg's
b. Develop set biological performance and fishery status indicators to ensure the resource is harvested at sustainable levels.	<ol style="list-style-type: none"> Undertake annual independent sampling of the pilchard stock. Undertake fishery dependent sampling through catch and effort data recorded in research logbooks. Ongoing development and improvement of performance indicators to ensure the most accurate biological research information is being used to manage the fishery. 	<ol style="list-style-type: none"> Annual spawning biomass estimate produced as part of the research program. Annual reporting of the percentage presence of age-classes within the population. Reporting of fishery status indicators (i.e. CPUE, catch and effort). 	<ol style="list-style-type: none"> Results of Fishery- independent research program undertaken by SARDI reporting on biological performance indicators. Results of Fishery dependant catch and effort data recorded by SARDI in the annual Fishery Assessment report. 	<ol style="list-style-type: none"> As specified in the TACC decision rules (see section 4.7). Level of catch relative to the annual TACC for pilchards.
Goal 2: Minimise adverse impacts of fishing operations on the ecosystem				
a. Minimise impacts of fishing operations on the structure of the ecosystem.	<ol style="list-style-type: none"> Measure the impacts of fishing operations on other species within the ecosystem. Promote harvesting techniques that minimise adverse impacts of fishing on habitat. Undertake precautionary harvesting strategies on the principal target species pilchards (<i>Sardinops sagax</i>). 	<ol style="list-style-type: none"> Performance indicators defining the impact of harvesting activities are currently being developed through research being undertaken by SARDI. Achievement of ecosystem research being undertaken by SARDI within timeframes. 	<ol style="list-style-type: none"> Development of ecosystem based performance indicators (within the next 3 years). 	<ol style="list-style-type: none"> That reference points quantifying the ecosystem interactions of harvest levels through the pilchard TACC be developed in the next 3 years.

Management Objectives	Management Strategies	Performance Indicators	Monitoring Program/Schedule	Limit Reference Points
Goal 2: Minimise adverse impacts of fishing operations on the ecosystem				
b. Minimise impacts of all fishing operations on bycatch and catches of endangered and protected species.	<ol style="list-style-type: none"> 1. Independent monitoring of bycatch and endangered and protected species. 2. Fishery dependent monitoring of by-catch and endangered and protected species through research logbooks. 3. Further development of research logbooks to enable the recording of interactions with bycatch and endangered and protected to be accurately recorded and quantified. 4. Adoption of codes of practice to minimise interactions with bycatch and endangered and protected species. 5. The consideration of the implementation of regulation minimising interactions with bycatch and endangered and protected species, should further research illustrate that such regulation is required. 	<ol style="list-style-type: none"> 1. Results of reports currently being produced by SARDI quantifying by-catch and interactions with endangered and protected species will enable performance indicators to be defined. 2. Acceptance of Codes of Practice developed to minimise and/or avoid by-catch, endangered and protected species. 	<ol style="list-style-type: none"> 1. Research logbook recording by-catch and endangered and protected species numbers and interactions (the development of an improved logbook will improve the accuracy of this information). 2. Independent observer program monitoring by-catch and protected and endangered species interactions. 3. Independent monitoring of the Code of Practice developed for the fishery. 	<ol style="list-style-type: none"> 1. Limit reference points to be developed following the completion of research being undertaken by SARDI to quantify interactions with bycatch and endangered and protected species.

Management Objectives	Management Strategies	Performance Indicators	Monitoring Program/Schedule	Limit Reference Points
Goal 3: Optimal utilisation of Pilchard Fishery resources within the constraints of sustainability imperatives				
a. Improve economic efficiencies in the commercial fishery.	<ol style="list-style-type: none"> 1. Ensure reliable economic performance indicators are measured annually. 2. Encourage the development of improved harvest, post-harvest, value adding and marketing strategies. 3. Develop arrangements that allow commercial operators to maximise operational flexibility and economic efficiency. 4. Consider economic and financial 	<ol style="list-style-type: none"> 1. Gross Value of Production (GVP), average price (per/kg). 3. Seasonal price fluctuation (per/kg). 4. Average financial return (e.g. gross income, total expenses, cash operating surplus, return on investment). 4. License value and fluctuation over time. 	<ol style="list-style-type: none"> 1. Economic performance report (annual). 	<ol style="list-style-type: none"> 1. Decreasing trends in annual return on investment.

Management Objectives	Management Strategies	Performance Indicators	Monitoring Program/Schedule	Limit Reference Points
Goal 3: Optimal utilisation of Pilchard Fishery resources within the constraints of sustainability imperatives				
b. Maintain a flow of social and economic benefit from the fishery to the broader community.	<p>impacts when implementing management arrangements.</p> <p>1. Measure the social and economic benefit of fishing on regional communities and the State.</p>	<p>1. Flow-on economic and social benefits of pilchard fishing operations to employment, household incomes and the regional community of Port Lincoln.</p>	<p>1. Economic performance indicator report (annual).</p>	
Goal 4: Good governance of the Pilchard Fishery				
a. Promote cost-effective management of the fishery.	<p>1. Develop and implement arrangements that are effective at achieving management objectives, while minimising costs.</p> <p>2. Recover licence fees from commercial licence holders that are sufficient to cover the attributed costs of fisheries management.</p> <p>3. Explore means for attracting additional funding for management of the fishery (i.e. research funding).</p>	<p>1. Total real costs of management, research and compliance for the fishery.</p> <p>2. Cost of management, research and compliance relative to Gross Value of Production for the fishery.</p>	<p>1. Cost recovery working group to determine real cost of management, research and compliance through the cost recovery process (annual).</p> <p>2. Economic performance indicator report (annual).</p>	
b. Promote co-management of the fishery.	<p>1. Provide mechanisms for and promote stakeholder involvement in the management of the fishery, through established co-management processes.</p>	<p>1. Ensure the PFWG membership reflects the stakeholder interest within the fishery.</p> <p>2. Ensure an appropriate number of meetings of licence holders are held on an annual basis to seek input and advise on proposed management arrangements for the fishery.</p>	<p>1. PIRSA/ PFWG to conduct annual compliance risk assessment.</p> <p>2. Annual SARDI spawning biomass report available in October (annually).</p>	<p>1. High level of disenchantment of stakeholders through correspondence to the Director, Minister or through public meetings.</p>

Management Objectives	Management Strategies	Performance Indicators	Monitoring Program/Schedule	Limit Reference Points
<p>Goal 4: Good governance of the Pilchard Fishery</p> <p>C. Provide an effective compliance program for the fishery.</p>	<ol style="list-style-type: none"> 1. Risk assessment of compliance issues. 2. Implement a cost-effective compliance and monitoring program to address identified risks. 3. Develop and implement methods to quantify illegal catch levels in excess of the annual TACC for pilchards. 	<ol style="list-style-type: none"> 1. Number of high-rated risks, as part of the annual compliance risk assessment. 2. Number of compliance checks undertaken by FISHWATCH. 3. Number of reports of illegal activities, relative to the number of compliance actions (e.g. expiations, formal briefs, cautions etc). 	<ol style="list-style-type: none"> 1. PIRSA to conduct annual compliance risk assessment. 	<ol style="list-style-type: none"> 1. Increasing trend in the level of illegal activity, relative to the number of compliance actions, detected in the fishery over a three-year period.

4.4 Monitoring Programs

Performance indicators are the basis on which the goals and objectives of the Management Plan can be evaluated. Performance indicators are designed to be practical and measurable and, as such, a number of monitoring and research programs are needed to gather the information needed to measure these indicators. The monitoring programs/schedules required for performance indicators to be adequately assessed are provided in sections 5.2 and 5.3.

4.5 Reporting on the Performance of the Management Plan

A report on the performance of the Management Plan will be provided by the consultative body for the fishery on an annual basis. At present this body is PFWG. The report will assess each performance indicator to detect whether limit reference points have been triggered and what action was or needed to be taken. These annual reports will advise the Minister for Agriculture, Food and Fisheries on the effectiveness of the Management Plan and performance of the fishery.

4.6 Management Responses

The management responses are linked to the performance indicators through the TACC decision rules (see section 4.7). Reference points within the performance indicators that have been developed for the fishery trigger management responses that have been defined within the TACC decision-making rules. Table 4 illustrates the reference points for the biological performance indicators that trigger management responses contained in the TACC decision-making rules.

Table 4: Management actions based on biological performance indicators.

Spawning biomass estimate	Presence of age classes	Management action (as % of spawning biomass).
< 100,000 tonnes		10% or 500 tonnes (which ever is greater).
100,000 – 150,000 tonnes	2 and 3 year old age classes weak or of average strength (<40% of catch).	10%
100,000 – 150,000 tonnes	2 and 3 year old age classes strong (>40% of catch).	12.5%
150,000 – 250,000 tonnes	2 and 3 year old age classes weak or of average strength (<40% of the catch).	12.5%
150,000 – 250,000 tonnes	2 and 3 year old age classes strong or of average strength (>40% of the catch).	15%
>250,000 tonnes	2 and 3 year old age classes weak or of average strength (<40% of the catch).	15%
>250,000 tonnes	2 and 3 year old age classes strong or of average strength (>40% of the catch).	17.5%

Table 4 illustrates the suggested management response (% of spawning biomass to be harvested) to be taken within ranges of reference points for both spawning biomass estimates and the percentage presence of age classes within the population. These management responses are considered to be decision rules as they are used as a guide, as opposed to specific management actions.

Following the ongoing review of research in the fishery these reference ranges may be modified and/or additional performance indicators added. It is generally considered that the decision rules will continue to be conservative until further research is able to illustrate the stock is able to handle higher levels of exploitation.

In addition to the management responses based on the performance indicators established for the fishery the Director of Fisheries also has the power to close and/or place a prohibition on the take of a species pursuant to the *Fisheries Act 1982*. These powers were enacted in 1995 and 1998 following the pilchard mass mortality events that occurred in these years.

4.7 Setting the Total Allowable Commercial Catch (TACC)

The TACC sets the level of exploitation in the fishery by restricting the total quantity of pilchards that can be taken. The setting of the TACC has historically been based on the information contained in the stock assessment and spawning biomass reports.

Since 2002, the setting of the TACC has been based on management decision rules, established for the fishery. These rules act as guidelines by establishing levels of exploitation based on biological performance indicators in the fishery, primarily the estimate of spawning biomass (see section 5.2).

Table 5: Performance indicators used to set the annual TACC for the fishery.

Performance Indicator	Description	Measurement
Estimate of Spawning Biomass	Reflects the number of individuals within the population that are estimated to be spawning on a particular day.	Daily Egg Production Method (DEPM) formula.
Presence of Age Classes	Reflects the percentage of different age classes present when sampling is undertaken.	Straight percentage of sample.

These two performance indicators are used as part of the TACC decision rules that are documented in the SARDI spawning biomass report. The decision rules are used as guidelines only for decision makers when setting the annual TACC. The decision rules are as follows:

1. If the estimate of spawning biomass is less than 100,000 t, the TACC should be set at 10% of the spawning biomass or 5,000 t (which ever is greater).
2. If there is evidence that the 2 and 3 year old age classes are weak or of average strength (e.g. <40% of the catch) and the estimate of spawning biomass is between 100,000 and 150,000 t, then the TACC should be set at 10% of the spawning biomass.
3. If there is evidence that the 2 and 3 year old age classes are strong (e.g. >40% of the catch) and the estimate of spawning biomass is between 100,000 and 150,000 t then the TACC should be set at 12.5% of the spawning biomass.
4. If there is evidence that the 2 and 3 year old age classes are weak or of average strength (e.g. <40% of the catch) and the estimate of spawning biomass is between 150,000 and 250,000 t, then the TACC should be set at 12.5% of the spawning biomass.
5. If there is evidence that the 2 and 3 year old age classes are strong (e.g. >40% of the catch) and the estimate of spawning biomass is between 150,000 and 250,000 t then the TACC should be set at 15% of the spawning biomass.
6. If there is evidence that the 2 and 3 year old age classes are weak or of average strength (e.g. <40% of the catch) and the estimate of spawning biomass is greater than 250,000 t, then the TACC should be set at 15% of the spawning biomass.
7. If there is evidence that the 2 and 3 year old age classes are strong (e.g. >40% of the catch) and the estimate of spawning biomass is greater than 250,000 t, then the TACC should be set at 17.5% of the spawning biomass.

In isolation, individual performance indicators are not considered to provide a robust measurement of the degree to which key management objectives are being achieved. The

spawning biomass estimate is the principal guide to the setting of the TACC. However, the presence of individual age classes provides a further indication of the robustness of the stock, which, based on the decision rules, allows a higher level of exploitation (i.e. TACC).

Prior to the introduction of the decision rules, the TACC was set at a conservative 10% of the spawning biomass. Following the pilchard kills in 1995 and 1998 the TACC was set at a conservative level to allow the fishery to recover. A TACC of 10% of the spawning biomass is considered to be extremely conservative, given that exploitation rates in other Clupeoid fisheries are as high as 20-30% of the spawning biomass (Staunton, Smith & Ward 1998).

The decision rules established for the fishery will continue to be reviewed on an ongoing basis and should scientific information illustrate that modification to the rules may be relevant, consultation with stakeholders will be undertaken to review either the reference points or the performance indicators upon which the rules are based.

5 RESEARCH

5.1 Background

Fisheries dependent research has been conducted since MSF holders first took pilchards in 1991. The catch and effort data has historically been used to analyse trends in catch and Catch Per Unit of Effort (CPUE) (see figure 3). In addition, age composition of the fished component of the stock has been collected, by sampling the catch since 1995.

Independent fisheries research first began in 1995 when independent sampling was undertaken as part of a FRDC project titled ‘A Collaborative Investigation of the Usage and Stock Assessment of Baitfish in Southern and Eastern Australian Waters, with Special Reference to Pilchards (*Sardinops sagax*)’. This project identified and developed a stock assessment method that provides an estimate of spawning biomass for the principal target species pilchards.

Information from both independent and dependent research is reported on in the spawning biomass report and the annual stock assessment report provided by the SARDI (e.g. Ward et al. 2004a and Rogers et al. 2004). The differentiation between the two documents being that the spawning biomass report only reports on the fishery independent surveying method undertaken to provide an estimate of spawning biomass.

In addition to research undertaken on the target species, research commenced in 2003 on analysing the ecosystem effects of removing pilchards, as part of commercial fishing activities, on the ecosystem. This research will enable the effects of harvesting activities on the abundance of other species that prey on pilchards to be quantified.

For further information on the biology of pilchards see the annual stock assessment report on the Primary Industries and Resources South Australia (PIRSA) website (www.pir.sa.gov.au).

5.2 Independent Stock Assessment

The independent stock assessment method of determining an estimate of spawning biomass is obtained by undertaking independent sampling of pilchard eggs throughout waters adjacent to South Australia. The sample sites, from which eggs are taken, were established as part of the initial FRDC project, which both refined the sampling method and determined the areas where eggs could be found. Sampling is undertaken in the months of February and March each year.

Pilchard eggs obtained from the sampling sites are counted and segregated into stages of development, as defined in the temperature – development key provided by White and Fletcher (1996). Once these parameters are established an estimate of mean egg production is calculated using the following equation:

$$P = e^{(\ln P_b + \sigma^2 / 3)} \dots\dots\dots \text{Equation 1.}$$

where σ^2 is the variance of the estimate of biased mean daily egg production (P_b).

To establish the adult reproductive parameters (i.e. female weight, sex ratio and batch fecundity) independent sampling of pilchard schools is undertaken. This sampling is undertaken daily following the completion of the egg sampling survey. Pilchards are located using a sonar and dual frequency echo sounder in areas where the species was likely to be found (Rogers et al. 2004). A gillnet is then set for between 15 minutes and 3 hours.

From each daily set the parameters of female weight, sex ratio batch fecundity and spawning fraction are obtained. These parameters are then applied to the mean egg production estimate across the spawning area to obtain the spawning biomass (B) through the following equation:

$$B = \frac{P \cdot A \cdot W}{R \cdot F \cdot S} \dots\dots\dots \text{Equation 2.}$$

where P is mean daily egg production, A is the spawning area, W is the mean weight of mature females, R is the sex ratio (proportion of females by weight), F is the mean batch fecundity (number of oocytes in a batch) and S is the mean spawning fraction (proportion of mature females that spawn each night) (Lasker 1985; Parker 1985; Alheit 1993).

Estimates of spawning biomass are calculated using the mean values of each of the adult reproductive parameters to ensure a conservative estimate of spawning biomass is determined.

This fishery independent sampling method is referred to as the Daily Egg Production Method (DEPM). The DEPM provides an estimate of the biomass of adult fishes that release batches of pelagic eggs throughout the spawning season. The method relies on the premise that spawning biomass can be calculated from estimates of the number of eggs produced per day in the spawning area (daily egg production) and the number of eggs produced per unit mass of population (daily fecundity).

A number of independent research methods have been employed throughout the world to assess the biological status and determine exploitation rates for Clupeoid fisheries. Methods that have been used to estimate the relative or absolute abundance of stocks of small pelagic fishes in Australia and New Zealand include: visual surveys from boats and aeroplanes (e.g. Blackburn 1950); pelagic trawl surveys (Collins and Barron 1981; Stevens et al. 1984; Zmiyevskiy in Fletcher 1991); hydroacoustic surveys using echo-sounders and sonar (Rapson 1953); various mathematical models (e.g. Fletcher 1992); and egg surveys (Fletcher et al. 1996).

Hydroacoustic survey methods have also been used extensively throughout the world to assess the biological status of Clupeoid stocks. In the last 20 years, the development of echo sounder and sonar technology has resulted in this method becoming a more accurate technique of assessing population abundance. Hydroacoustic survey techniques have not been applied in the South Australian Pilchard Fishery, as the initial cost of obtaining the equipment required to undertake the surveys is considered too significant to justify the benefits. However, future investigation of this technique and its application to the fishery may warrant its use as a method for estimating population abundance.

Due to the short life span and highly fecund nature of Clupeoid species, populations of these stocks are generally extremely variable. Consequently, classical fisheries models that rely on fishery-dependent data have not been considered appropriate for estimating stock abundance in the South Australian Pilchard Fishery. In addition, the reliance on historical catch and effort data, and the relative unsuitability for schooling pelagic species such as Clupeoids, has meant that classical fisheries models are not considered appropriate for the South Australian Pilchard Fishery. However, the application of an age-structured model that has been developed by SARDI as part of an FRDC project will continue to be investigated as a predictive management tool for providing an estimate of pilchard abundance.

Based on the assessment of the application of other fishery independent stock assessment methods in the fishery, the DEPM method will continue to be utilised until such time as other

methods are considered to be more cost effective and/or provide a more accurate assessment of the status of the pilchard stock.

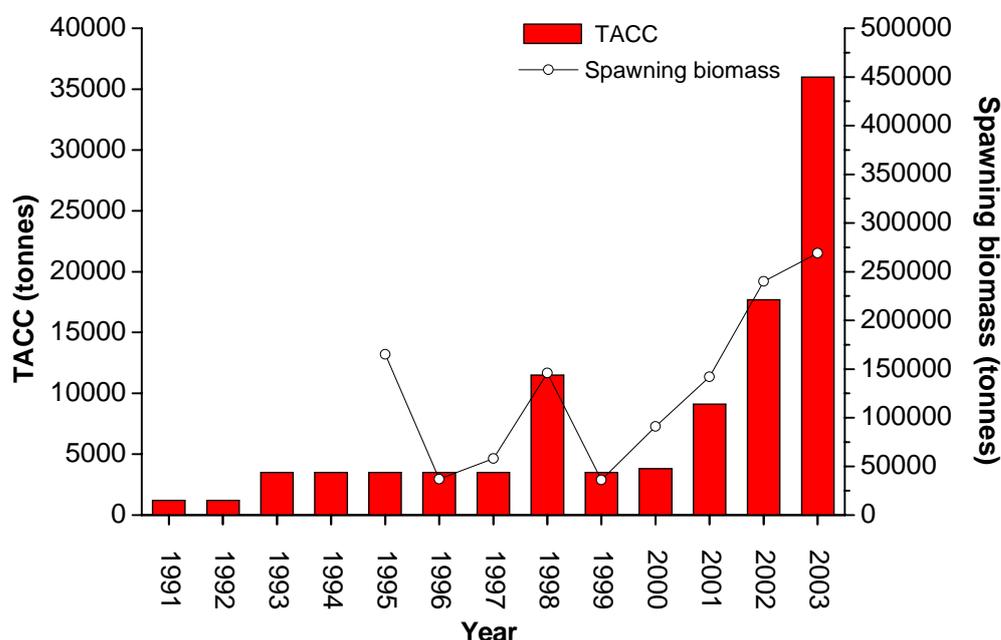


Figure 2: The TACC for the South Australian Pilchard Fishery between 1991 and 2003 and spawning biomass estimates undertaken by SARDI Aquatic Sciences between 1995 and 2003.

(Source: Rogers et al. 2004)

5.3 Annual Stock Assessment

In conjunction with the annual spawning biomass report, an annual stock assessment report is prepared on the fishery by SARDI. The stock assessment reports on catch and effort data, age and size structure, age and growth, reproductive biology and estimates of spawning biomass.

The report is designed to:

- Update and replace previous reports;
- Provide a comprehensive summary of catch and effort statistics for the fishery up to 31 December of the year prior to the release of the report;
- Summarise the findings of any recent research on pilchards; and
- To identify and assess potential harvest strategies for the fishery.

5.3.1 Catch and Effort data

Catch in the fishery has steadily increased since the early 1990s. The most notable declines in both catch and effort have occurred in 1995 and 1998 following the pilchard mass mortality events. In 1995 the mortality event killed over 75% of the adult stock (Ward et al. 1999; 2001). The stock recovered quickly with catches increasing to 6431 tonnes in 1998, when another mortality event (in October - November) again killed over 70% of the stock (Ward et al. 1999, 2001). Following the mass mortality event, effort and catch fell to 415 boat days and 3548 tonnes respectively (see figure 3). Since the mass mortality event in 1998 catches, as a result of increases in TACCs, have increased substantially (see figure 2).

In the case of schooling pelagic fishes, such as pilchards that undergo large inter-annual variation in abundance, CPUE is not considered to be a good index of abundance. However, CPUE has historically been reported on in stock assessments for the fishery as it illustrates catching efficiency and provides some indication of abundance.

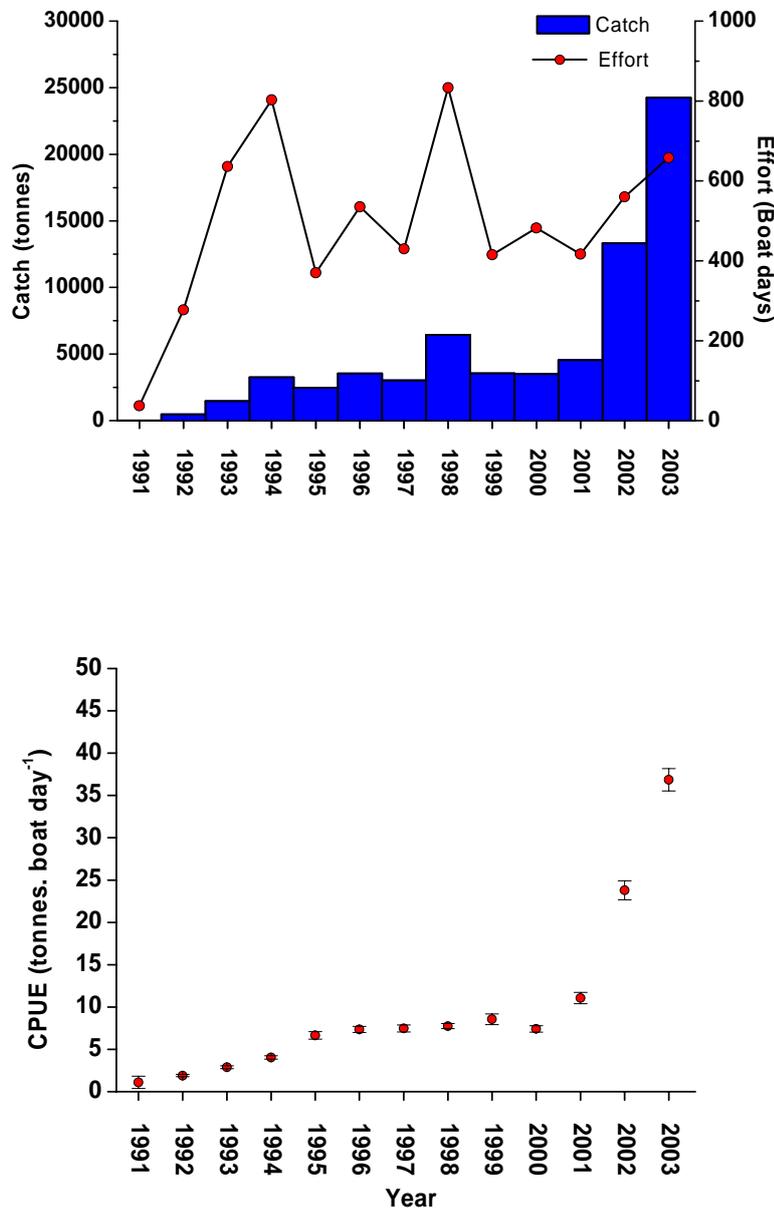


Figure 3: Trends in annual catch, effort and CPUE between 1991 and 2003.

(Source: Ward et al. 2003)

The annual stock assessment report on the fishery also provides historical information on catch and CPUE within months. This data illustrates the intra-annual catch patterns of catch, effort and CPUE. Peaks in catches have historically occurred between February and August (Rogers et al. 2004). It is suspected that during this period upwellings occur that cause fish to aggregate in inshore areas, therefore increasing their vulnerability to capture (see figure 4).

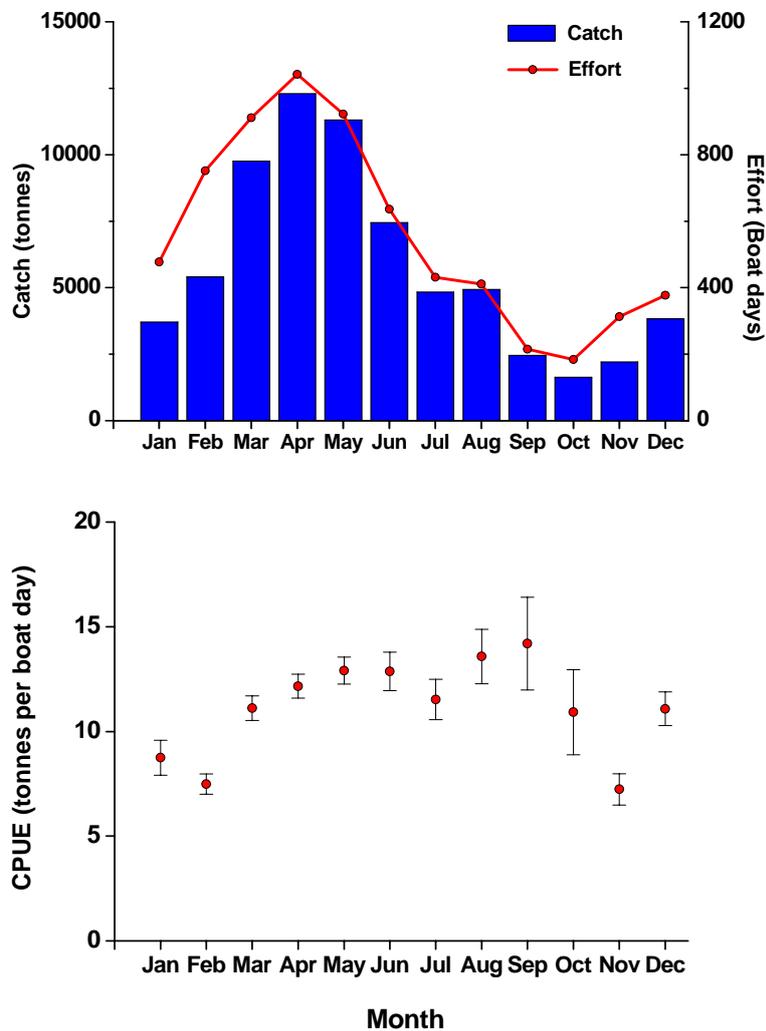


Figure 4: Trends in monthly catch, effort and CPUE between 1991 and 2003.

(Source: Rogers et al. 2004)

5.3.2 Reproductive parameters

Length frequency sampling of the catch is also undertaken for the purpose of establishing age and size structure of the population. This information is used to establish percentage age and size classes within the population. By understanding the strength of the age classes within the population, the ability for ongoing recruitment to be maintained is better understood. This is illustrated by the changes in the size and age relationships that occurred following the mass mortality events of 1995 and 1998, where only single age classes were present within the population (Ward et al. 2001).

The percentage presence of individual age classes also provides information concerning recruitment in the fishery. The population is considered to be more robust when there is a greater proportion of older and larger fish in the population as a larger number of eggs will be produced when fish spawn due to the exponential relationship between size and egg production.

Information on the percentage presence of age classes within the population is also a biological performance indicator for the fishery, as it provides a direct indication of the robustness of the stock.

Catch sampling will continue to be undertaken and used as a guide when assessing the stock, so that harvesting strategies can be determined on the basis of the annual strength of the population and the ability for ongoing recruitment to occur.

Reproductive biology is also reported on in the stock assessment for the purpose of reporting basic biological parameters that provide a guide for illustrating the ability of the stock to maintain ongoing recruitment (Ward et al. 2003b). The following reproductive biology parameters are reported:

- Length and age at first maturity;
- Sex ratio;
- Maturity stages; and
- Gonosomatic index.

These parameters vary seasonally and by location throughout the State. The ongoing monitoring enables months and individual years to be compared. While this information generally illustrates the ability of the stock to reproduce in sufficient quantities to sustain recruitment, it is considered that the continued monitoring of these parameters may lead to the ability to predict variation in stock abundance, particularly where extreme declines or increases occur.

The length and age at first maturity data, sex ratio and maturity stage data is obtained when undertaking length frequency catch sampling. While gonosomatic index is obtained by sampling a proportion of the catch within areas and on a monthly basis (Ward et al. 2003a).

5.3.3 Spatial Patterns

When the fishery first commenced in 1991, licence holders spent a large proportion of their fishing effort searching in Gulf St Vincent, around Kangaroo Island and off western Eyre Peninsula (Ward et al. 2003b). During the mid 1990s, the majority of fishing was undertaken in Spencer Gulf near Port Lincoln, while from 1996 to 1998 the Coffin Bay area became the principal fishing area (Ward et al. 2004a).

Since 1999 operations have centred predominately around the southern Spencer Gulf area, with catches progressing further north in Spencer Gulf over the period 2001 to 2003. These significant increases in catch are predominately a result of larger catches being available through the substantial increases in the TACC since 2001 (see figure 5).

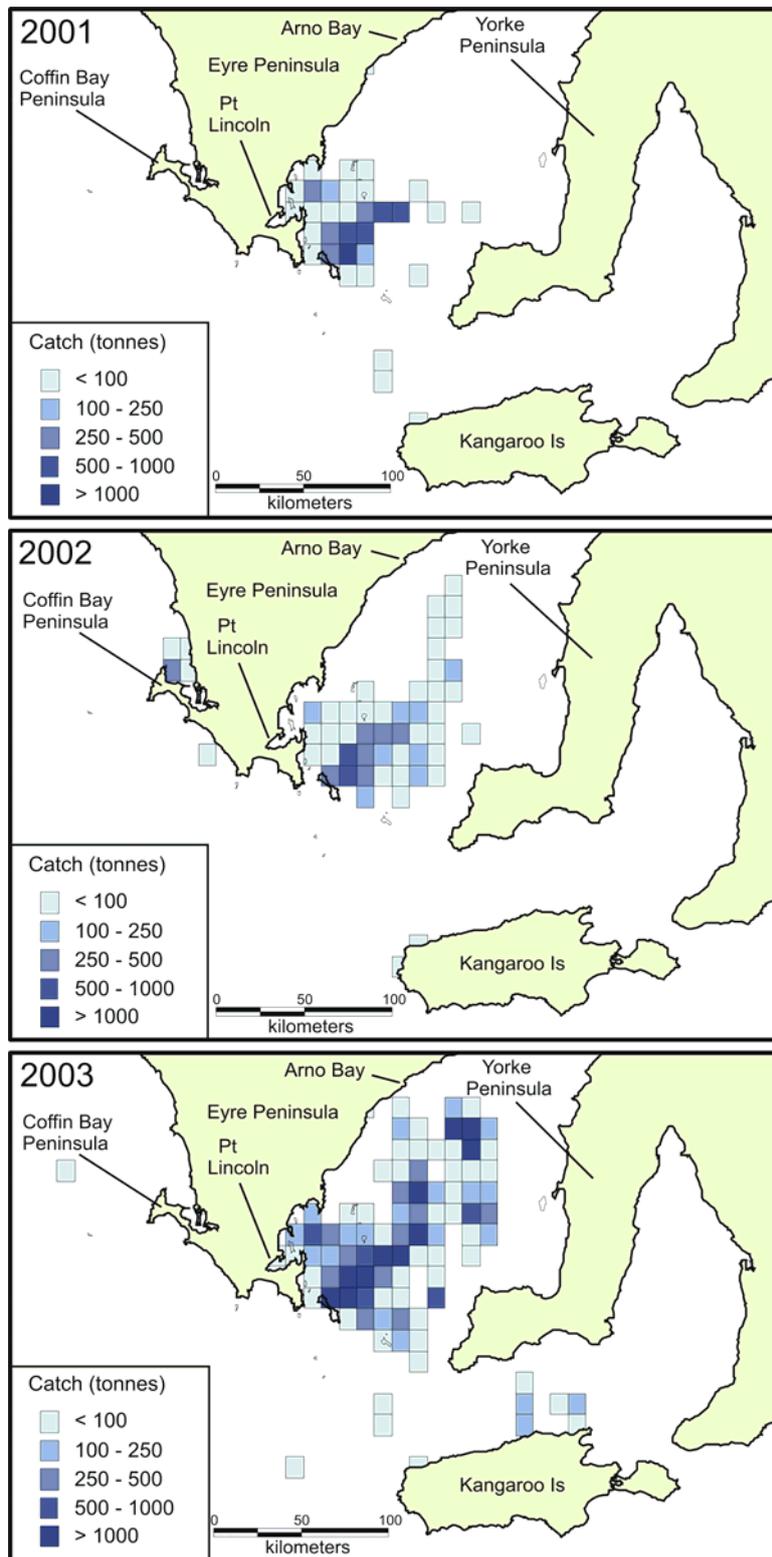


Figure 5: Spatial pattern of pilchard catches over the period 2001 to 2003.

(Source: Ward et al. 2004b)

5.4 Other bait species

Fisheries independent research on species other than pilchards (*Sardinops sagax*) that licence holders are permitted to take (i.e. species from the families Engraulididae and Clupeidae) is not currently undertaken. It is not considered that these species are harvested in sufficient numbers to suggest that commercial fishing activities are impacting on abundance. Until such time as catch

data from research logbooks illustrates that catches or effort on these species has increased independent research will not be undertaken.

As part of the process of assessing the South Australian Pilchard Fishery against the ‘*Guidelines for the ecologically Sustainable Management of Fisheries*’, pursuant to the EPBC Act the need to set annual Trigger Catch Limits (TCLs) for other bait species has been identified. These annual TCLs are:

- Anchovies – 150,000 kgs
- Bluesprats – 30,000 kgs
- Marays – 50,000 kgs

The TCL for individual species identifies the level of catch whereby management arrangements to limit the quantities of catch taken will be considered. These TCLs have been implemented in the event that incentive is created to target quantities of these species larger than historically taken (see table 9).

Catches of these other species are monitored through the SARDI research logbook. Table 9 illustrates the research logbook recordings of these other baitfish species from the families Clupeidae and Engraudae over the period 1999 to 2002. This information illustrates that no seasonal pattern in the catches of baitfish, other than pilchards has occurred over the period 1999 to 2002.

Table 4: Catches of bait species recorded in the Commercial fishing logbook from 1999 to 2002.

Year	Species (estimated kg's)			
	Anchovies	Bluesprats	Marays	Species other
1999	93,180	0	8,500	43,870
2000	610	1,000	19,300	0
2001	20,000	0	0	24,000
2002	7,500	0	0	9,000

(Source: Ward et al. 2003b)

5.5 Endangered and Protected species

Fishery independent sampling to quantify interactions with endangered and protected species commenced in January 2005. This program involves the placement of independent observers from SARDI aboard vessels in the fishery to establish if interactions with endangered and protected species are occurring, the types of interactions that may be occurring and the recurrence of these interactions.

This research will enable the recommendations in regard to endangered and protected species, pursuant to the Commonwealth EPBC Act to be addressed and actions taken where necessary (see section 2.4.3.).

Preliminary results from the observer program, released in August 2005, revealed some dolphin mortalities as a result of interactions with pilchard nets. The fishery was subsequently closed for a 4-week period, pending the finalisation of a industry Code of Practice to address interactions with endangered and protected species.

In September 2005, the fishery reopened subject to the ongoing monitoring of interactions with endangered and protected species through an independent observer program. An ongoing observer program to cover 10% of all fishing activities was introduced in August 2005.

Should observer coverage reveal that fishers are not complying with the Code of Practice and/or dolphin mortalities have occurred, further measures to prevent interactions with endangered and protected species in the fishery will be implemented, including spatial or temporal closures.

5.5.1 Code of Practice for Endangered and Protected Species

In September 2005 industry implemented a Code of Practice to avoid and/or minimise interactions with endangered and protected species. The Code of Practice details several measures to release endangered and protected species encircled within pilchard nets. These methods involve releasing sections of the net to enable endangered and protected species to move back into the water column unharmed. If these methods are unsuccessful the Code of Practice specifies that the pursued net will be opened to release endangered and protected species and any catch within the net.

The effectiveness of the Code of Practice in avoiding and/or minimising interactions with endangered and protected species will be monitored through the observer program. Through these observations the Code of Practice may be modified to improve its effectiveness.

Should specific methods adopted by fishers to avoid and/or minimise interactions with endangered and protected species prove to be effective, consideration may be given to legislating these measures.

6 ECOLOGICAL IMPACTS OF FISHING

No information specifically relating to the broader ecosystem impacts of pilchard fishing is currently available. However, as part of the SARDI research project “Assessing the Potential Ecological Effects of the South Australian Pilchard Fishery” specific research into the ecological effects of commercial pilchard fishing will be undertaken. As part of this study, further research will be conducted into the effect of changes in the abundance of pilchards on higher order predators.

Apart from the future research to be undertaken significant literature addressing the ecological role of Clupeoids in southern Australian waters has been written. This literature deals specifically with the ecological interactions with finfish, seabirds and mammals (e.g. Kemper and Gibbs 1997, Barker and Vestjens 1990, Smith 1993, Grove-Jones and Burnell 1990, Bertoni 1997 and Cappo 1987 a,b).

6.1 Fish and cephalopods

Pilchards, marays and anchovies are commonly eaten by a large number of predatory fishes and cephalopods (Ward et al. 1998). No published data are available on the quantity of baitfishes utilised by predatory fishes or the effects of prey depletion on stocks of predatory fish in Australian waters. However, considerable documentation is available in relation to the importance of baitfishes to higher order predators.

Murphy (1977) noted that piscine predators utilise a wide range of prey, which presumably buffers populations from the effects of inter-annual fluctuations in the abundance of baitfishes. However, in high latitudes the opportunities to switch prey may be limited as food webs are often simple and include relatively few species of small planktivorous fishes. Therefore, in the low diversity environments of southern and eastern Australia (e.g. South Australia) the depletion of Clupeoid stocks on predatory species may be most apparent (Ward et al. 1998).

Research has shown that juvenile southern bluefin tuna predominantly feed on Clupeoids (Sheard 1950; Serventy 1956; Young et al. 1997). Therefore, pilchard stocks are considered to be highly

significant for juvenile southern bluefin tuna that appear to migrate between the Great Australian Bight and the southern Indian Ocean, before finally moving to their spawning grounds off Indonesia. Research on the closely related northern bluefin tuna suggests that local abundance of that species may be positively correlated with the local abundance of pilchards. This information suggests that the same relationship may exist between juvenile southern bluefin tuna and pilchards in the waters adjacent to South Australia.

Aerial surveys in waters adjacent to South Australia show that areas in which Australia salmon are highly abundant coincide with areas where pilchards are highly abundant and spawn (Cappo 1987b). In addition, preliminary data on Australian salmon suggests that this species may consume approximately 13,500 tonnes of pilchards annually (Jones et al. 1997). This information suggests that a direct relationship exists between Australia salmon and pilchard populations. Dimmlich and Jones (1997) have also documented that in years where there are large numbers of sub-adult Australian salmon present in South Australian waters, stocks could be adversely affected by fishery-induced reductions in pilchard abundance.

Other research undertaken also illustrates that Clupeoids are an important component of the diets of arrow squid (*Nototodarus gouldii*), snook (*Sphyrana novahollandiae*), leather jackets (*Nelusetta ayrandi*) and barracouta (*Thyrsites atun*) (Ward et al. 1998).

6.2 Seabirds

Many of the 120 species of seabirds that occur in waters adjacent to South Australia feed on Clupeoids, but few data are available on the composition of their diets (Barker and Vestjens 1990, Smith 1993). The work undertaken suggests seabirds eat a variety of fish species. Observations suggest that the feeding preferences of most seabirds are related to prey size and prey type (e.g. Blaber et al. 1995). In terms of baitfish, the literature illustrates that small birds feed on small Clupeoids such as anchovies, sprats and juvenile pilchards, while larger birds (e.g. gannets, albatrosses etc) commonly feed on adult pilchards and round herrings (Ross et al. 1996).

Many overseas studies have identified the relationship between fluctuations in baitfish stocks and seabird populations (e.g. Furness and Cooper 1982; Duffy 1983; Tovar et al. 1987). However, no specific studies of the relationships between seabird and pilchard populations have been undertaken. Although, it has been identified by Ward et al. (1998) that such studies are particularly critical for little fairy penguin colonies in South Australia, as few quantitative data have previously been collected and there is a relative paucity of alternative prey species.

6.3 Mammals

A number of studies have identified that Clupeoids are an important part of the diets of seals, dolphins and whales (Shaughnessy et al. 1995; Kemper & Gibbs 1997; Crawford et al. 1992). The direct interactions with these mammals have not been quantified, however, anecdotal evidence exists to illustrate these ecological interactions.

Kearney et al. (2003) has highlighted a significant increase in seal numbers over the next 40 years, as simulated in models illustrating the change in population dynamics of species over time. This study suggests that pilchard populations may be effected by a significant increase in natural mortality, as a result of seal predation. However, quantification of the impact on pilchard populations remains untested, primarily due to the environmental variables that cannot be incorporated in the biological modelling (i.e. trophic interactions and species replacement) (Goldsworthy et al. 2002). As such, it is not considered that seal populations can continue to increase at an exponential rate, however consideration must be given to the results of the study and the ability of this change in population dynamics to impact on the pilchard biomass.

Shaughnessy et al. (1996) observed high pupping mortalities at the breeding colonies for New Zealand fur seals on Neptune and Kangaroo Islands, which may have resulted from the mass mortality of pilchards that occurred in 1995. Considerable research has been undertaken on the breeding colonies of Australian fur seals and Australian sea lions in the waters adjacent to South Australia. As part of this research the ecological effects of expanding pilchard fisheries is being monitored on an ongoing basis.

Studies of the gut contents of the common dolphin (*D. delphinus*) in South Australian waters suggests that cephalopods may be more commonly eaten than pilchards (Kemper and Gibbs 1997). Research undertaken in South Africa illustrated that the diet of the common dolphin is predominantly pilchards and anchovies (Crawford et al. 1992). It has been suggested that due to the opportunistic nature of these feeding habits the dependence of this species on pilchards is not significant.

In addition, dolphin mortalities have occurred as a result of commercial fishing activities (see section 5.5). These interactions will continue to be monitored to ensure broader ecosystem impacts do not occur through interactions with endangered and protected species.

Southern humpback and southern right whales have been observed feeding around schools of baitfish, but it is not known whether these whales were feeding on baitfish or plankton. Humpback whales have been observed feeding on schools of herring and capelin in the Northern Hemisphere (Baker et al. 1992). This information suggests that ecological interactions may be occurring, but they are yet to be quantified.

6.4 Impacts on the Physical Environment

Research into the impact of pilchard fishing operations on physical habitat has not yet been undertaken. Physical interactions do occur when purse seine nets are operated in waters shallower than the depth of the net.

Purse seine nets are not generally operated in waters shallower than the depth of the net as it is difficult to draw in the purse when hauled along the substrate and aggregations of pilchards have historically been located in waters greater than the depth of the net. As part of the FRDC project “Assessing the Potential Ecological Effects of the South Australian Sardine Fishery”, quantification of any interactions between purse seine nets and the benthos when undertaking pilchard fishing operations will be undertaken.

6.5 Water quality

The impacts of pilchard fishing on water quality are considered to be low due to the small number of vessels operating across South Australia relative to the geographic expanse of the fishing grounds. Industry is in the process of developing a code of practice that will address the disposal of waste at sea.

7 COMPLIANCE AND MONITORING

The compliance of quotas and other regulations is monitored by PIRSA Fishwatch. The strategic aim of PIRSA Fishwatch is “to achieve optimal levels of compliance by all fishers.”

Optimal compliance is that which holds the level of non-compliance at an acceptable level, which can be maintained at a reasonable cost for compliance services, whilst not compromising the integrity and sustainability of the fisheries resource.

7.1 Compliance Risk Assessment Model

To achieve a level of optimal compliance PIRSA Fisheries compliance activities are assessed using a risk assessment model. The risk assessment model has been established for the purpose of directing compliance effort towards identified risks in the fishery. Since adoption, this approach has proven to be successful as resources can be allocated to target identified illegal activity.

The annual risk assessment model process is as follows:

- A model illustrating specific compliance risks in the fishery and mitigation strategies to address these risks is developed by PIRSA Fisheries Compliance, against which the likelihood and probability of this occurring are ranked.
- The model is then provided to the PFWG for comment. Following comment from the committee the compliance effort directed at specific risks is apportioned based on the rankings received.

Since the instigation of the risk assessment model a number of compliance risks have historically been identified. These risks are:

- Quota evasion;
- Fishing in netting closure areas or aquatic reserves; and
- The taking of species other than pilchards.

The principal risk the assessment has identified annually since its inception is quota evasion. The CDR form underpins quota evasion in the fishery, which is the method of monitoring the actual take of pilchards against individual quota allocations and the TACC (see Appendix 1). The CDR form requires both the licence holder and the processor to verify the catch taken and the quantity of fish received respectively. This verification process provides the means for PIRSA Fisheries to monitor quota evasion.

Historically, incentive has not existed in the fishery to take quantities of pilchards greater than individual quota allocations, as the annual TACC has not been harvested in recent years. However, with larger vessels entering the fishery capable of taking significantly larger catches and the development of markets to take larger quantities of pilchards, compliance for preventing quota evasion is becoming an increasing priority.

A number of mitigation strategies to address quota evasions, which are reviewed on an annual basis, have been developed to address this risk. These strategies are as follows.

- Education programs relating to licence conditions/ requirements;
- The investigation of electronic data transfer opportunities;
- At sea and on land inspections of processors and licence holders;
- Targeted processor audits;
- Investigation into alternative methodologies for weighing of catch;
- Intelligence driven operations to investigate quota evasion; and
- The investigation of possible illegal activities.

8 REFERENCES

- Alheit, J. (1993). Use of the daily egg production method for estimating biomass of Clupeoid fishes: A review and evaluation. *Bull. Mar. Sci.* 53(2): 750 - 767.
- Baker, C.S., Straley, J.M. and Perry, A. (1992). Population characteristics of individually identified humpback whales in Alaska: summer and fall 1986. *Fish. Bull.* 90(3): 429 – 437.
- Barker, R.D. and Vestjens, W.J.M. (1990). *The food of Australian Birds*. CSIRO Div. Wild. And Ecol., Canberra.
- Bertoni, M. (1997). Fishery, reproductive biology, feeding and growth of the snook (*Sphyraenidae*: *Sphyraena novaehollandiae*) in South Australia. M. Appl. Sci (Fisheries) Unpublished Thesis, Australian Maritime College, Tasmania. 126pp.
- Blaber, S.J., Milton, D.A., Smith, G.C. and Farmer, M.J. (1995). Trawl discards in the diets of tropical seabirds of the northern Great Barrier Reef. *Mar. Ecol. Prog. Ser.* **127**: 1 –13.
- Blackburn, M. (1950). Studies on the age, growth, and life history of the sardine *Sardinops neosardineus* (Steindachner), in Southern and Western Australia. *Aust. J. Mar. Freshw. Res.* 1: 221 - 258.
- Cappo, M.C. (1987a). The biology and exploitation of Australian salmon in South Australia. *SAFISH* 12(1). 4 –14.
- Cappo, M.C. (1987b). The fate and fisheries biology of sub-adult Australian salmon in South Australian waters. FIRTA Report 84/75 162pp.
- Collins, S.P. and Barron, M.P. (1981). Demersal and pelagic trawling survey of the MT “Denabola” in southern Australian waters, 1979 – 80. *Tasm. Fish. Res.* 24:1-48.
- Commonwealth of Australia (1992). *The National Strategy for Ecological Sustainable Development*. Canberra: AGPS.
- Crawford, R.J.M., Underhill, L.G., Raubenheimer, C.M., Dyer, B.M., and Martin, J. (1992). Top predators in the Benguela ecosystem – implications of their trophic position. *Benguela Trophic Functioning.* **12**: 675 –687.
- DAFF (1999). Bycatch (National Policy). <http://www.affa.gov.au> [Electronic reference.]
- Dimmlich, W.F. and Jones, G.K. (1997) Australian salmon and Australian herring. Fisheries Assessment Report to PIRSA for the Marine Scalefish Fishery. South Australian Fisheries Assessment Series 97/08. 34pp.
- Duffy, D.C. (1983). Environmental uncertainty and commercial fishing: effects on Peruvian guano birds. *Biol. Conservation.* 26(3): 227 – 238.
- FAO (2000). *Code of Conduct for Responsible Fisheries*. Rome: Food and Agricultural Organisation of the United Nations.
- Fletcher, W.J. (1991). A synopsis of the biology and exploitation of the Australian sardine, *Sardinops neoplichardus* (Steindachner) Part II: History of stock assessment and exploitation. *Fish. Res. Rep. West. Aust.* 91: 1 - 55.

- Fletcher, W.J. and Tregonning, R.J. (1992). Distribution and timing of spawning by the Australian sardine (*Sardinops sagax neosardineus*) off Albany, Western Australia. *Aust. J. Mar. Freshw. Res.* 43: 1437 - 1449.
- Fletcher, W.J., Lo, N.C.H., Hayes, E.A. Tregonning, R.J., Blight, S.J. (1996). Use of the daily egg production method to estimate the stock size of Western Australian sardines, *Sardinops sagax*. *Mar. Freshw. Res.* 47 (6): 819-825.
- Fletcher, A. J., Chesson, J., Fisher, M., Sainsbury, K. J., Hundloe, T., Smith, A. D. M & Whitworth, B. (2002). *National ESD Reporting Framework for Australian Fisheries: The how to "Guide for Wild Capture Fisheries"*. FRDC Project No. 2000/145.
- Furness, R.W. and Cooper, J (1982). Interactions between breeding seabird and pelagic fish populations in the southern Benguela region. *Mar. Ecol. Prog. Ser.* 8(3): 243-250.
- Goldsworthy, S.D., Bulman, C., Xi, H., Larcome, J and Littman, C. (2002). Trophic interactions between marine mammals and Australian fisheries: An ecosystem approach. Draft Chapter for book "Trophic Interactions Between Fisheries and Marine Mammals".
- Grove-Jones, R.P and Burnell, A.F. (1990). Oceanjacket traps assessed. *SAFIC* 15(1):10-11.
- Jones, J.B., Hyatt, A.D., Hine, P.M., Whittington, D.A., Griffin, D.A., and Bax, N.J. (1997). Special Topic Review: Australasian Pilchard Mortalities. *Wo. Jo. Micro. Biotech*, 3: 383-392.
- Kearney, B., Foran, B., Poldy, F., Lowe, D. (2003). Modelling Australia's Fisheries to 2050: Policy and Management Implications. Fisheries Research and Development Corporation, 27-28.
- Kemper, G.M. and Gibbs, S.E. (1997). A study of life history parameters of dolphins and seals entangled in tuna farms near Port Lincoln, and comparisons with information from other South Australian dolphin carcasses. Unpublished Report to Environment Australia (Australian National Conservancy Agency). 49pp.
- Lasker, R. (1985). An egg production method for estimating spawning biomass of pelagic fish: application to northern anchovy, *Engraulis mordax*. *NOAA Tech. Rep. NMFS*, 36: 1 – 99.
- Mackie, D.W. (1991). A Management plan for the Experimental Pilchard Fishery. South Australian Fisheries Management Series, Paper number 13. pp 2-3.
- Murphy, G.I. (1977). Clupeoids. (pp 283-308). In: Gulland, J. A. (ed). *Fish Population Dynamics*. John Wiley, London.
- Parker, K. (1985). Biomass model for the egg production method. In: An egg production method for estimating spawning biomass of pelagic fish: application to northern anchovy, *Engraulis mordax*. *NOAA. Tech. Rep. NMFS*, 36: 5 - 6.
- Rogers, P.J., Stephenson, P., McLeay, L. J, Dimmlich, W. F. and Ward, T. M. (2004). Fishery Assessment Report – Sardine (*Sardinops sagax*). SARDI Aquatic Sciences. Final report to PIRSA Fisheries. pp15-25.
- Rapson, A.M. (1953). Pilchard shoals in south-west Australia. *Aust. J. Mar. Freshwat. Res.* 4:234-249.

- Ross, G.J.B., Weaver, K. and Greig, J.C. (1996). *The Status of Australia's Seabirds*. Proceedings of the National Seabird Workshop, Canberra. 236pp.
- Serventy, D.L. (1956) The southern bluefin tuna, *Thunnus thynnus maccoyii* (Castlenau) in Australian waters. *Aus. J. Mar. Freshwater Res.* 7: 1 – 43.
- Shaughnessy, P.D., Goldsworthy, S.D. and Libke, J.A. (1995). Changes in abundance of New Zealand fur seals, *Arctocephalus forsteri*, on Kangaroo Island, South Australia. *Will. Res.* 22:201-215.
- Shaughnessy, P.D., Dennis, T. and Seager, P. (1996). Abstract to Australian Wildlife Management Society.
- Sheard, K. (1950). Factors in the behaviour of pelagic fish shoals in South Australia and New South Wales. *CSIRO Div. Of Fisheries Bull.* 251: 72 –74.
- Smith, G.C. (1993). Feeding and breeding on crested terns at a tropical locality – comparison with sympatric black-naped terns. *Emu.* 93:65-70.
- Stauton Smith, J and Ward, T.M. (1998). Estimates of the 1997 Spawning Biomass of Sardines (*Sardinops sagax*) in Southern Queensland. QDPI Report. 15p.
- Stevens, J.D., Hausfeld, H.F. and Davenport, S.R. (1984). Observations on the biology, distribution and abundance of *Trachurus declivis*, *Sardinops neoplichardus* and *Scomber australasicus* in the Great Australian Bight. *CSIRO Marine Laboratories Rep.* 164.
- Tovar, H., Guillen, V. and Nakama, M.E. (1987). Monthly population size of three guano bird species off Peru, 1953 to 1982. (p. 208-233). In: Pauly, D. and Tsukayama, T. (Eds) *The Peruvian Anchovetta and its Upwelling Ecosystem: Three Decades of Change*. ICLARM Studies and Reviews 15.
- Ward, T.M., Kinloch, M., Jones G.K., and Neira, F.J. (1998). A Collaborative Investigation of the Usage and Stock Assessment of Baitfish in Southern and Eastern Australian Waters, with Special Reference to Sardines (*Sardinops sagax*). Final Report to FRDC. 324 pp.
- Ward, T.M., Westlake, M., McLeay, L.J. and Jones, J.K. (1999). Pilchard Mortality Events in South Australia. Final report to the Joint Scientific Pilchard Working Group. 41p.
- Ward, T.M., Hoedt, F.E., McLeay, L.J., Dimmlich, W.F., Kinloch, M.W., Jackson, G., McGarvey, R., Rogers, P.J., and Jones, K. (2001). Effects of the 1995 and 1998 mass mortalities on the spawning biomass of *Sardinops sagax* in South Australia. *ICES. J. Mar. Sci.* 58(4): 830-841.
- Ward, T.M., McLeay, L.J., Rogers, P.J. and Dimmlich, W.F. (2003a). Spawning Biomass of Sardine (*Sardinops sagax*) in South Australia in 2003. SARDI Aquatic Sciences Publication No. RD/03/0195.
- Ward, T.M., Rogers, P.J., McLeay, L.J., Schmarr, D. and Dimmlich, W.F. (2003b). Fishery Assessment Report – Sardine (*Sardinops sagax*). SARDI Aquatic Sciences. Final report to PIRSA Fisheries. pp10-30.
- Ward, T.M., McLeay, L.J. and McClatchie, S. (2004a). Spawning Biomass of Sardine (*Sardinops sagax*) in South Australia in 2003. SARDI Aquatic Sciences. Report to PIRSA Fisheries. pp 12-32.

- Ward, T.M., Simon, D.G and Page, B. (2004b). Trophodynamics of the GAB: assessing the need for an Ecological allocation in the SA Pilchard Fishery. SARDI Aquatic Sciences. Final report to the Fisheries Research and Development Corporation (FRDC). 25p.
- White, K.V. and Fletcher, W.J. (1996) Identifying the developmental stages for eggs of the Australian sardine, *Sardinops sagax*. Fisheries Western Australia. Fisheries Research Report No. 103.
- Young, J.W., Lamb, T.D., L, S.D., Bradford, R.W. and Whitelaw, A.W. (1997) Feeding ecology and inter-annual variations in diet of southern bluefin tuna, *Thunnus maccoyii*, in relation to coastal and oceanic waters off eastern Tasmania, Australia. *Env. Biol. Fishes.* 50: 275 – 291.

APPENDIX 1: Catch Disposal Record Form

PF CDR

PRIMARY INDUSTRIES (S.A.) FISHERIES PILCHARD CATCH AND DISPOSAL RECORD

Prior Report No.

Estimated weight reported

PART A

Vessel Name:

Licence Number:

Time of Unloading: : am/pm

Date of Unloading: / /

Port or Location of Unloading:

Does this CDR represent the entire catch landed: YES/ NO PLEASE CIRCLE

If NO, associated CDR no's:

Name of Receiving Processor:

Measured Total Weight: kgs

Method used:

PF TF no's associated with this catch:

I certify that the information recorded on Part A of this form is true and correct.

Signature of Licence Holder or Registered Master: _____

Print Full Name: _____

Date: ____/____/____ Time: _____ am/pm.

To be completed by licence holder or registered master immediately on completion of unloading and forwarded (PART A ONLY) to PIRSA Fishwatch, PO Box 282 Port Adelaide 5015, within 24 hours of unloading.

PART B

Name of Registered Fish Processor: _____

Address of Premises or name of Carrier
Vessel Delivered to: _____

Accurate Weight of Pilchards: KGS

Approved Method used:

PF TF Numbers Received:

I Certify that the weight recorded on Part B of this form is true and correct.

Signature of Registered Processor: _____

Print Full Name: _____

Processor/Farm Number: _____ Date: ____/____/____ Time: _____ am/pm.

To be completed by the Registered Fish Processor and delivered to PIRSA Fishwatch, PO Box 282 Port Adelaide, 5015 within 7 days of taking delivery of Pilchards. Green copy required.

APPENDIX 2: Glossary

Age structure A breakdown of the different age groups within an individual population, or population sample.

Allocation Distribution of the opportunity to access fisheries resources, within and between stakeholder groups.

Aquatic reserve An area of water, or land and water, established as an aquatic reserve by proclamation under the *Fisheries Act 1982* and managed for the protection of aquatic habitat.

Biodiversity The variability among living organisms from all sources (including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part) and includes diversity within species, between species and of ecosystems.

Biomass The total weight or volume of individuals in a fish stock.

Boat limit The maximum number of a species that can be legally retained on a boat per day or per fishing trip, as specified.

By-catch In the South Australian Pilchard Fishery, by-catch refers to the living and non-living component of the catch that is not targeted and discarded. Includes that part of the catch that is not landed but is killed as a result of interactions with fishing gear.

By-product The component of the catch that is not targeted and retained because it has commercial value to the fisher.

Catch The total amount (weight or number) of a species captured from within a specified area over a given period of time. Includes any animals that are released or returned to the water.

Catch per unit of effort (CPUE) The weight or number of a species caught by a specified amount of effort. Typically, effort units are defined using a combination of the following factors: gear type; gear size; the amount of gear; the amount of time the gear is used; and the number of people operating the gear. CPUE is often used as an index of relative abundance in fisheries stock assessment. In modern assessments, CPUE is standardised to account for the diverse range of factors that can affect CPUE.

Closures Prohibition of fishing during particular times or seasons (temporal closures) or in particular areas (spatial closures), or a combination of both.

Co-management Arrangements between governments and stakeholder groups to allow joint responsibility for managing fisheries resources on a cooperative basis. Co-management arrangements can vary from consultative where co-managers have an advisory capacity, to informative where co-managers have decision-making powers.

Commercial fishing Fishing undertaken for the purposes of trade or business, where the catch is sold for financial gain.

Common property resource A resource that is determined to be owned by the community, or by the State on behalf of the community, and to which no individuals or user groups have exclusive access rights.

Discards The component of the catch that is released or returned to the water after capture.

Ecologically sustainable development Using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased.

Ecologically viable stock Refers to the maintenance of the exploited population at high levels of abundance designed to maintain productivity, provide margins of safety for error and uncertainty and maintain yields over the long term in a way that conserves the stocks role and function in the ecosystem.

Economic efficiency The maximisation of the value of the net benefits derived from fishery resources.

Ecosystem A dynamic complex of plant, animal, fungal, and microorganism communities and the associated non-living environment interacting as an ecological unit.

Effective fishing effort Measures of fishing effort that have been standardised so that the measure is proportional to the fishing mortality rate that the gear(s) impose on the stock of fish (e.g. 'hooks per day of fishing'). Management measures to limit effective effort imply that the fishing mortality rate is to be limited.

Effort The amount of fishing taking place, usually described in terms of gear type and frequency or period during which the gear is in use (e.g. 'hook-sets,' 'trawl-hours,' 'searching hours').

Exploitation rate Applied to a fish stock, it is the fraction of the fishable biomass removed by fishing. An exploitation rate of 0.1 indicates that 10% of the available stock is being harvested within the time frame considered (per year, month, etc.). As a measure of fishing pressure, it is proportional to fishing mortality.

Fish stock The living resources in the community or population from which catches are taken in a fishery.

Fishery A term used to describe the collective enterprise of taking fish. Usually defined by a combination of the species caught (one or several), the gear and/or fishing methods used, and the area of operation.

Fishery-dependent data Information collected about a fishery or fish stock by the participants of a fishery, e.g. catch and effort information from fishery log sheets.

Fishery-independent data Information collected about a fishery or fish stock by researchers, independent of the fishery, e.g. scientific surveys, observer reports.

Fisheries Management Committee (FMC) A statutory advisory body established by the Minister to provide a stakeholder forum for consideration of management issues relevant

to a specific fishery. Fisheries Management Committees are designed to allow for stakeholder input to fisheries management.

Fishing effort The amount of fishing gear of a specific type used on the fishing grounds over a given unit of time, e.g. number of shots (number of times pilchard nets were deployed).

Fishing mortality The proportion of the stock removed as part of commercial and/or recreational fishing activities on the stock.

Fully exploited Describes a fish stock for which current catches and fishing pressure are close to optimum (the definition of which may vary between fisheries; for example, catches are close to maximum sustainable yield). Categorising a species as ‘fully fished’ suggests that increasing fishing pressure or catches above optimum (allowing for annual variability) may lead to overfishing.

Gear restriction A type of input control used as a management tool to restrict the amount and/or type of fishing gear that can be used by fishers in a particular fishery.

Habitat The place or type of site in which an organism naturally occurs.

Harvest The total number or weight of fish caught and retained from an area over a period of time.

Harvest strategy A plan, under input or output control, for working out how the allowable catch from a stock will be calculated each year (e.g. as a constant proportion of the estimated biomass).

Input controls Limitations on the amount of fishing effort; restrictions on the number, type, and size of fishing vessels or fishing gear, or on the fishing areas or fishing times in a fishery.

Limited entry Fishing effort is controlled by restricting the number of operators/participants. It usually requires controlling the number and size of vessels, the transfer of fishing rights, and the replacement of vessels.

Logbook An official record of catch and effort data made by fishers.

Management objective A target that is actively sought and provides a direction for management action.

Marine park An area of water, or land and water, considered to be of national significance because of the aquatic flora or fauna of those waters or the aquatic habitat, and established as a marine park by proclamation under the *Fisheries Act 1982*.

Marine protected area An area of land and/or sea especially dedicated to the protection and maintenance of biological diversity and of natural and associated cultural resources, and managed through legal or other effective means.

Maximum sustainable yield The highest theoretical equilibrium yield that can be continuously taken (on average) from a stock under existing (average) environmental conditions without affecting significantly the reproduction process.

Mortality Rate of deaths (usually in terms of proportion of the stock dying annually) from both fishing activities on the stock and environmental causes.

Non-target species Species that are unintentionally taken when undertaking fishing activities.

Offshore Constitutional Settlement (OCS) An agreement between the State(s) and the Commonwealth whereby the State or the Commonwealth or both (Joint Authority) determine the management jurisdiction for a species, gear type or fishery (the take of a specie or species by a particular gear type) within the Australian Fishing Zone (AFZ). Where no OCS agreement exists, the management jurisdiction for a species remains with the State out to the 3 nm baselines, and the Commonwealth from the 3 nm baselines out to the 200 nm limit of the AFZ.

Output controls Limitations on a tradeable commodity within a fishery (i.e. catch, net length, fishing days or a combination of these inputs).

Over-exploited (or overfished) A fish stock that is exploited beyond that limit which is believed to be sustainable in the long term and beyond which there is an undesirably high risk of stock depletion and collapse. The limit may be expressed, for example, in terms of a minimum biomass or a maximum fishing mortality, beyond which the resource would be considered to be over-exploited.

Overfishing Can be defined in two ways which can act independently or concurrently: (1) 'recruitment overfishing,' where fishing activities are causing a reduction in recruitment in succeeding years and cause the mortality of too many fish in total, too many pre-productive fish, or too many fish that have only spawned a few times; and (2) 'growth overfishing,' where fishing activities lead to a reduction in the size of the individuals of a species, as a consequence of which few specimens grow to the size for optimum yield.

Performance indicator A specific state, or variable, which can be monitored in a fishery to give a measure of the state of the fishery at any give time. In fisheries management, each performance indicator would be linked to one or more reference points and used to track the state of the fishery in relation to those reference points.

Population A group of individuals of the same species, forming a breeding unit and sharing a habitat.

Precautionary approach An approach that applies the precautionary principle.

Precautionary principle This principle asserts that where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing measures to prevent environmental degradation. In the application of the precautionary principle, public and private decision-making should be guided by: (1) careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment; and (2) an assessment of the risk-weighted consequences of various options.

Quota A limit on the weight or number of fish that may be caught in a particular stock or area.

Recruitment The addition of new individuals to a stock.

Retained The component of the catch that are kept and not discarded.

Seasonal closure The closure of a fishing ground for a defined period of time often used as a tool by fisheries managers to protect a stock during a spawning season.

Selectivity The ability of a type of gear to target and catch a certain size or species of fish.

Size limits A minimum or maximum size limit determines the legal size at which a given species can be retained.

Size of maturity Length or weight of the fish at which 50% of the group, population or stock of a species have attained reproductive maturity.

Socio-economic Relating to both social and economic considerations.

Spatial Relating to an area or space, often used in seasonal closure arrangements or spatial closure arrangements to protect fish stocks.

Spawning Biomass That proportion or numbers within a stock that are capable of reproducing.

Species A group of organisms capable of interbreeding freely with each other but not with members of other species.

Stakeholder An individual or a group that has an interest in a resource and its use.

Stock In the strict sense, a distinct, reproductively isolated population. In practice, a group of individuals of a species occupying a defined spatial range independent of other groups of the same species, which can be regarded as an entity for management or assessment purposes.

Stock assessment A relatively detailed and comprehensive analysis of stock status (catch and effort, abundance, distribution, age structure, etc.) to support the management of the species/fishery.

Sustainable use The use of components of biological diversity in a way and at a rate that does not lead to their long term decline, thereby maintaining their potential to meet the needs and aspirations of present and future generations.

Target species The most highly sought component of the catch taken by fishers.

Temporal Of or relating to time.

Threatened A species or community that is vulnerable, endangered or presumed extinct.

Total Allowable Catch (TAC) That proportion (weight or number) of a species that may be taken by the commercial and recreational sector within a given timeframe (usually relates only to the commercial sector).

Total Allowable Commercial Catch (TACC) That proportion (weight or number) of a species that may be taken by the commercial sector within a given timeframe.

Trigger Catch Limits (TCLs) A level of catch that once exceeded in an individual species management arrangements for that species need to be considered.

Uncertain A fish stock that may be underfished, fully fished or overfished, but for which there is inadequate or inappropriate information to make a reliable assessment of its status.

Under-exploited (or underfished) A fish stock that has the potential to sustain catches higher than those currently taken.

Yield The amount of biomass or the number of units that can be harvested currently in a fishery without compromising the ability of the population/ecosystem to regenerate itself.

Appendix 3: Acronyms

	Meaning
ATBOA	Australian Tuna Boat Owners Association
CPUE	Catch per Unit of Effort
DEPM	Daily Egg Production Method
EPBC	Environment Protection and Biodiversity Act
FMC	Fisheries Management Committee
FRDC	Fisheries Research and Development Corporation
PFWG	Pilchard Fishery Working Group
PIRSA	Primary Industries and Resources South Australia
SAFIC	South Australian Fishing Industry Council
SARDI	South Australian Research and Development Institute
SARFAC	South Australian Recreational Fishing Advisory Council
SBT	Southern Bluefin Tuna
SMC	Scalefish Management Committee
TACC	Total Allowable Commercial Catch
TCLs	Trigger Catch Limits