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Informing the review of the Commonwealth Policy on Fisheries Bycatch through assessing trends in bycatch of key Commonwealth fisheries

Tuck, G.N., Knuckey, I. and Klaer, N.L.

FRDC 2012/046 May 2013

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FISHERIES RESEARCH & DEVELOPMENT CORPORATION

Australian Government
Department of Sustainability, Environment, Water, Population and Communities
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FRDC Project: 2012/046

Date: May 2013

Author: Tuck, Geoffrey N. (Geoffrey Neil), author.

Title: Informing the review of the Commonwealth Policy on Fisheries Bycatch through assessing trends in bycatch of key Commonwealth fisheries / G.N. Tuck, I. Knuckey and N. L. Klaer.

ISBN: 9781922173300 (paperback)

Subjects: Bycatches (Fisheries)--Monitoring--Australia. Fisheries--Monitoring--Australia.

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CSIRO, issuing body

Dewey Number: 639.20994

Preferred way to cite this report: Tuck G.N., Knuckey, I. and Klaer, N.L. 2013. Informing the review of the Commonwealth Policy on Fisheries Bycatch through assessing trends in bycatch of key Commonwealth fisheries. Fisheries Research and Development Corporation final report 2012/046. 240p.

Cover photographs: Front cover photograph of shy and white-capped albatross, and back cover photograph of shy albatross kindly provided by Rachael Alderman (DPIPWE). Photographs of CTS trawl catch kindly provided by Ian Knuckey (Fishwell Consulting).

CONTENTS

GLOSSARY

These definitions have been taken from the Commonwealth Policy on Fisheries Bycatch (2000) unless stated otherwise in the chapters.

Bycatch

> That part of a fisher's catch which is returned to the sea either because it has no commercial value or because regulations preclude it being retained, and that part of the catch that does not reach the deck of the fishing vessel but is affected by interaction with the fishing gear.

Discards

> That part of the unintended catch that is returned to the sea.

Byproduct

> That part of the unintended catch that is kept or sold by the fisher

Note that discards may include species of commercial value that have been discarded due to market reasons.

1 NON-TECHNICAL SUMMARY

2012/046 Informing the review of the Commonwealth Policy on Fisheries Bycatch through assessing trends in bycatch of key Commonwealth fisheries

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OBJECTIVES:

1. Document changes in Commonwealth fisheries relevant to bycatch.
2. Collate and synthesise all available bycatch data for Commonwealth fisheries.
3. Analyse and report on trends in bycatch rate, total bycatch and catch composition.

NON TECHNICAL SUMMARY:

OUTCOMES ACHIEVED

To provide a means of evaluating changes in bycatch over the last 10 years and inform the current review of the Commonwealth Policy on Fisheries Bycatch, an examination of the existing data is required, together with a description of the changes that have occurred in each fishery that specifically (or indirectly) relate to bycatch. This report provides background information on the existing data on bycatch from key Commonwealth fisheries. The fisheries considered are the Southern and Eastern Scalefish and Shark Fishery (SESSF), the Northern Prawn Fishery (NPF), Sub-Antarctic Fisheries, the Coral Sea Fishery (CSF), the Eastern Tuna and Billfish Fishery (ETBF) and the Small Pelagic Fishery (SPF). Outcomes achieved include the documentation of the data collected, the bycatch management processes that have been put in place and the temporal trends in observations of bycatch and bycatch composition.

A number of measures have recently been introduced to reduce bycatch and discards from Australia's Commonwealth fisheries – these include fishery closures to help protect Australian sea lions and Gulper sharks, seabird mitigation measures for longline and trawl fisheries, various seal, turtle and general bycatch reduction or exclusions devices, and gear changes to reduce fish bycatch. Data suggest that these measures have, to varying degrees, reduced bycatch and/or discards. In some cases data availability or precision are either insufficient to make reasonable judgments about the influence of measures on changes in bycatch, or it may simply be too early to quantify the effectiveness of bycatch measures. In addition, there are difficulties in estimating catches and bycatch rates for rarer species/groups when, for economic reasons, observer coverage has been set at levels optimised for information on commercial target species. Fortunately, this issue has reduced in recent years with a greater focus on obtaining better estimates of the catch of bycatch, TEP and high risk species. Statistical analyses will be necessary to ensure the data and results are interpreted appropriately.

The purpose of this report is to inform the review of the Commonwealth Policy on Fisheries Bycatch. In March 2012, the Minister for Agriculture, Fisheries and Forestry, announced the review of the Commonwealth Policy on Fisheries Bycatch, with the aim of improving the management of bycatch in Commonwealth fisheries. An important need of the review is an understanding of the data that have been collected, and whether these data provide an indication of the effectiveness of measures put in place to reduce bycatch. For each of the key Commonwealth fisheries, this report describes the bycatch arrangements and summarises the available data on bycatch species, and, where appropriate, the trends in bycatch or discards over time.

There are a number of definitions of bycatch, but for the purposes of this report, unless stated otherwise, the definition will follow that of the Commonwealth Policy on Fisheries Bycatch (2000). Bycatch is defined as 'that part of a fisher's catch which is returned to the sea either because it has no commercial value or because regulations preclude it being retained, and that part of the catch that does not reach the deck of the fishing vessel but is affected by interaction with the fishing gear'. Species of commercial value that have been discarded due to, for example, market reasons or a lack of available quota, are also summarised in this report, although they are not considered bycatch under some definitions. Bycatch species may include fish, crustaceans, sharks, molluscs, marine mammals, reptiles and birds. Habitats and communities are also important elements to be considered, but are beyond the scope of this review. The data summarised include total catch (logbook records of target and non-target species), effort, catch composition, on-board observations and scientific surveys. The key Commonwealth fisheries considered are the Eastern Tuna and Billfish Fishery (ETBF), the Northern Prawn Fishery (NPF), the Small Pelagic Fishery (SPF), the Antarctic Fisheries, the Coral Sea Fishery (CSF) and the Southern and Eastern Scalefish and Shark Fishery (SESSF).

Care should be taken when interpreting bycatch results presented in this report. Temporal changes in levels of bycatch alone should not be interpreted as an indication of changes in either fishing practices or in animal population size. Due to differences in the magnitude of annual observation effort by gear, season, area, or even species focus, trends in the numbers of raw observations of bycatch can be misleading. In addition, scaling up of bycatch observations to a fishery-wide estimate of total bycatch should only be done using appropriate statistical methods. Fishery indicators such as a bycatch rate should also be interpreted with caution, as a decrease in bycatch rate, for example, may either be due to a decrease in susceptibility to the gear or a decrease in population abundance. These two interpretations of changes in bycatch rate have dramatically different implications for management. An example of this has occurred in the SESSF where increases in discarding in the mid 1990s and early 2000s were related to large and episodic increases in the population of small blue grenadier and did not reflect a change in fishing practices. Similarly, recent increases in bycatch of unicorn icefish and grey rock cod in the Heard Island and McDonald Islands Fishery are believed to be due to increases in the population size of these fish, not a change in gear selectivity. While full quantitative assessments of the impact of fisheries-related mortality on non-target species are generally impractical for all but the most data-rich species, alternative methods and indicators, such as those proposed by the ERA process, have been adopted to assess data-poor non-target species and these continue to be utilised by AFMA to assess the environmental credentials of their fisheries.

Observer coverage has been variable across Commonwealth fisheries, with historically valuable and high profile (due to potential interactions with high risk species) fisheries such as the Antarctic Fisheries and the SESSF having higher observer coverage than others. Observer coverage has also been small in some fisheries due to low realised levels of bycatch from these fisheries (e.g. the CSF, Southern Squid Fishery). The focus of observer coverage has also varied, for example, between target species observations, discarding practices and observations of high risk species. For instance, the Integrated Scientific Monitoring Program (ISMP) of the SESSF was originally (1993) designed to provide estimates of the retained and discarded proportions of the fish catch in the SESSF (with emphasis on the South East Trawl sector), but has more recently (2009) undergone a review so that better estimates of bycatch of major non-quota and Threatened, Endangered or Protected species (TEPS) can be obtained.

Statistical analyses that would allow reasonable estimates of total annual discards from observations of rates were not available for fisheries other than the SESSF, and were generally beyond both the scope of this report and the data available. For the SESSF, trawling and Danish seine fishing have the greatest bycatch levels and discard rates. Total discard rates (weight of discards divided by total catch weight) appear relatively constant over time. Various measures to change gear selectivity to reduce fish bycatch by trawl have been trialled, and although potentially effective, a strong reduction in bycatch attributed to gear is not evident in the data for the South East Trawl sector. Bycatch management in the gillnet sector of the SESSF has focused largely on mesh size restrictions for shark gillnets to target medium sized gummy shark. The shark gillnet method is also subject to many area closures designed to reduce bycatch of pupping school shark, and interactions with TEPS. For the Antarctic fisheries, all voyages carry AFMA observers and follow strict bycatch management measures. Bycatch of fish species has generally always been low in this fishery. While effort in the CSF is low, and bycatch of high risk species is also likely to be low, measures have been introduced to further reduce bycatch, including trip limits for deepwater sharks. Annual reporting of discard species in this fishery was generally low (<100kg). For the ETBF, observer and logbook data indicate no significant trend in fish discard rates over the last decade. According to observer data, small percentages of target species (tunas and billfish) are discarded, while larger percentages (73% and 96%) of shark and other bycatch species have been recorded as discarded. The NPF catches numerous species, with total bycatch (by weight) potentially being up to 95% of the catch. As a result of voluntary license buy-backs and gear unit reductions over the period of 1998 to 2011, the estimated volume of bycatch has been reduced by around 50%. Overall, although there has been targeted bycatch reduction programs for many fisheries, the most evident reductions in total quantities of bycatch or discards from Commonwealth fisheries over the last 10 years, appear to have resulted from the declining effort brought about by the Commonwealth fisheries structural adjustment and other management arrangements to reduce effort.

Reducing interactions with TEPS has been a major focus of Commonwealth fisheries over the past decade and data suggest that there has been considerable progress in this respect. Bycatch of seabirds and other TEPS are of very low incidence or non-existent in Australia's Antarctic fisheries, which is a major achievement given the region's proximity to breeding colonies and concentrations of seabirds. Turtle bycatch in the NPF has been substantially reduced since mandating the use of Turtle

Exclusion Devices (TEDs) in 2000. For the ETBF, flesh-footed shearwaters were a major component of the bycatch in the early 2000s, but have not been observed caught since the mid 2000s. Similarly, observations of albatross bycatch in the ETBF have also reduced to very small numbers since 2008. Estimated rates of total seabird bycatch in the ETBF have also declined. On the other hand, observations of turtle bycatch in the ETBF have been variable with no clear trend evident. In the CSF, while observer coverage is low, there have been no reported interactions with turtles in either the logbook or observer data. TEDs are currently used by CSF trawl vessels when fishing for crustaceans. Management closures in the SESSF have resulted in large reduction in sea lion captures in the shark gill net fishery.

Caution is required when interpreting observations of TEP bycatch. As TEPs bycatch is of low incidence compared to general bycatch, estimates can be very uncertain and data can be confounded by the increase in TEP reporting in recent years. Also, in some circumstances an increase in the number of observations of TEP species interactions may be directly related to changes in gear configuration as part of mitigation trials. In the ETBF the increased observations of flesh-footed shearwater bycatch were likely related to trials investigating seabird mitigation techniques. Likewise, the increased number of seals captured in the SPF in 2005 was related to mitigation trials for new designs of Seal Exclusion Devices. Statistical analyses of bycatch rates that account for different gear types (and other influential factors such as reporting rates) should be conducted in these circumstances. In some instances, due to the very recent implementation of bycatch measures and increased observer effort, conclusions regarding the level of bycatch and effectiveness of bycatch management measures are not able to be made at this point in time. For example, although apparently effective, it is too early to quantify the value of Vessel Management Plans to reduce the capture seabirds in the SESSF.

KEYWORDS: Bycatch, Australian Commonwealth fisheries, TEPS, trawl, gillnet, longline fisheries.

2 ACKNOWLEDGEMENTS

Enormous thanks are due to Leonie Wyld (CSIRO) for her assistance in the production of this report. Neil Klaer and Malcolm Haddon (CSIRO) are thanked for their time and expertise in providing extensive assistance with logbook database querying and summations. Cathy Bulman, Natalie Dowling, Dy Furlani, Judy Upston and Sally Wayte (CSIRO) are thanked for their critical reviews of earlier versions of the chapters. The CSIRO Wealth from Oceans Flagship is thanked for their funding support. The authors wish to thanks the AFMA managers for their helpful comments with regard to their fisheries, in particular Steve Auld, Peter Neave, Matthew Piasente, Fiona Hill, Brodie Macdonald, George Day, Kylie Tonon, Erik Raudzens, Mike Yates and Brad Milic. John Garvey (AFMA) is thanked for his assistance with logbook extracts. Jeremy Lyle (IMAS) is thanked for providing information used in the SPF chapter. We also thank three anonymous reviewers for their supportive and helpful comments on the draft version of this report.

3 BACKGROUND

The Commonwealth Policy on Fisheries Bycatch was first introduced in 2000, and numerous changes to fishing practices, legislation and community expectations have occurred since then. As part of the Department of Agriculture, Fisheries and Forestry review of the Commonwealth Policy on Fisheries Bycatch, this report provides background information on the data collection and monitoring processes for bycatch and discard species, summarises the data available (categorised into appropriate areas and times), and a chronology of the various bycatch management measures that have been established for each of the key Commonwealth fisheries.

As stated in the Terms of Reference (DAFF, 2012), it is intended that the review will, among other objectives:

- Consider and assess the robustness and applicability of risk based approaches to bycatch management for species or groups of species, taking into account their biological status, data availability and other factors.
- Review approaches to incorporating and addressing the potential cumulative impacts of fisheries' interactions with bycatch.
- Strengthen the existing bycatch management tools and arrangements (including bycatch and discard work plans, ecological risk assessment and management and national plans of action) through mechanisms that will enhance benchmarking, performance monitoring and reporting.
- Identify gaps, needs and priorities for future bycatch research that could be incorporated into strategic research plans.

This report summarises bycatch data and current bycatch management measures across key Commonwealth fisheries and should facilitate the review in achieving these objectives.

4 NEED

The Australian Government Department of Agriculture, Fisheries and Forestry is currently undertaking a review of the Commonwealth Policy on Fisheries Bycatch. The review is supported by an Advisory Committee comprising industry, departmental, research and NGO representatives. Since the first Commonwealth Policy on Fisheries Bycatch was introduced in 2000, Commonwealth fisheries have been through significant change. This includes changing gear, bycatch mitigation measures, the Commonwealth Harvest Strategy Policy and fishery restructuring. ABARES have looked at threatened, endangered and protect species (TEPS) interactions and a few fisheries have reported annual bycatch statistics during some periods. However, there has been no overall synthesis and analysis of bycatch since 2000 for Commonwealth fisheries.

Given the importance of this review, a detailed analysis is required to inform the review and provide a means of evaluating changes in bycatch over the last 10 years or so. Where data are statistically sufficient to produce these estimates, such an analysis should include estimates of bycatch rate, total bycatch by fishery and bycatch composition.

5 OBJECTIVES

1. Document changes in Commonwealth fisheries relevant to bycatch.
2. Collate and synthesise all available bycatch data for Commonwealth fisheries.
3. Analyse and report on trends in bycatch rate, total bycatch and catch composition.

6 METHODS

For each Commonwealth fishery considered, nominated project staff that were familiar with each fishery provided: (i) a brief general background to the fishery; (ii) a description of the operational changes that may have directly or indirectly impacted bycatch; and (iii) bycatch data summaries in the form of tables and figures.

To describe the fishery changes, project staff consulted with fishery researchers and managers and reviewed the various sources of documentation on bycatch assessments that have been provided in the past (e.g. ERA, Bycatch Action Plans). In order to produce the bycatch summary statistics, data held by AFMA and CSIRO was sourced and collated. These data included bycatch in numbers (e.g. TEPS) and weight (non-commercial, non-target species) from on-board observations. Data was checked for quality and quantity and appropriate summary metrics were produced (trends in bycatch and discard rates, magnitude, composition of bycatch). Due to small sample sizes and non-representative sampling, provision of trends in bycatch data was not always possible. Where appropriate, the trends in bycatch metrics were compared to historical changes in fishery policy (e.g. are changes a reflection of mandated gear constraints, changing effort distributions or simply due to poor sample sizes).

Based on the above work, members of the Advisory Committee reviewing the policy will then be able to consider what data are available to inform the review process and potentially what impact policy changes may have had. For each fishery, the data summaries also provide benchmarks for future reference against which changes in bycatch can be compared.

The key Commonwealth fisheries considered relevant were: the SESSF (including the Gillnet Hook and Trap Sector, Commonwealth Trawl Sector and Great Australian Bight Trawl Sector), the Northern Prawn Fishery, the Small Pelagic Fishery, HIMI and Macquarie Island Antarctic Fisheries, the Coral Sea Fishery, and the Eastern Tuna and Billfish Fishery. The final report summarising bycatch data and bycatch management actions for each of these fisheries was presented to the Advisory Committee.

7 RESULTS/DISCUSSION

7.1 Antarctic Fisheries

Commercial fisheries target Patagonian toothfish in the AFZ at Macquarie Island. Between 1996 and 2008 the majority of the catch was taken by demersal trawl, however demersal longline fishing commenced in 2007 and has become the sole method. From 1997 all voyages have carried AFMA observers. By weight, trawl bycatch is dominated by the sleeper shark, grenadiers (*Macrourus* spp.) and stone crabs, with occasional bycatch of corals, algae and other invertebrates. Longline bycatch is similar, with violet cod making a greater contribution. The fishery has always been subject to strict bycatch management measures and fish bycatch levels have generally remained low and steady. There have been no deaths of seabirds or marine mammals as a result of interactions with fishing gear, since operations began in 1994.

Commercial fisheries target Patagonian toothfish and mackerel icefish within the AFZ at Heard Island and McDonald Islands. Toothfish are targeted with demersal trawls and longlines, whereas icefish are generally targeted with midwater trawls. All voyages carry two AFMA and/or independent scientific observers. The most common bycatch species in the mackerel icefish fishery are unicorn icefish, grey rock cod, Eaton's skate and Patagonian toothfish. A small number of invertebrate taxa are also caught. Similar species comprise the dominant bycatch in the trawls targeting Patagonian toothfish, however deep water species such as grenadiers are also common. The bycatch in the longline fishery is dominated by deeper water taxa including grenadiers, and softnosed skates (primarily *B. irrasa*). The fisheries have always been subject to strict bycatch management measures and fish bycatch has generally remained low and steady, although an increase in unicorn icefish and grey rock cod bycatch has been observed in the trawl fisheries in recent years. This may be due to an increased abundance of these species. Interactions with black-browed albatrosses during midwater trawling in the mackerel icefish fishery in 2004 led to the introduction of a closed season, and no bird bycatch has occurred in that fishery since. Vessels in the toothfish trawl and longline fishery have occasional interactions with elephant, crabeater and fur seals, and a range of petrel species.

7.2 Coral Sea Fishery

The Line, Trawl and Trap Sectors of the Coral Sea Fishery (CSF) are the only sectors to take any appreciable bycatch, as the various Hand Collection Sector methods are highly selective. The CSF catches in excess of 850 species, which vary depending on the methods used as well as the areas and times fished. Due to the variability in species caught and in fishing effort across the different fishery sectors, the distinction between target and bycatch species is difficult to make, if not a redundant distinction, since for the line, trawl and trap sectors in particular, there are no clearly defined "target species" *per se*. It is emphasised that though some species or species groups seem to be more consistently taken, it is not appropriate to categorise the species caught less frequently, or in smaller quantities as byproduct or bycatch.

Logbook reported catches and discards are generally time- and gear-sporadic, with low tonnages. Of 70 species/species groups/families categorised as “discard”, there were only 31 for which (i) the annual logbook reported catch peaked at >1t and/or there were 2 or more years of appreciable catch, or (ii) the annual logbook discards spanned 2 or more years, with an annual reported discard peak of >100kg. Annual reported discarding by species was generally low (<100kg) and temporally sporadic. Discarding appeared to be highest in the line sector and lowest in the trawl sector. All annual peaks in logbook catch or discarding occur prior to 2009. Commonwealth Harvest Strategies were implemented on July 1, 2008. However, since there was no introduction of quotas or TAC under the CSF Harvest Strategy, it is unlikely that the lower reported catches and discards post-2008 are related to the implementation of the Harvest Strategy.

The issues with defining “bycatch” for the CSF and delineating this within the logbook data limit the extent to which the data is useful. However, *even if* the logbook data summaries could be considered reflective of bycatch patterns in the Line, Trawl and Trap Sectors, the highly varied nature of the fishery, and the recent low levels of catch, mean that any observed patterns are unlikely to reflect mandated gear constraints, or changing effort distributions. They are most likely simply due to low sample sizes and the highly varied and unconstrained nature of the fishery.

Available observer data are even more sporadic in nature and represent extremely low coverage of the fishery, embracing only two gear types (auto-longline and dropline) across only 7 years, and generally only a low proportion of the reported logbook catch for these gear types. Any interpretations from such data should be made with extreme caution. The only valid outcome from summaries of the observer data are that they agree with the logbook summaries that sharks and dogfish feature consistently and predominantly amongst the discarded species (while noting that ERA Status Reports flagged the take of shark species as a concern and trip limits for deepwater sharks were introduced in 2010).The paucity of fishing effort since then and the low numbers of reported catch mean it is not possible to evaluate the effectiveness of this measure.

7.3 Eastern Tuna and Billfish Fishery

The Eastern Tuna and Billfish Fishery (ETBF) extends from the tip of Cape York to the South Australia/Victoria border. The great majority of the catch is taken with pelagic longline; however, a small quantity is taken using minor-line methods (trolling, hand lining and rod and reel fishing). Longline effort peaked in 2003 at 12.7 million hooks but has since declined reaching 6.6 million hooks in 2011. According to logbook data, a total of 3,441,021 fish (consisting of 105 species) were caught by longline sets since August 2000 while 492,835 (14.32%) of these fish were discarded. Of this total catch, tunas, billfish, byproduct, sharks and other bycatch species made up 56.6%, 11.2%, 19.7%, 3.6% and 8.8% respectively. Furthermore, of the nine tuna and seven billfish species caught, 3.84% and 7.03% respectively were discarded, while of seven byproduct species 2.17% were discarded. On the other hand, of the 28 shark and 54 other bycatch species 61.4% and 99.2% of the fish caught were discarded respectively.

Observer data indicates a total of 235 species have been caught by pelagic longline operations in the ETBF since 2001 consisting of 10, 8, 7, 39 and 171 tunas, billfish, byproduct, shark and other bycatch species respectively of which 7.9%, 14.3%,

5.8%, 72.8% and 96.4% have been discarded. As with the logbook data, for each of these catch categories there is no significant trend in discard rates over the past decade. Of the 235 species observed caught, for 136 species fewer than 10 fish were caught on average each year while between 10 and 100 fish were caught on average for 56 species. The observed catch of seabirds has decreased since 2007 with no birds recorded or observed caught since the start of 2010. On the other hand, the annual observed interaction rate with marine turtles varied between 12.8 and 31.1 per million books over the period 2007-2011 while the interaction rate with marine mammals varied between zero and 7.14 per million books over the same period.

7.4 Northern Prawn Fishery

The Northern Prawn Fishery (NPF) is a multispecies trawl fishery targeting a number of prawn species along with byproduct including squid, cuttlefish, bugs, scallops, scampi and fish. The bycatch of the fishery can comprise up to 56 elasmobranch, 450 teleost and 230 invertebrate species. In addition, the NPF interacts with a number of EPBC listed TEPs; at least 5 marine turtle species, 15 sea snake species, 5 sawfish species and a number of Syngnathidae species. Since the first NPF Bycatch Action Plan was implemented in 1998, it is estimated that total bycatch volume for the NPF has been reduced by around 50% due to a combination of voluntary licence buy-backs and compulsory gear unit reduction schemes. These measures have resulted in a 50% reduction in fishing effort in the NPF since 1998. In addition, the mandatory implementation of Turtle Excluder Devices in 2000 has led to significant reductions in catches of marine turtles and other large bycatch species across the NPF. However the reduction in small-sized bycatch from the introduction of Bycatch Reduction Devices in 2001 has been minimal and variable. Due to significant spatial differences in catch rates of total bycatch, the diversity of TED and BRD types used throughout the fishery and the lack of comprehensive data on bycatch recorded by the commercial fleet, it is difficult to estimate current total bycatch volume caught across the fishery with acceptable accuracy.

7.5 Small Pelagic Fishery

The main species groups reported as SPF-associated bycatch comprise cephalopods, fishes, seabirds and marine mammals, particularly seals and dolphins. Very few bycatch fish species were discarded during observer trips between 2007-2010. Similarly, almost all reported bycatch fish species were retained during 2002-2011 based on Commonwealth logbook data.

A total of 37 interactions between seabirds and mid-water trawl gear and one using purse-seine gear were reported by on-board observers in 2002 and 2006 and during Commercial fishing operations in 2006. Commonwealth logbooks show no seabird interactions in the Jack Mackerel Fishery (JMF) in 2001-2002 or the SPF before 2006 and 2007-2011.

Of the 184 seal interactions with mid-water trawl gear reported during 2001-2010, 175 were incidentally caught during scientific projects aimed to determine the type and frequency of interactions and to assess the performance of various excluder devices as a means to mitigate seal and dolphin interactions. Most of the seals were believed to be Australian fur seals, with 145 reported as surviving the interaction. There have been no reported incidental interactions between fur seal and mid-water

trawls since 2007. Also, no interactions between fur seal and purse-seines have been recorded in observer or Commonwealth logbook databases. However, these reports are based on observer coverage of <13% mid-water trawl shots (per annum) since 2007, and <15% purse-seine shots (per annum) since 2001.

A total of 25 dolphin mortalities (with mid-water trawls) were reported during 2001-2009. There have been no reported incidental interactions with dolphins since June 2005, following the introduction of bycatch management measures.

No interactions between TEP species and SPF mid-water trawl or purse-seine operations have been reported since the inception of the 2009 Management Plan. The lack of reported interactions coincides with a reduction in effort in the fishery, a decline in observer coverage as well as no mid-water trawl fishery catches in 2011, and the absence of observers in the purse-seine fishery except in 2010. However, management measures currently in place have been designed to minimise bycatch in mid-water trawl and purse-seine operations in the SPF.

7.6 Southern and Eastern Scalefish and Shark Fishery

Australia's Southern and Eastern Scalefish and Shark Fishery (SESSF) is a complex multi-species, multi-gear fishery, which includes the Commonwealth Trawl Sector (CTS; including the South East Trawl (SET), and Victorian Inshore Trawl (VIT) sectors), the Great Australian Bight Trawl sector (GABT); the Gillnet, Hook and Trap sector (GHAT), and the East Coast Deepwater Trawl sector (ECDWT).

Information on SESSF bycatch (including byproduct), discarding, and fishery interactions with TEPs is provided for the period 1993 to 2011 (SET), or since records are first available (for GHAT and GABT, since approximately 1999). The Integrated Scientific Monitoring Program (ISMP), which is focused on collecting information on fishery discards, is the primary source of the information. In addition to investigating trends in the SESSF bycatch, a summary is provided of research on bycatch reduction measures that have been trialled, some of which have been taken up or mandated by the fishery. Further, a summary of management changes, to provide some context for interpreting trends in bycatch and discarding in the SESSF is included.

The composition and level of bycatch taken in each of the sectors of the SESSF is dependent on the target species and fishing methods used. Trawling in the SET and GABT, as well as Danish seine fishing, have the greatest bycatch levels and discard rates of the SESSF, but also take the majority of the landed catch. Monitoring by the ISMP for over 20 years in the south east trawl fishery has enabled trends in discards to be examined. These data indicate a reduction in the mass of trawl discards since the mid-2000s, with discard rates for quota species being variable and dependent on the influx of small fish, in particular of blue grenadier, as well as other factors, such as market prices and availability of quota. Fishing effort in the SESSF has reduced by approximately one third since the mid-2000s and probably accounts for the largest reduction in overall discard levels. A number of fish bycatch reduction measures have been trialled in this fishery, with varying degrees of success. Changes in TEP wildlife interactions are not able to be interpreted with confidence at this stage due to the recent redesign of the ISMP and introduction of new mitigation measures (for seabirds, gulper sharks and sea lions).

There are some caveats for interpreting trends and correlating these with management changes and other factors -whilst there is a reasonable time-series of observations for general bycatch, particularly for the SET fishery, changes to the ISMP design have added variability to the estimated trend in discards and bycatch of species over time. Similarly, spatial and temporal shifts in fishery dynamics may also impact on trends. As such, caution should be taken when interpreting trends in bycatch or discarding, as observations may be influenced by factors other than those either imposed by management (to reduce bycatch or discarding) or to due population changes.

8 BENEFITS

The purpose of this report is to inform the review process considering Australia's Commonwealth Policy on Fisheries Bycatch. The report will facilitate recommendations being made by the Advisory Committee supporting this process. In addition, the report will be of substantial benefit to all major stakeholders involved in the management of Commonwealth fisheries, and other parties with an interest in the management of bycatch species. This includes the Australian Fisheries Management Authority (AFMA), the Department of Agriculture, Fisheries and Forestry (DAFF), industry participants, environmental agencies, scientists, conservation bodies and the public. The report describes the currently available data and the management practices as they relate to bycatch monitoring, mitigation and management for key Australian Commonwealth fisheries. In this regard, the report provides a baseline from which management decisions can be based and a historical perspective against which future data collection and management actions can be compared.

9 FURTHER DEVELOPMENT

This report presents a comprehensive overview of the data and the various management measures relating to bycatch for key Australian Commonwealth fisheries. The main purpose of this report was to inform the review of the Commonwealth Policy on Fisheries Bycatch and provide baseline information for future assessments of bycatch. Analyses of bycatch rates or trends in total bycatch were, in many cases, beyond the scope of this project. Even where there were sufficient data, the statistical methods needed to assess temporal trends in bycatch rates and total bycatch are non-trivial and dedicated studies will be required to address this management need. In addition, methods to determine population impacts of bycatch on what are in many cases, data-poor species are a significant and growing area of current research. More generally, the applicability of formal management strategies for bycatch species, similar to those adopted for target species, needs further consideration.

Due to the recent implementation of bycatch measures and increased observer coverage for some fisheries, conclusions regarding the level of bycatch and effectiveness of bycatch management measures were not able to be made at this point in time. This includes measures adopted to reduce the capture of Australian Sea Lions and seabirds in the SESSF. Further analyses should be conducted to consider how successful these programs have been and if alternative measures are necessary.

10 PLANNED OUTCOMES

This project's planned outcomes were to provide:

- a means of informing the current review of the Commonwealth Policy on Fisheries Bycatch;
- an examination of the existing data;
- a description of the changes that have occurred in each fishery that specifically (or indirectly) relate to bycatch; and
- data summaries, where statistically appropriate, of bycatch/discard rates, total bycatch by fishery and bycatch composition and will be in the form of a report to the Advisory Committee.

The outcomes of this project are relevant to and will support the Advisory Committee reviewing the Commonwealth Policy on Fisheries Bycatch through the provision of a comprehensive document describing the data and the measures relating to bycatch in Australia's Commonwealth fisheries. Initial project outcomes were presented to the Advisory Committee in October 2012 and February 2013.

The project examined the existing bycatch data for each of seven major Australian fisheries. These data were predominantly held by the Australian Fisheries Management Authority (AFMA) and included logbook and on-board observations of fish discard and wildlife interactions, and scientific surveys. The project was able to summarise these data in a manner that would enable stakeholders and managers an opportunity to judge whether monitoring and bycatch measures have been adequate and where improvement can be made.

The project provided detailed descriptions of the various measures that have been adopted in the fisheries to specifically reduce bycatch, or that may have had an indirect influence on bycatch levels.

The project provided summary analyses of bycatch observations and trends in bycatch and bycatch rates over time, where data were sufficient. In some cases, recent changes in observer focus and the introduction of new management measures meant that it is currently too soon to judge the effectiveness of these measures.

The project results will provide baseline data to support the review into the Commonwealth Policy on Fisheries Bycatch and enable comparisons of historic trends with future data collection and management actions.

11 CONCLUSION

Project objectives:

1. Document changes in Commonwealth fisheries relevant to bycatch.
2. Collate and synthesise all available bycatch data for Commonwealth fisheries.
3. Analyse and report on trends in bycatch rate, total bycatch and catch composition.

Document changes in Commonwealth fisheries relevant to bycatch.

Since the Commonwealth Policy on Fisheries Bycatch was introduced in 2000, the legislative, economic and social environment influencing fisheries management, with regard to both target and non-target species, has changed considerably. Examples of these changes include:

- the Ministerial Direction of 2005 to cease overfishing and recover over-fished stocks;
- Bycatch Action Plans; and
- Ecological Risk Assessments (ERAs) for each Commonwealth fishery have also been completed since the release of the policy, along with Ecological Risk Management (ERM) to respond to the risk assessments

The Ministerial Direction of 2005 led to the implementation of the Commonwealth Harvest Strategy Policy (2007) and substantial reductions in fishing effort across Commonwealth fisheries. This in turn had a marked influence on overall bycatch levels in Commonwealth fisheries. A number of direct measures, such as the use of alternative gear types and spatial closures, have been introduced since 2000 to reduce fish discarding and to reduce the bycatch of TEP species, such as seabirds, turtles and sea lions. These changes are documented in this report for each of the key fisheries examined.

Collate and synthesise all available bycatch data for Commonwealth fisheries.

An important need of the bycatch review is an understanding of the data that have been collected, and whether these data provide an indication of the effectiveness of measures put in place to reduce bycatch. The key Commonwealth fisheries considered are the Eastern Tuna and Billfish Fishery (ETBF), the Northern Prawn Fishery (NPF), the Small Pelagic Fishery (SPF), the Antarctic Fisheries, the Coral Sea Fishery (CSF) and the Southern and Eastern Scalefish and Shark Fishery (SESSF). This report describes the currently available data on bycatch and discards, provides a description of the policy arrangements and, where appropriate, the trends in bycatch or discards over time.

Australian fisheries and environmental legislation is designed to promote the sustainable harvesting of target species and minimise the impact of additional incidental mortality on non-target species and populations. Non-target species are defined as all species that have been unintentionally taken by fishing operations and include fish, crustaceans, sharks, molluscs, marine mammals, reptiles and birds. Habitats and communities are also important elements to be considered in bycatch policy, but are currently beyond the scope of this review. The data summarised include total catch (logbook records of target and non-target species), effort, catch

composition, on-board observations and scientific surveys. Where possible, the report references the scientific literature for statistical analyses of bycatch rates where these exist (eg for the ETBF). Historically, due to the data collection process largely focussing on target species, data for non-target species is often considerably poorer than for target species. However, there is now an increased focus on monitoring bycatch and discards.

Analyse and report on trends in bycatch rate, total bycatch and catch composition.

Interpretation of bycatch data, and of temporal trends in the magnitude or rate of bycatch in particular, is complicated by several factors and these should be considered when drawing conclusions from the data summaries provided in this report. In particular:

1. Temporal changes in the magnitude of observations of bycatch alone should not be interpreted as providing an indication of changes in fishing practices or changes in population abundance.
2. Temporal increases in bycatch observations (and consequent bycatch) may be related to increased observation effort, for example, due to changes in focus or associated with mitigation trials. Similarly, increases in the mass of fish discards may be due to large recruitment events and not related to fishing practices.
3. Bycatch rates can be a misleading measure of the environmental performance of a fishery.
4. Impacts of bycatch at a population level are difficult to ascertain without rigorous statistical and population studies.
5. In some fisheries the effectiveness of recent changes to observer coverage and management measures to reduce bycatch is not yet possible to gauge.

For each of the major fisheries considered in this report, the main conclusions are summarised below.

Antarctic Fisheries – All voyages carry AFMA observers and there have been very strict environmental regulations in these fisheries since their establishment. Bycatch of fish species is generally low for both the Macquarie Island and Heard Island and McDonald Islands fisheries and TEPs interactions are of very low incidence for both trawl and longline gears. For the Macquarie Island fishery, there have been no fatal interactions with seabirds or marine mammals as a result of interactions with fishing gear since operations began in 1994.

Coral Sea Fishery – The large number and variability of species caught in this fishery make the distinction between target and bycatch species difficult to make. The Line, Trawl and Trap sector of the fishery is the only one to take any appreciable bycatch. Logbook and observer data are generally sporadic. Low levels of recent catch make interpretation of bycatch trends difficult.

Eastern Tuna and Billfish Fishery – This predominantly longline fishery has seen a reduction in effort by nearly half (to 6.6 million hooks in 2011) since its peak in 2003. AFMA implemented an observer program in 2003 and the percentage of observed sets averaged around 6% between 2005 and 2011 (with a high of 8.5% in 2008).

However, the number of hooks observed for a given set has been recorded in the database for only 70% of all observed sets resulting in a reduction in the percentage of sets in some years for which catch rates can be determined (e.g. only 2% in 2008). Discard rates recorded by observers are substantially higher than those recorded on logbooks. Observer data indicates high inter-annual variability in the discard rates of target species over the past decade but no significant trends while the discard rate of by-product species shows an increase in recent years. The discard rate of sharks shows an increase over the past decade while the rate for by-catch species has been relatively constant. Bycatch rates for seabirds appear to have decreased over time, whereas rates for turtles and marine mammals have been variable.

Northern Prawn Fishery – This multi-species fishery can have up to 95% of the catch being bycatch. However, since the first NPF Bycatch Action Plan was implemented in 1998, there has been about a 50% reduction in fishing effort, suggesting estimated total bycatch volume has also been reduced by around 50%, as a result of licence buy-backs, gear unit reduction schemes and bycatch reducing devices (TEDs and BRDs). Turtle excluder devices have been very successful at reducing bycatch of turtles and other large bycatch such as sharks, rays and large sponges. However the reduction in small-sized bycatch since the introduction of Bycatch Reduction Devices in 2001 has been minimal and variable.

Small Pelagic Fishery – Total commercial shots for both the mid-water trawl and purse-seine fisheries peaked in 2006 at over 190 each and has reduced substantially since then, to 91 for purse-seine and zero for mid-water trawl in 2011. Records of fish discarding are minimal in this fishery. An increase in the number of observed seal interactions occurred during scientific trials testing seal excluder devices for mid-water trawl. Minimal interactions have been observed with TEPs since the mid-2000s, coinciding with the introduction of bycatch action plans, a reduction of effort in the SPF and lower observer coverage.

Southern and Eastern Scalefish and Shark Fishery – Fishing effort in this multi-species fishery has reduced by approximately one third since the mid-2000s. The composition and level of bycatch taken in each of the sectors of the SESSF is dependent on the target species and fishing methods used. Monitoring by the ISMP for over 20 years in the south east trawl fishery has enabled trends in discards to be examined. These data indicate a reduction in the mass of trawl discards since the mid-2000s, with discard rates of quota species being variable and dependent on the influx of small fish, in particular of blue grenadier, as well as other factors, such as market prices and availability of quota. A number of fish bycatch reduction measures have been trialled in this fishery, with varying degrees of success. TEP wildlife interactions are not able to be interpreted with confidence at this stage due to the recent redesign of the ISMP and introduction of mitigation measures (for seabirds, gulper sharks and sea lions).

12 APPENDIX 1: INTELLECTUAL PROPERTY

The research is for the public domain. The report and any resulting manuscripts are intended for wide dissemination and promotion. All data and statistics presented conform to confidentiality arrangements.

13 APPENDIX 2: STAFF

The following table lists staff involved in the project.

Name	Organisation	Chapter	Funding
Campbell, Robert	CSIRO	Principal author ETBF	FRDC and in-kind
Dowling, Natalie	CSIRO	Principal author CSF	FRDC and in-kind
Klaer, Neil	CSIRO	Co-PI	FRDC and in-kind
Fry, Gary	CSIRO	Principal author NPF	FRDC and in-kind
Lamb, Tim	AAD	Co-author Antarctic Fisheries	In-kind
Hay, Ian	AAD	Co-author Antarctic Fisheries	In-kind
Knuckey, Ian	Fishwell Consulting	Co-PI, Principal author SESSF	FRDC and in-kind
Miller, Margaret	CSIRO	Co-author NPF	FRDC and in-kind
Sporcic, Miriana	CSIRO	Principal author SPF	FRDC and in-kind
Tuck, Geoff	CSIRO	Principal Investigator, Co-author ETBF	FRDC and in-kind
Upston, Judy	CSIRO	Co-author SESSF	FRDC and in-kind
Welsford, Dirk	AAD	Principal author Antarctic Fisheries	In-kind
Wylde, Leonie	CSIRO	Report Production	FRDC and in-kind

14 APPENDIX 3: ANTARCTIC FISHERIES: MACQUARIE ISLAND PATAGONIAN TOOTHFISH

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14.1 Summary

Commercial fisheries target Patagonian toothfish in the AFZ at Macquarie Island. Between 1996 and 2008 the majority of the catch was taken by demersal trawl, however demersal longline fishing commenced in 2007 and has become the sole method. From 1997 all voyages have carried AFMA observers. Trawl bycatch is dominated by the sleeper shark, grenadiers (*Macrourus* spp.) and stone crabs, with occasional bycatch of corals, algae and other invertebrates. Longline bycatch is similar, with violet cod making a greater contribution. The fishery has always been subject to strict bycatch management measures and fish bycatch levels have generally remained low. There have been no deaths of seabirds or marine mammals as a result of interactions with fishing gear, since operations began in 1994.

14.2 Fishery Description

The Macquarie Ridge is a large, long and mostly submarine feature situated around 1500 km southeast of Tasmania. Aerial projections of the ridge form Macquarie Island and the adjacent Bishop and Clerk, and Judge and Clerk Islets. The Australian EEZ (Exclusive Economic Zone) and the AFZ (Australian Fisheries Zone) around Macquarie Island extend for 200 nm apart from the north east sector where a shared boundary with New Zealand lies approximately 175 nm from the coast.

Australian vessels first caught Patagonian toothfish in the AFZ around Macquarie Island in 1994 and 1995 during exploratory trawling for orange roughy (*Hoplostethus atlanticus*). A trawl fishery targeting toothfish subsequently developed, and between 1996 and 1999, targeted aggregations of juvenile toothfish in the Aurora Trough, a long depression immediately west of the island, and in canyons to the north of the island in the region known as the Northern Valleys. In 1999 the trawl fishery was limited to a research quota due to low available biomass in the Aurora Trough. Available biomass increased to a point where commercial fishing recommenced in 2003. Between 2007 and 2010, an experimental longline fishery was trialled, and since 2011, longline has been the sole method used to target toothfish. Longline fishing occurs across a larger geographic and depth range than past trawling, occurring at many locations along the Macquarie Ridge, as well as in Aurora Trough. Further detail on this fishery can be found in Patterson and Skirtun (2011) and Fay and Tuck (2011).

14.3 Bycatch Data Collection and Holdings

Two or more scientific observers - including government observers from AFMA; AAD and CSIRO scientists; and Data Collection Officers (DCOs) from government accredited third parties - have been deployed during all fishing operations in the Macquarie Island Fishery since December 1996. These observers are tasked with

identifying and quantifying all bycatch caught, monitoring numbers of seabirds and marine mammals around the vessels during fishing operations, and recording any interactions between the fishing gear and wildlife. They also collect biological data from regular subsamples of vertebrate bycatch taxa. The biological data collected are sex, length, weight, and gonad development as well as otoliths from fishes. Observers operate on opposing shifts to ensure 24 hours coverage of fishing operations. On trawl voyages they observe upwards of 90% of all hauls. On longline vessels, between 60% and 70% of all hooks retrieved are observed. Non-target species for each fishing event is accumulated onboard by the crew for identification and quantification by the observer, and this is the basis of data entered by the skipper into the vessel logbook. Consequently there is a high level of confidence in data on non-target species for this fishery.

The AAD developed Fishlog in 1995/96. This is an integrated system of electronic scales and measuring board, ruggedized laptop and data entry form and database. Fishlog is provided aboard all fishing vessels operating in the Macquarie Island fishery, and facilitates easy collection of large amounts of high quality data by observers.These data are submitted to the AAD after each voyage, quality checked and then entered into a secure database at the AAD. A copy of this database is also housed at AFMA.

Vessels are also required to estimate and report all bycatch in their logbooks on a shot-by-shot basis and submit these estimates to AFMA.

14.4 Bycatch Management Measures

14.4.1 General

The obligation to manage bycatch is specified in the *Macquarie Island Toothfish Fishery Management Plan 2006*, which requires AFMA to regulate bycatch of fish and invertebrate species, minimise incidental interactions with seabirds and marine mammals, and minimise the ecological impacts of fishing on habitats in the fishery area. No fish species other than Patagonian toothfish are permitted to be targeted in the Macquarie Island fishery. All catches of non-target species are required to be retained, with the exception of large sharks (e.g. *Somniosus* spp.), algae and invertebrates such as stony corals or sponges that are unlikely to attract or provision seabirds. Vessels are permitted to discharge offal and bycatch outside of the Australian EEZ, and non-target catches are generally not landed as a byproduct.

From the start of the targeted toothfish fishery in 1996, bycatch of finfish, sharks and marine invertebrates have been limited to 50 t per season for any single species and 200 t for all species combined. A large Marine Reserve where commercial fishing is prohibited was established to the east of Macquarie Island in 1999.

14.4.2 Seabirds

The Management Plan introduced in 2006 requires Statutory Fishing Right (SFR) holders to employ measures to mitigate bycatch and TEP interactions that are consistent with the Conservation Measures regulating fishing in the adjacent CCAMLR area[1] as well as additional measures that go beyond CCAMLR requirements.

The longline vessel that conducted the experimental fishery from 2007-2010 employed the following measures: the use of integrated-weight longline gear, twin bird-scaring streamer lines and Bird Exclusion Devices (BEDs) during hauling; no discarding of any offal, fish meal or bycatch; a season limited to 1 May to 31 August; night-setting only; minimising lighting on-board the vessels; and minimising the use of plastic packing bands.

Under the *Threat Abatement Plan for the Incidental Catch (or bycatch) of Seabirds During Oceanic Longline Fishing Operations* (2006)[1], the experimental longline fishery also had a performance measure of maintaining bird bycatch rates at below 0.01 birds per 1000 longline hooks per season. Longline operations are limited to 1 May to 31 August each year, when at-risk seabirds are less numerous. Additionally, to protect local breeding populations during the experimental phase of the longline fishery, longlining was to cease if any endangered seabirds were killed, These seabirds are wandering albatross (*Diomedea exulans*), black-browed albatross (*D. melanophris*), grey-headed albatross (*D. chrysostoma*), grey petrel (*Procellaris cinerea*) and soft-plumaged petrel (*Pterodroma mollis*). The fishery was also required to close if more than one bird of a vulnerable or at-risk species, including the southern giant petrel (*Macronectes giganteus*), northern giant petrel (*Macronectes halli*), light-mantled albatross (*Phoebetria palpebrata*) and blue petrel (*Halobaena caerulea*), or if a total of three of any other seabirds, were caught (Hewitt and Hay, 2007). With the end of the experimental longline fishery in 2010, and since the commencement of the commercial longline fishery in 2011, bycatch limits for endangered, vulnerable and at-risk seabirds have also been included in the conditions for SFR holders. Further, under the requirements of the Threat Abatement Plan the catch rate limit of 0.01 other bird species per 1000 hooks per season also applies.

SFR conditions for trawling operations in place since 2006 include prohibiting the use of a 'third wire' netsonde cable, mesh sizes of less than 120 mm, and bobbins and rockhopper disks of less than 520 mm and 400 mm respectively.

14.5 Bycatch Composition and Quantities

The total catch of toothfish and the bycatch of fish and invertebrates for the trawl fishery (Table 14.1) and longline fishery (Table 14.2) indicate that bycatch weight is dominated by the sleeper shark *Somniosus antarctica*, macrourids, the stone crab *Lithodes murrayi* with occasional bycatches of corals, algae and other invertebrates, comprising sponges and cephalopods and echinoderms. There have been no deaths of seabirds or marine mammals as a result of interactions with fishing gear, since operations began in 1994 (Table 14.3).

Neither the species limits nor overall limit for bycatch of finfish, sharks and marine invertebrates has been reached in any season in this fishery. Interactions with wildlife have also never led to a closure. Detailed assessments of bycatch and fisheries interactions conducted for trawling in this fishery have identified no species at risk (He and Furlani, 2001; Zhou *et al.*, 2009).

[1] http://www.antarctica.gov.au/science/southern-ocean-ecosystems-environmental-change-and-conservation/southern-ocean-fisheries/seabird-bycatch/threat-abatement-plan-seabirds

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Table 14.1 Toothfish effort, catch and bycatch composition in the Macquarie Island toothfish trawl fishery by season (1 December to 30 November the following year). Catches are rounded to the nearest 0.1 tonnes; - indicates no catch recorded, 0.0 indicates the taxon was recorded, but total catch was less than 0.1 tonnes. These figures include elasmobranchs that were returned to the sea if they are judged by the on-board observers to have a good chance of survival.

Season	Effort (Hauls)	Toothfish catch (t)	Bycatch (t)												
			Somniosus antarctica	*Macrourus carinatus*	*Lithodes murrayi*	*M. whitsoni*	*M. holotrachys*	*Antimora rostrata*	*Halargyreus johnsonii*	Corals	Algae	Other macrourids[b]	Other elasmo-branchs	Other fish	Other inverte-brates
1993/94 [a]	49	77	-	-	-	-	-	-	-	-	-	-	-	-	-
1994/95	267	353	-	-	-	-	-	-	-	-	-	-	-	-	-
1996/97	292	934	-	-	-	-	-	-	-	-	-	-	-	-	-
1997/98	320	1133	11.1	1.1	1.8	-	-	0.1	0.0	0.9	0.4	0.0	0.0	0.1	1.1
1998/99	388	444	3.5	3.5	1.5	-	-	0.8	0.5	21.0	0.1	14.8	-	0.2	0.6
1999/00[c]	161	85	4.8	17.8	0.6	-	0.0	3.6	2.3	0.5	0.6	0.7	0.0	0.3	1.2
2000/01	116	16	1.1	1.9	0.3	-	-	0.2	0.1	2.0	0.0	0.0	0.0	0.1	0.4
2001/02	116	27	-	-	0.1	-	-	0.1	-	0.1	0.0	1.0	-	0.3	1.7
2002/03	123	40	0.0	0.0	0.1	-	1.1	0.3	0.2	7.4	0.0	0.1	-	0.1	0.9
2003/04	114	354	7.7	-	0.2	-	-	0.2	-	0.1	0.1	0.8	-	0.0	0.1
2004/05	33	58	0.4	0.1	0.0	0.0	-	0.0	0.0	0.4	0.0	0.0	-	0.0	0.1
2005/06	184	273	5.8	1.0	-	-	-	0.4	0.1	2.8	-	0.1	0.2	0.0	0.8
2006/07	112	238	1.8	0.0	0.3	0.3	-	0.0	-	-	-	0.1	-	0.0	0.1
2007/08	118	242	4.5	-	1.4	3.4	-	0.0	-	0.0	6.2	0.0	0.1	0.0	0.4
2008/09	174	307	9.2	0.0	0.3	0.3	5.5	0.4	0.0	0.0	23.6	0.9	-	0.1	0.3

[a] No bycatch data was required to be recorded during exploratory and development fishing between 1994/5 and 1996/7.
[b] This group is primarily made up of unspecified *Macrourus* spp., which can be difficult to identify to species level in the field.
[C] The fishery in these years was restricted to a research catch only due to low estimates of trawl available biomass.

Table 14.2 Toothfish effort, catch and bycatch composition in the Macquarie Island toothfish longline fishery by season (1 December to 30 November the following year). Catches are rounded to the nearest 0.1 tonnes; - indicates no catch recorded, 0.0 indicates the species was recorded, but total catch was less than 0.1 tonnes.

Season	Effort (Sets)	Toothfish catch (t)	Bycatch (t)							
			Antimora rostrata	*Somniosus antarctica*	Macrourids[a]	Rajids	Lithodids	Other elasmo-branchs	Other fish	Other invertebrates
2006/07[b]	35	84	0.1	-	0.1	-	0.0	-	-	0.2
2007/08	59	148	5.8	-	7.2	0.5	0.0	1.5	1.5	0.3
2008/09	67	214	2.6	-	7.0	-	0.0	-	0.2	0.1
2009/10	52	264	1.7	4.8	5.0	-	0.1	0.0	0.1	0.1
2010/11	170	358	6.3	-	9.6	0.0	0.1	0.7	0.3	0.2

[a] This group is primarily made up of unspecified *Macrourus* spp., which are difficult to identify to species level in the field.
[b] Longlining operated through the 2006/07-2009/10 seasons under an experimental permit, before being accepted as a commercial fishing method in 2010/11.

Table 14.3 Seabird and marine mammal interactions recorded in the Macquarie Island toothfish fishery, for all gear types, 1996-2011.

Season	Gear Type	Taxon	Number	Interaction
1996/97	Trawl	Prion (Procellariidae)	2	Found on deck with broken wings and euthanased
1996/97	Trawl	*Mirounga leonina*	1	Decomposed corpse caught in trawl
2002/03	Trawl	*Phalacrocorax atriceps*	1	Landed on deck then flew away
2002/03	Trawl	Petrel (Procellariidae)	1	Found dead on deck

15 APPENDIX 4: ANTARCTIC FISHERIES: HEARD ISLAND AND MCDONALD ISLANDS PATAGONIAN TOOTHFISH AND MACKEREL ICEFISH FISHERIES

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15.1 Summary

Commercial fisheries target Patagonian toothfish and mackerel icefish within the AFZ at Heard Island and McDonald Islands. Toothfish are targeted with demersal trawls and longlines, whereas icefish are generally targeted with midwater trawls. All voyages carry two AFMA and/or independent scientific observers. The most common bycatch species in the mackerel icefish fishery are unicorn icefish, grey rock cod, Eaton's skate and Patagonian toothfish. A small number of invertebrate taxa are also caught. Similar species comprise the dominant bycatch in the trawls targeting Patagonian toothfish, however deep water species such as grenadiers are also common. The bycatch in the longline fishery is dominated by deeper water taxa including grenadiers, and softnosed skates (primarily *B. irrasa*). The fisheries have always been subject to strict bycatch management measures and fish bycatch has generally remained low and steady, although an increase in unicorn icefish and grey rock cod bycatch has been observed in the trawl fisheries in recent years. This may be due to an increased abundance of these species. Interactions with black-browed albatrosses during midwater trawling in the mackerel icefish fishery in 2004 led to the introduction of a closed season, and no bird bycatch has occurred in that fishery since. Vessels in the toothfish trawl and longline fishery have occasional interactions with elephant, crabeater and fur seals, and a range of petrel species.

15.2 Fishery Description

The Heard Island and McDonald Islands (HIMI) are a group of volcanic cones that emerge above sea level from the Kerguelen Plateau, the largest submarine plateau in the Southern Ocean. Unregulated trawl fisheries were conducted by Soviet Bloc vessels on the Kerguelen Plateau, targeting species such as the marbled rock cod (*Notothenia rossii*), grey rock cod (*Lepidonothothen squamifrons*) and the mackerel icefish (*Champsocephalus gunnari*), until 1979 when France declared a 200 nm EEZ around the Iles Kerguelen to the north of HIMI. In 1981 Australia extended the Australian Fishing Zone to HIMI (Duhamel and Williams, 2011a; Pshenichnov, 2011), and signed the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR). CCAMLR Conservation Measures as well as Australian domestic legislation apply at HIMI (Constable and Welsford, 2011; Duhamel *et al.*, 2011; Duhamel and Williams, 2011b).

No commercial fishing occurred until 1996 when an exploratory trawl fishery commenced and discovered aggregations of mackerel icefish and Patagonian toothfish (*Dissostichus eleginoides*).Commercial trawling for these species has occurred every season thereafter. Toothfish are targeted with demersal trawls on the upper slope of the plateau down to around 1000 m, while icefish are generally targeted using midwater trawl on the plateau at 100-400 m depth. In 2003 an exploratory longline fishery began and since then longlining has grown to exceed trawling in terms of total capture of toothfish. Longlining targets larger fish on the

deeper slopes of the plateau, generally in depths from 1000 to 1800 m (Welsford *et al.*, 2011). On a few occasions, fishing has also been attempted using pots. However, bycatch in this method is negligible and no interactions with marine mammals or seabirds have been observed when using this fishing method, and so it is not discussed further here. Further detail on this fishery can be found in Patterson and Skirtun (2011) and Constable and Welsford (2011).

15.3 Bycatch Data Collection and Holdings

Observer coverage and data collection, management and quality assurance provisions in the HIMI toothfish and icefish fisheries are identical to those for the Macquarie Island toothfish fishery. Two or more scientific observers have been present on-board Australian fishing vessels from the commencement of fishing in 1996, performing tasks in line with the Conservation Measures developed by CCAMLR and those required under domestic regulations.

Observers operate on opposing shifts to ensure 24 hours coverage of fishing operations. On trawl voyages they observe upwards of 90% of all hauls. On longline vessels, between 60% and 70% of all hooks retrieved are observed. Non-target species for each fishing event is accumulated onboard by the crew for identification and quantification by the observer, and this is the basis of data entered by the skipper into the vessel logbook. Consequently there is a high level of confidence in data on non-target species for this fishery.

15.4 Bycatch Management Measures

15.4.1 General

During the exploratory fishery in 1995/96, no target species were prescribed, and a 50 tonne catch limit applied to all species (CCAMLR, 1995). Minimum mesh sizes in demersal and midwater trawl nets were required to be at least 120 mm when targeting toothfish and 90 mm when targeting mackerel icefish. In addition, a move-on rule was included to prevent depletion of localised aggregations, whereby if in any haul, the bycatch of grey rock cod, marbled rock cod, unicorn icefish (*Channichthys rhinoceratus*) or soft-nosed skates (*Bathyraja* spp.) exceeded 5% of the catch, then the vessel was required to move at least 5 nm from, and not return to, the location were the bycatch occurred for at least 5 days. Vessels were also required to report all haul-by-haul catch and bycatch data to CCAMLR and AFMA every ten days. To mitigate wildlife interactions, netsonde cables were also prohibited, and all plastic packing bands had to be cut and incinerated at sea. In addition to the CCAMLR measures, no offal was permitted to be discarded inside the EEZ, any interactions with seabirds and marine mammals were required to be reported, and all shark species are returned to the sea (none are retained).

15.4.2 Finfish, sharks and skates

In 1996/97, specific catch limits for mackerel icefish and toothfish were set for the first time, and bycatch was defined as any fish, crustacean or cephalopod captured other than the target species (CCAMLR, 1996). A move on provision was also added, such that if any catches of mackerel icefish contained more than 10% by number of juveniles <28 cm, the vessel was required to move at least 5 nm away for at least 5 days.

In 1997/98, a revised assessment of the most common bycatch species was conducted (Constable *et al.*, 1998), resulting in revised bycatch limits for grey rock cod (325 t), unicorn icefish (80 t) and soft-nosed skates (120 t) (CCAMLR, 1998). Directed fishing for these species and the marbled rock cod was prohibited. All other species retained a 50 t bycatch limit. The move-on provisions were also modified, such that a bycatch of 100 kg or greater that was more than 5% of the total catch of fish species, or was greater than 2 t, required the vessel to move 5 nm for 5 days from the midpoint of the trawl track where the bycatch was taken. Similarly a minimum catch of 100 kg was required before assessing the move-on rule for juvenile icefish catches and the threshold length was decreased to 24 cm.

In 1998/99 measures remained unchanged with the exception of changes to the bycatch limit for grey rock cod (80 t), unicorn icefish (150 t) and soft-nosed skates (50 t), (CCAMLR, 1998). In 2001/02, the move-on rule was modified, with the threshold catch remaining at 2 t for more common species (unicorn icefish and grey rock cod) and decreasing to 1 t for all other species (CCAMLR, 2001). The list of species with a 2 t threshold for move-on expanded to include *Macrourus* spp. and skates in 2002/03 (CCAMLR, 2002). Review of the biological parameters of another relatively common bycatch species, the ridge-scaled grenadier (*Macrourus carinatus*) (van Wijk *et al.*, 2000; van Wijk *et al.*, 2003), also led to the catch limit for *Macrourus* spp. being set at 465 t in that season. This was subsequently revised down to 360 t to reflect uncertainty in life history parameters, and has remained at that level since 2003/04 (CCAMLR, 2003). The bycatch limit for soft-nosed skates also returned to 120 t in 2002/03 and has remained at that level since.

15.4.3 Seabirds

With the commencement of the longline fishery in 2002/03, longline regulations applied at HIMI included a season limited to 1 May to 31 August, night setting only, prohibition of offal dumping, the use of streamer lines, minimising lighting aboard the vessel while fishing, and deploying a device to discourage birds from taking baits during hauling Australian vessels also were early adopters of other effective mitigation measures such as zero discarding of offal and the use of integrated weight line from 2002/03, and the development of bird exclusion devices (BEDs), which in 2009/10 became mandatory in other CCAMLR longline fisheries with a high risk of seabird bycatch (SC-CAMLR, 2009).

In 2003, levels of seabird bycatch in mackerel icefish trawls conducted in the Southern Atlantic near South Georgia lead CCAMLR to require all trawlers, including those at HIMI, to clean nets prior to each set and minimise the amount of time the nets were on the water's surface (CCAMLR, 2003).

In 2003/04, a season extension to 14 September, with a three seabird bycatch limit during the extension, was allowed for longline vessels that had shown full compliance with management measures in the previous season (CCAMLR, 2003). Two observers were also required to be on-board during the season extension. In 2004/05, the requirement for night-setting only was removed for vessels using integrated weight line that had demonstrated they could achieve line sink rates of at least 0.3 m per second in the top 15 m of the water column, but was retained for fishing during the season extension (CCAMLR, 2004). Season extensions of 1 to 30 September applied in 2005/06 and 15 to 30 April in 2006/07 (CCAMLR, 2005, 2006).

1 to 14 September was included as part of the main season and the season extension included 15 September to 31 October, and 15-30 April in 2009/10 and 2010/11 (CCAMLR, 2009; 2010). In 2011/12 and 2012/13, the period when daytime setting was permitted was extended to include 15 April to 31 October, however the 3 seabird limit continues to apply during the period 15-30 April and 15 September to 31 October (CCAMLR, 2011).

15.5 Bycatch Composition and Quantities

The most common bycatch in the mackerel icefish trawl fishery is the unicorn icefish, followed by the grey rock cod, Eaton's skate (*B. eatonii*) and Patagonian toothfish (Table 15.1). Jellyfish, sponges and asteroids are also relatively common bycatch. Other skates in the genus *Bathyraja* spp. and porbeagle sharks, and the southern sleeper shark (*Somniosus antarctica*) are occasionally caught, and are tagged and released if the observers determine that they are likely to survive.

A similar suite of species comprise the dominant bycatch in the trawls targeting Patagonian toothfish (Table 15.2), however as toothfish are targeted in deeper water than mackerel icefish, deep water species such as grenadiers in the genus *Macrourus* are also common. The bycatch of species such as unicorn icefish and grey rock cod have increased over recent years, which may be due to an increase in the abundance of these species in the main trawl grounds where toothfish are targeted (Nowara, 2009).

Bycatch in the longline fishery is dominated by deeper water taxa including grenadiers in the genus Macrourus, and softnosed skates (primarily the sandpaper skate *B. irrasa*), the majority of which are released alive (Table 15.3). Large sleeper sharks are occasionally hooked and are also released at the surface.

In the mackerel icefish trawl fishery, few interactions with marine mammals have been observed, with three subantarctic fur seals (*Arctocephalus gazella*) being found dead in the net on three separate occasions, and a dead southern elephant seal (*Mirounga leonina*) found once (Table 15.4). Fatal interactions with seabirds have involved the black-browed albatross (*Thalassarche melanophrys*), white-chinned petrels (*Procellaria aequinoctialis*), cape petrels (*Daption capense*) and one southern giant petrel (Table 15.5). No fatal interactions with seabirds have occurred since the introduction of a closed season for midwater trawling (1 February-31 March) and the limiting of midwater trawls to nighttime.

Small numbers of fatal interactions between the toothfish trawl fishery and marine mammals have occurred in most seasons, generally involving sub-Antarctic fur seals, although elephant seals and one crab-eater seal have been observed dead in the trawl net (Table 15.6). The majority of fatal interactions for seabirds involve collisions with the superstructure of the vessel, often associated with bad weather (Table 15.7). However, the majority of interactions in this fishery are non-fatal, with several species of petrel having been observed landing on the deck and flying away apparently unharmed.

The majority of interactions between seals and longliners targeting toothfish involve animals that die after becoming hooked or entangled with the mainline (Table 15.8). Elephant seals are most common although sub-Antarctic fur seals have been recorded on two occasions. As in the trawl fishery, interactions with seabirds are

generally non-fatal, unless they involve collisions with the vessel superstructure (Table 15.9). Cape petrels and the northern and southern giant petrels (*Macronectes halli* and *M. giganteus*) account for the majority of interactions. All direct interactions with the fishing gear resulting in fatalities involved cape petrels.

The total allowable catch by species or overall has never been reached in any season in this fishery, nor have interactions with wildlife led to a closure. Detailed assessments of bycatch and fisheries interactions conducted for trawling and longlining in this fishery have identified no bycatch species at risk (He and Furlani, 2001; Zhou *et al.*, 2009).

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Table 15.1 Catch, effort and bycatch composition in the Heard Island and McDonald Islands mackerel icefish trawl fishery by season. Note that catches are calculated for a season from 1 December to 30 November the following year. Catches are rounded to the nearest 0.1 tonnes; - indicates no catch recorded, 0.0 indicates the taxon was recorded, but total catch was less than 0.1 tonnes. These figures include rajids and other elasmobranchs that were returned to the sea if they are judged by the on-board observers to have a good chance of survival, as well as catches taken during the annual Random Stratified Trawl Survey.

Season	Efforts (Hauls)	Icefish catch (t)	Toothfish catch (t)	Bycatch (t)												
				Ch. rhino.	*B. eatonii*	*L. squam.*	Anemones	Medusae	Sponges	Asteroids	Other Rajids[a]	Other elasmobranchs[b]	Other fish	Other invertebrates	Algae	Total Bycatch
1996/97	70	221	1	3.4	0.5	0.1	0.0	0.7	0.1	0.0	0.9	1.4	0.1	0.3	-	7.5
1997/98	101	99	3	4.7	1.0	0.7	1.4	4.5	2.0	0.4	0.2	0.5	0.3	16.9	0.0	32.6
1998/99	17	2	1	0.6	0.0	0.1	0.1	0.3	0.0	0.0	0.0	-	0.0	0.1	-	1.2
1999/00	108	138	7	3.7	0.3	0.2	0.4	0.3	0.4	0.1	0.1	0.3	0.2	0.2	-	6.2
2000/01	186	1158	7	1.6	0.9	0.4	0.5	1.3	3.2	0.3	0.3	0.3	0.2	0.1	-	9.1
2001/02	141	839	4	3.9	0.7	0.5	0.6	0.6	0.5	0.7	0.1	1.2	0.2	0.2	0.0	9.2
2002/03	296	2355	10	20.1	19.1	0.1	3.3	0.2	1.1	1.6	1.5	3.9	0.6	1.7	-	53.2
2003/04	49	72	0	6.9	2.7	0.0	0.1	0.0	0.1	0.1	0.2	0.0	0.1	0.1	-	10.3
2004/05	247	1841	4	37.7	6.1	0.1	0.3	0.3	0.4	0.2	0.2	1.8	0.5	0.2	-	47.8
2005/06	198	660	2	27.6	6.6	0.0	0.5	0.4	0.7	0.5	0.3	1.9	0.1	0.2	-	38.8
2006/07	83	2	1	3.5	0.5	0.0	0.1	0.0	0.2	0.1	0.1	0.0	0.1	0.6	-	5.2
2007/08	99	207	1	9.4	3.1	0.1	0.3	6.4	0.8	0.4	0.2	0.0	0.2	0.1	-	21
2008/09	79	95	2	7.7	8.4	0.7	1.6	0.3	0.6	1.0	0.5	0.0	0.3	5.8	-	26.9
2009/10	234	362	20	52.1	31.9	0.5	10.6	0.3	3.1	4.0	0.9	1.3	2.0	2.3	-	109
2010/11	63	1	1	1.5	0.5	1.1	0.8	0.1	0.5	0.7	0.1	0.0	0.5	1.5	-	7.3
Total	1971	8052	64	184.5	82.4	4.6	20.6	15.7	13.8	9.9	5.6	12.6	5.2	30.3	0.0	385.3

[a] This group consists primarily of *B. irrasa* and *B. murrayi*.

[b] This group includes the porbeagle shark (*Lamna nasus*) and southern sleeper shark (*Somniosus antarctica*), which are generally tagged and released alive by observers.

Table 15.2 Catch effort and bycatch composition in the Heard Island and McDonald Islands Patagonian toothfish trawl fishery by season. Note that catches are calculated for a season from 1 December to 30 November the following year. Catches are rounded to the nearest 0.1 tonnes; - indicates no catch recorded, 0.0 indicates the taxon was recorded, but total catch was less than 0.1 tonnes. These figures include rajids and other elasmobranchs that were returned to the sea if they are judged by the on-board observers to have a good chance of survival.

Season	Efforts (Hauls)	Toothfish catch (t)	Icefish catch (t)	Bycatch (t)															
				L. squam.	*Ch. rhino.*	*S. ant.*	*B. eatonii*	*B. irrasa*	*M. whitsoni*	*M. carinatus*	Medusae	Sponges	Coral	Asteroids	Other macrourids[a]	Other Elasmo branchs[b]	Other fish	Other inverts	Algae	Total Bycatch
1996/97	553	1866	7.6	0.3	0.4	2.6	0.5	0.3	-	0.9	0.6	1.0	8.0	1.3	0.0	2.4	0.1	8.2	-	26.6
1997/98	500	3783	17.0	0.2	0.1	6.1	2.4	0.6	0.0	0.1	3.3	1.3	1.9	0.8	0.6	2.0	0.1	0.3	0.0	19.8
1998/99	649	3545	0.1	9.7	0.5	5.5	2.1	0.4	-	0.0	0.5	0.3	0.2	0.1	1.6	0.1	0.5	2.1	0.0	23.6
1999/00	932	3556	0.0	0.6	0.1	7.0	6.9	1.8	0.1	0.8	1.0	1.2	0.5	0.9	2.5	0.2	0.2	3.0	0.0	26.8
2000/01	1179	2981	0.4	3.5	0.0	6.1	3.1	1.3	-	2.1	3.7	0.9	0.4	0.5	0.1	0.3	0.3	1.6	0.0	23.9
2001/02	1055	2749	1.0	1.1	0.5	5.3	2.6	0.9	-	1.7	5.2	1.0	0.6	0.9	2.4	0.3	0.3	0.9	0.0	23.7
2002/03	1050	2587	0.2	0.3	0.5	4.2	5.7	1.8	-	0.5	1.6	0.6	0.3	0.5	1.0	0.3	0.2	0.8	0.0	18.3
2003/04	1582	2279	8.1	2.7	0.5	11.2	5.6	1.7	1.6	0.5	2.2	1.3	0.1	0.7	1.5	0.4	0.2	1.6	0.0	31.8
2004/05	1054	2119	0.0	2.1	0.1	3.2	2.4	0.4	1.6	0.0	1.2	1.1	1.6	0.4	0.7	0.2	0.5	1.2	0.0	16.7
2005/06[c]	1253	1796	0.0	5.8	2.8	6.9	7.6	4.0	1.2	0.0	1.4	0.8	0.5	1.6	0.2	0.8	0.5	1.4	0.0	35.5
2006/07	1218	1787	0.0	10.0	12.4	6.2	10.9	3.4	3.3	-	1.1	0.8	0.2	1.7	1.2	2.0	0.2	2.0	0.0	55.4
2007/08	981	1618	0.0	20.3	29.7	5.7	11.3	4.1	3.8	-	9.5	2.3	0.7	1.8	1.4	1.7	0.2	6.0	-	98.5
2008/09	760	1286	0.0	25.6	46.4	3.1	8.8	1.9	1.2	-	1.5	1.9	0.3	1.9	2.2	2.1	0.6	3.4	-	100.9
2009/10	788	1247	0.4	47.6	28.5	1.2	6.7	1.2	0.8	-	1.7	12.6	1.0	3.1	2.0	2.0	0.6	10.1	-	119.1
2010/11	588	1147	0.1	26.7	23.4	7.0	4.0	0.7	3.8	0.0	1.2	0.3	0.1	1.0	0.2	0.8	0.2	4.4	-	73.8
Total	14142	34346	34.9	156.4	145.8	81.2	80.6	24.6	17.5	6.8	35.8	27.2	16.3	17.4	17.8	15.4	4.5	46.8	0.0	694.1

[a] This group consists primarily of unidentified *Macrourus* spp.

[b] This group consists primarily of unidentified *Bathyraja* spp. which are released if judged by the observer to have be likely to survive, and and southern sleeper shark (*Somniosus antarctica*) which are generally tagged and released alive by observers.

[c] In 2005/06, the trawl fleet decreased from two to one vessel.

Table 15.3 Toothfish effort, catch and bycatch composition in the Heard Island and McDonald Islands Patagonian toothfish longline fishery by season. Note that catches are calculated for a season from 1 December to 30 November the following year. Catches are rounded to the nearest 0.1 tonnes; - indicates no catch recorded, 0.0 indicates the taxon was recorded, but total catch was less than 0.1 tonnes.

Season	Efforts (Sets)	Toothfish catch (t)	Bycatch (t)								
			Antimora rostrata	*Somniosus antarctica*	*Macrourus* spp.	*Bathyraja* spp.	Asteroids	Other Elasmo branchs	Other fish	Other inverts	Total Bycatch
2002/03	94	270	0.0	1.5	0.1	0.7	0.0	0.0	0.0	0.0	2.3
2003/04	278	566	0.1	-	0.4	1.9	0.0	-	0.0	0.0	2.4
2004/05	261	636	0.2	-	0.5	1.0	0.0	0.0	0.0	0.0	1.7
2005/06	289	648	0.3	0.6	23.1	23.7	3.0	0.0	0.2	0.0	50.9
2006/07	271	625	0.3	-	56.0	13.5	0.5	0.1	0.1	0.0	70.5
2007/08[a]	454	825	0.6	1.0	83.8	23.2	2.9	0.0	0.0	0.1	111.6
2008/09	557	1173	5.2	0.3	117.1	41.1	4.2	0.0	0.1	0.1	168.1
2009/10	414	1216	1.6	2.7	113.9	22.2	2.6	0.0	0.0	0.0	143
2010/11	405	1143	4.4	-	135.8	29.2	3.9	-	0.0	0.1	173.4
Total	3023	7102	12.7	6.1	530.7	156.5	17.1	0.1	0.4	0.3	723.9

[a]In 2007/08, the longline fleet increased to two vessels.

Table 15.4 Marine mammal interactions recorded in the Heard Island and McDonald Islands mackerel icefish trawl fishery by season, 1996-2011.

Season	Taxon	Number	Interaction
2001/02	*Arctocephalus gazella*	1	Found dead in net
2002/03	*Arctocephalus gazella*	2	Found dead in net
	Mirounga leonina	1	Found dead in net

Table 15.5 Seabird interactions recorded in the Heard Island and McDonald Islands mackerel icefish trawl fishery by season, 1996-2011.

Season	Taxon	Number	Interaction
1997/98	*Procellaria aequinoctialis*	1	Found dead enmeshed in net
1998/99	*Macronectes giganteus*	1	Found dead in net
	Procellaria aequinoctialis	1	Found dead in net
	Daption capense	1	Observed floating dead near warps
2002/03	*Procellaria aequinoctialis*	1	Found dead in net
	Procellaria aequinoctialis	1	Found dead in fish pound
	Thalassarche melanophrys	1	Broke wing on trawl net and euthanised
	Thalassarche melanophrys	1	Found dead with wound from warp wire
2004/05[a]	*Procellaria aequinoctialis*	4	Found dead enmeshed in net
	Thalassarche melanophrys	7	Found dead enmeshed in net

[a]In 2005/06, midwater trawling was prohibited between 1 February and 31 March, and all midwater trawling limited to nighttime.

Table 15.6 Marine mammal interactions recorded in the Heard Island and McDonald Islands Patagonian toothfish trawl fishery by season, 1996-2011.

Season	Taxon	Number	Interaction
1997/98	*Mirounga leonina*	1	Decomposing carcass caught in net
	Arctocephalus gazella	1	Found dead in net
	Arctocephalus gazella	1	Found in net and released alive
1999/00	*Arctocephalus gazella*	1	Found dead in fish pound
2000/01	*Arctocephalus gazella*	3	Found dead in net
	Arctocephalus gazella	1	Found dead in fish pound
	Arctocephalus gazella	2	Found in net and released alive
2001/02	*Arctocephalus gazella*	2	Found dead in net
	Mirounga leonina	1	Found dead in net
2002/03	*Arctocephalus gazella*	1	Found dead in net
	Mirounga leonina	1	Found dead in net
	Lobodon carcinophagous	1	Found dead in net
2003/04	*Arctocephalus gazella*	1	Found dead in net
2004/05	*Arctocephalus gazella*	1	Found dead in net
2005/06	*Hydrurga leptonyx*	1	Found dead in net
[a]	*Arctocephalus gazella*	4	Found dead in net
2006/07	*Arctocephalus gazella*	1	Found dead in net
2010/11	*Arctocephalus gazella*	1	Found in net and released alive

[a]In 2005/06, the trawl fleet decreased from two to one vessel.

Table 15.7 Seabird interactions recorded in the Heard Island and McDonald Islands toothfish trawl fishery by season, 1996-2011[a].

Season	Taxon	Number	Interaction
1999/00	*Procellaria aequinoctialis*	1	Wing found snagged on trawl warp
2001/02	*Daption capense*	1	Flew into warp wire. Recovered and released apparently unharmed
2002/03	*Daption capense*	2	Found dead enmeshed in net
2004/05	*Procellaria aequinoctialis*	1	Found dead entangled in rope hanging over the side of the vessel
	Procellaria aequinoctialis	1	Found dead in fish pound
2006/07	*Daption capense?*	1	Observer noted bird entangled near seal excluder. Body not found.
	Daption capense	1	Found dead in fish pound
2008/09	*Daption capense*	1	Died after entanglement with paravane
2009/10	*Daption capense*	1	Found dead in fish pound
2010/11	*Thalassarche melanophrys*	1	Entangled briefly in net, escaping apparently unharmed

[a]In 2005/06, the trawl fleet decreased from two to one vessel.

Table 15.8 Marine mammal interactions recorded in the Heard Island and McDonald Islands Patagonian toothfish longline fishery by season, 2003-2011[a].

Season	Taxon	Number	Interaction
2002/03	*Mirounga leonina*	3	Found dead entangled in mainline
2003/04	*Mirounga leonina*	1	Found dead entangled in mainline
	Arctocephalus gazella	1	Found dead hooked in mouth
2004/05	*Mirounga leonina*	5	Found dead hooked in mouth
2006/07	*Mirounga leonina*	1	Found dead entangled in mainline
2007/08	*Arctocephalus gazella*	1	Found dead entangled in mainline
	Mirounga leonina	2	Found dead entangled in mainline
	Unidentified seal	1	Hooked briefly and swam away
2008/09	*Mirounga leonina*	2	Found dead entangled in mainline
2009/10	*Mirounga leonina*	1	Briefly entangled then swam away

[a]In 2007/08, the longline fleet increased to two vessels.

Table 15.9 Seabird interactions recorded in the Heard Island and McDonald Islands toothfish longline fishery by season, 2003-2011[a].

Season	Taxon	Number	Interaction
2003/04	*Daption capense*	3	Briefly entangled in snood, released unharmed
2005/06	*Daption capense*	1	Briefly entangled and hooked after flying into hauling room, released unharmed
	Daption capense	1	Briefly entangled in tori line, flew away unharmed
2007/08	*Macronectes halli*	1	Hooked in wing and drowned during setting
	Macronectes giganteus	1	Entangled in tori line and fell into water, life status unknown
2008/09	*Daption capense*	1	Hooked in beak and drowned during setting
	Macronectes spp.	1	Briefly hooked before escaping with apparently minor injuries
2009/10	*Macronectes halli*	2	Briefly hooked before escaping
	Daption capense	1	Hooked and drowned during hauling
	Daption capense	1	Hooked and drowned during setting
	Daption capense	1	Hooked during hauling. Observer removed hook and released bird with apparently minor injuries
2010/11	*Macronectes halli*	1	Hooked in wing during hauling and broke free.
	Macronectes halli	1	Briefly entangled with bird exclusion device during hauling

[a]In 2007/08, the longline fleet increased to two vessels.

16 APPENDIX 5: CORAL SEA FISHERY

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CSIRO Wealth from Oceans Flagship and Marine and Atmospheric Research

16.1 Summary

The Line, Trawl and Trap Sectors of the Coral Sea Fishery (CSF) are the only sectors to take any appreciable bycatch, as the various Hand Collection Sector methods are highly selective. The CSF catches in excess of 850 species, which vary depending on the methods used as well as the areas and times fished. Due to the variability in species caught and in fishing effort across the different fishery sectors, the distinction between target and bycatch species is difficult to make, if not a redundant distinction, since for the line, trawl and trap sectors in particular, there are no clearly defined "target species" *per se*. It is emphasised that though some species or species groups seem to be more consistently taken, it is not appropriate to categorise the species caught less frequently, or in smaller quantities as byproduct or bycatch.

Logbook reported catches and discards are generally time- and gear-sporadic, with low tonnages. Of 70 species/species groups/families categorised as "discard", there were only 31 for which (i) the annual logbook reported catch peaked at >1t and/or there were 2 or more years of appreciable catch, or (ii) the annual logbook discards spanned 2 or more years, with an annual reported discard peak of >100kg. Annual reported discarding by species was generally low (<100kg) and temporally sporadic. Discarding appeared to be highest in the line sector and lowest in the trawl sector. All annual peaks in logbook catch or discarding occur prior to 2009. Commonwealth Harvest Strategies were implemented on July 1, 2008. However, since there was no introduction of quotas or TAC under the CSF Harvest Strategy, it is unlikely that the lower reported catches and discards post-2008 are related to the implementation of the Harvest Strategy.

The issues with defining "bycatch" for the CSF and delineating this within the logbook data limit the extent to which the data is useful. However, *even if* the logbook data summaries could be considered reflective of bycatch patterns in the Line, Trawl and Trap Sectors, the highly varied nature of the fishery, and the recent low levels of catch, mean that any observed patterns are unlikely to reflect mandated gear constraints, or changing effort distributions. They are most likely simply due to low sample sizes and the highly varied and unconstrained nature of the fishery.

Available observer data are even more sporadic in nature and represent extremely low coverage of the fishery, embracing only two gear types (auto-longline and dropline) across only 7 years, and generally only a low proportion of the reported logbook catch for these gear types. Any interpretations from such data should be made with extreme caution. The only valid outcome from summaries of the observer data are that they agree with the logbook summaries that sharks and dogfish feature consistently and predominantly amongst the discarded species (while noting that ERA Status Reports flagged the take of shark species as a concern and trip limits for deepwater sharks were introduced in 2010).The paucity of fishing effort since then and the low numbers of reported catch mean it is not possible to evaluate the effectiveness of this measure.

16.2 Fishery Description[2]

16.2.1 General

The Coral Sea Fishery (CSF) covers waters from the east of Sandy Cape (Fraser Island) to east of Cape York. The Fishery commences east of the Great Barrier Reef Marine Park and extends to the edge of the Australian Fishing Zone. It excludes the areas of the Coringa-Herald and Lihou Reef National Nature Reserves. Together the Nature Reserves cover approximately 17,000 km^2 of coral reef habitat (AFMA, 2010).

The CSF includes the following methods:

- Otter trawl ("Trawl Sector")
- Demersal finfish traps ("Trap Sector")
- Demersal longlines (with automatic baiting subject to application and additional conditions), trotlines, droplines and handlines ("Line Sector")
- Hand collection with or without underwater breathing apparatus, and for the aquarium fish collection, cast, scoop and seine nets, and handlines with barbless hooks. Non-mechanical implements can also be used for collection of live rock ("Hand Collection Sector")

There are a total of 17 fishing permits in the Coral Sea Fishery targeting a wide range of finfish species, as well as shark, lobster, trochus, sea cucumber and live rock (limestone encrusted with coralline algae and other encrusting species). Rosy jobfish, alfonsino and red emperor are the three most common species (by weight) taken for seafood markets in the CSF. In the aquarium sector, fishing is highly selective and the species targeted change in response to market demand.

The Line, Trap and Trawl sectors are required to carry an observer on the first trip of every fishing season and on every fourth trip thereafter with the objective of covering 25% of the effort. Where certain automatic or random baiting gear is used this level increases to every third trip. Observer coverage for the hand collection sectors is prescribed at AFMA's discretion. This is due to the low risk of interacting with listed species, the absence of bycatch and discarding, and the fact that hand collection involves diving, making observation difficult.

The CSF catches in excess of 850 species. The species caught vary depending on the methods used as well as the areas and times fished. Due to the variability in species caught and in fishing effort across the different fishery sectors, the distinction between target and bycatch species is difficult to make, if not a redundant distinction, since for the line, trawl and trap sectors in particular, there are no clearly defined "target species" *per se*.

Wilson *et al.* (2010) emphasises that although some species or species groups seem to be more consistently taken, it is not appropriate to categorise the species caught less frequently, or in smaller quantities as byproduct or bycatch. However, those species that logbook, observer and/or catch disposal records (CDRs; from the SAN Landing logbook) indicate to be consistently discarded, would equate to bycatch.

From the perspective of bycatch, it is noted that

[2] Majority of text taken from AFMA (2010)

- Bycatch is negligible for the Hand Collection Sector (Aquarium, Lobster and Trochus, Sea Cucumber), as fishers can take target species discriminately.
- Wilson *et al.* (2010) report that the Line, Trawl and Trap Sectors take a wide variety of species, with operations varying both temporally and spatially. These fishing methods are relatively non-selective. Anecdotal reports suggest the trap-caught fish can be released alive if unwanted; however, post-release survival is not well documented for this fishery. Possible ghost fishing from lost traps has been mitigated through the use of sacrificial anodes on trap doors.

This report will therefore focus, from here on in, on the Line, Trawl and Trap Sectors, these being the only sectors of the CSF with any appreciable bycatch.

It must be emphasised that, due to the low levels of effort within the Line, Trawl and Trap Sectors (since 2007, total effort has remained below 120 days of operations, with negligible fishing in 2009 and 2012 (to date); Figure 16.1), the amount of logbook data is correspondingly low (especially relative to the latent effort that exists within the fishery), and the amount of observer data that exists is even lower. Additionally, the Line, Trawl and Trap Sectors are highly variable in terms of the range of species caught, and is often exploratory in nature. The logbook data is also acknowledged to have problems with species mis-identification (Dowling *et al.*, 2007). For all of these reasons, the reader is urged to treat the outcomes of the data summaries undertaken here with caution.

16.2.2 Management arrangements for the line, trawl and trap sector[3]

Line Sector

The line sector includes auto-longline, demersal longline, and other line including trotlines, droplines, setlines and handlines. There are no total allowable catches (TACs), but there are spatial controls for the line sector. Auto longliners must fish in waters deeper than 200m. The take of tuna or tuna-like species is not permitted. The usual trip length is about 12 days fishing and 2 days each way steaming.

There is an MOU in the northern Coral Sea covering members of the Coral Sea Fishery Association (CSFA) for resource protection and tourism – in addition to the Lihou and Coringa-Herald reef closures, the waters within 4 km around an additional 4 islands are closed to line fishing; these reefs are Osprey Reef, two at Holmes Reef and Herald Reef.

Trawl sector

The otter trawl fishery sector comprises separate finfish and crustacean fisheries, using demersal and midwater trawl gear, each with different permit conditions. There are 2 trawl fishing concessions. There are no size limits on boats, and there are no TACs or quotas. Input controls include gear restrictions of a minimum mesh size and fitting of Turtle Exclusion Devices (TEDs) for crustacean trawling operations.

[3] from Dowling *et al.* (2007) and Wilson *et al.* (2010)

Finfish trap sector

There are no TACs or quotas in the finfish trap sector. The take of tuna or tuna-like species is not permitted. All fish traps must be constructed of metal, be set and hauled individually, and include in their design a sacrificial anode (of no more than one month life span) that will ensure the trap doors will open within 1 month if lost, and as such minimise ghost fishing. The maximum trap size is 1.8 metres x 1.8 metres x 0.8 metres.

By nature, the finfish trap fishery is exploratory and the overall status of the fishery is uncertain as most stocks have not been formally assessed. Trap discard is approximately 16%. Traps have some environmental advantage (over line fishing) of having no interaction with sharks and no loss due to “bite off”. Traps typically catch smaller fish of a given species than do lines (e.g. rosy jobfish average weight 4-7kg on line, 1.5kg in trap).

It was suggested at the October 2006 stakeholder meeting that a limit should be placed on the number of traps that may be carried per vessel. The group had reservations about looping and the option for monofilament traps. The latter permits more ghost fishing and may be eaten by large predators. Steel traps are expensive so operators make a strong effort to retrieve them. Steel traps also have no interactions with large predators. Subsequently, management rules were amended in 2007 to limit the number of traps on-board at any time to 50, and to allow only metal traps.

16.2.3 Ecological Risk Assessment [4]

The Coral Sea Fishery has undertaken a preliminary Level 1 Ecological Risk Assessment (ERA) and a semi qualitative Level 2 ERA for Chondrichthyan and Protected (TEP) species. Hand collection methods presented a low risk to all species considered. Finfish trapping also presented a low risk to most species, with bathyl and reef sharks the only exception with medium risk.

Marine turtles, bathyl sharks (>200m) and reef sharks were all afforded a high risk rating for trawl and line methods, while pelagic and shelf sharks were given a high risk rating for line methods only. There have been no reported interactions with turtles in the CSF. This is supported by observer coverage which covers a minimum of 25% of trips. This is supported by observer coverage which covers a minimum of 25% of trips, although the reader is reminded that the observer data are sporadic due to the small number of total trips.

The Lobster and Trochus, Aquarium, and Sea Cucumber sub-sectors employ methods which are highly selective and able to avoid bycatch species. No species were identified as being at high risk from hand collection methods under the ERAs conducted for the CSF to date. Hand collection methods in the CSF are highly selective and do not result in bycatch; consequently there is unlikely to be any discarding.

[4] Text taken from AFMA (2010)

Line Sector

Trip limits for deepwater sharks were introduced in 2010 and discourage fishing where there is a high bycatch of these species. Additional trip limits for other potential high risk species will continue to be implemented through the CSF Harvest Strategy.

Future bycatch mitigation measures may include the design and implementation of best practice protocols for handling of sharks and other species of concern. In the future it may also be necessary to further investigate the risk factors for turtles if interactions are detected and if necessary, develop best practice handling protocols.

Trawl Sector

Bycatch reduction measures such as the use of Turtle Excluder Devices (TEDs) and trip limits may help demonstrate sustainability. Current TED usage requirements may need to be reviewed if interactions with turtles are detected.

The 2010 Bycatch and Discard Workplan (AFMA 2010) acknowledged the risks associated with localised depletion of shark species, and with turtle interactions. Current Turtle Exclusion Device (TED) usage requirements may be reviewed by AFMA if interactions with turtles are detected. As with the line sector, trip limits for deepwater sharks were introduced in 2010 and discourage fishing where there is a high bycatch of these species. Development of operating procedures outlining areas (including depths) fished, timing of fishing (if appropriate) and other measures may further assist in this regard.

Trap sector

No species were identified as being at high risk from demersal fin fish trapping under the ERAs conducted for the CSF to date. Detailed reporting and the use of observers will continue to be used to identify any emerging risks posed by the use of demersal finfish traps. Trap design, including the nature of sacrificial anodes on trap doors, is regulated through permit conditions. Best practice guidelines for handling and release of unwanted species and operation of traps more generally may reduce any existing risks posed by this sector.

16.3 Bycatch Management Measures[5]

16.3.1 Closed area spatial management

Two Marine Protected Areas, Coringa-Herald National Nature Reserve and Lihou Reef National Nature Reserve, exist within the bounds of the CSF and cover an area of approximately 17,000 square kilometres. No commercial fishing is permitted in these reserves and management provisions are in place to detect any illegal fishing in these waters.

Provisions are in place for the Lobster and Trochus and the Sea Cucumber sectors which require fishing operators to move their mother-ship once a specified amount of catch or effort is reached. These measures help prevent localised depletion within the fishery.

[5] Text taken from AFMA (2010)

Since July 2005 fishing permit holders targeting sea cucumbers have been signatories to the Memorandum of Understanding (MOU) in relation to the Queensland Sea Cucumber Association for the Waters under AFMA Jurisdiction (2005–2008). This stipulates a three-year rotational harvesting strategy for sea cucumber on 21 reefs within the Coral Sea. The conditions of this memorandum are now incorporated into the permit conditions and management arrangements for the sector.

Auto-longliners must fish in waters deeper than 200 metres unless an observer is on board. If an observer is on board 50% of hooks may be set shallower than 200 metres.

An MOU exists between the Coral Sea Fishers Association (CSFA) and the Cod Hole and Ribbon Reef Operators Association (CHARROA). Under the MOU, the CSFA has agreed not to hook fish within two kilometres of particular reefs in the CSF (Osprey Reef, Bougainville Reef, Flora Reef, Dart Reef and Heralds Surprise reef) in order to preserve iconic species of importance to tourist operators. In addition, a circular area with 0.75 nautical mile radius around CHARROA moorings at Osprey Reef, namely North Horn and Admiralty Anchor is protected from all fishing of sharks, rays, potato cod, Maori wrasse, Queensland groper, anemones and anemone fish.

16.3.2 Catch limits

Trip limits were introduced in 2010 for deepwater sharks. Catches of these species are extremely low and infrequent in the CSF, however AFMA has taken a highly precautionary and proactive approach in recognition that these species may be more susceptible than others to overfishing due to their low rates of reproduction.

All deepwater sharks brought aboard live must be released alive, while a very small quantity of any dead animals may be retained to facilitating the collection of information on species occurrence.

The limits in the CSF are 15kg per permit per day and 90kg per permit for trips lasting greater than six days. These limits are the same as used in the SESSF as part of the stock rebuilding strategy for upper-slope dogfish, however instead of applying to only four species, the CSF limits apply to all deepwater sharks that occur in the CSF; this is believed to be about 19 species.

Additional limits for other potential high risk species exist in the CSF Harvest Strategy and will continue to be updated as risk assessments evolve.

16.3.3 Improved fishing gears and practices

Mesh size limits apply to the Trawl sector. Mesh size must not be less than 38 millimetres at any part of the net. Methods for measuring the net mesh size are prescribed in CSF permit conditions.

When fishing for crustaceans, a Turtle Excluding Device (TED) must be used. These TEDs are defined as:

(a) A rigid or semi-rigid inclined barrier structure comprised of bars extending from the foot to the head of the net that is attached to the circumference of the net which must guide turtles towards an escape hole immediately forward of the grid; and

(b) An escape hole with the following minimum measurements when measured simultaneously with the net taut:
   i) 760mm across the width of the net,
   ii) a perpendicular measure of 380mm from the midpoint of the width measure; and

(c) A maximum bar spacing of 120mm.

Although no observer reports or logbook records have recorded any interaction with turtles in the CSF to date, it is reiterated that the logbook data may be unreliable, and the observer data are sporadic. Turtles do occur at a wide range of depths encompassing the range of depths over which CSF trawling is undertaken.

AFMA acknowledges that further expert advice may help better determine the extent to which different turtles occupy different depth strata in the CSF however a number of issues remain which also warrant consideration. Benefits of TEDs include:

1. TEDs can reduce the risk trawling poses to turtles during setting and hauling as nets pass through the water column;

2. TEDs can reduce bycatch of other animals such as sharks, rays and skates;

3. Turtles as well as bathyl and reef sharks were found to be at high risk from trawl activity in the CSF and other Chondrichthyan species and cetaceans were found to be at medium risk in the CSF (Table 16.1). In the absence of information to modify existing risk ratings, measures must be taken to mitigate risk based on best available knowledge.

Acknowledging the developmental nature of the CSF, AFMA has stated that it will closely monitor trawl interaction rates with TEP species and review the current provisions for TED requirements as necessary (AFMA, 2010).

16.4 Harvest Strategy Arrangements for the Line, Trawl and Trap Sectors[6]

Commonwealth Fishery Harvest Strategies were implemented on July 1, 2008 for all Commonwealth managed fisheries.

The following issues were critical in developing a harvest strategy for the CSF Line, Trawl and Trap Sectors

- Due to the variable and often exploratory nature of the fishery, target species are difficult to define.
- The GVP for the fishery is low and minimal research funding is available.
- There is much latent effort.

[6] Text from Dowling *et al.* (2007) and Wilson *et al.* (2010)

- There is very little information availableother than logbook data (which has problems with species mis-identification) and some length-frequency information which has been collected by observers but not analysed. No habitat mapping has been undertaken and as such there is no estimate of the size of the resource or the exploitation rate.
- Observer requirements should be reviewed in the process of addressing information needs for the fishery.

16.4.1 Summary of line, trawl and trap sector harvest strategy

(Dowling *et al.* 2007, but wording taken from the 2009 BRS Fishery Status Report):

The Harvest Strategy employs a suite of triggers associated with total catch, total catch of high risk or vulnerable species, changes in catch composition, changes in the spatial extent of the fishery, and changes in catch rate.

Level 1 triggers are designed to detect changes in the fishery, resulting in an investigation to identify the reasons for the change. The investigation may include logbook analysis, industry consultation, and a revised risk analysis. If a reasonable justification is made to explain the activation of the Level 1 trigger, the fishery may continue without additional management intervention. In the absence of an explanation, a management response may be invoked.

Level 2 triggers require some form of assessment. Until this is undertaken, the trigger acts as the cap to exploitation.

16.4.2 Additional points

- The harvest strategy is a general approach where reference points are set to detect changes in species composition, spatial fishing patterns, declines in overall CPUE and overarching values for total catch. Separate triggers for vulnerable species are included. This strategy should identify changes in the fishery without having to nominate key species. As the fishery develops, a clearer identification of key species and their sustainability in given areas should be obtained. When this occurs, the harvest strategy is likely to incorporate species-specific reference points and decision rules. The fishery should aim to be managed as a Tier 3 fishery; that is, using age and length information to provide estimates of natural and fishing mortality and spawner-biomass-per-recruit, which would form the basis for more informed decision rules. However, this information is not yet available, and the analysis required to obtain it is a cost that would be borne by industry once the fishery is developed to a point that greater justification would be required in order for further expansion to occur (Dowling *et al.* 2007).

16.5 Bycatch Composition and Quantities

16.5.1 Methods

The summaries herein presented were derived primarily from logbook data, although summaries using the available observer data are also presented. Logbook and observer data is maintained by AFMA and was made available to CSIRO in the form of an Access data base. Database queries were undertaken only on the section of

the logbook and observer database identified as the Coral Sea Fishery. The logbook data spanned the years 1998 to (partially) 2012. The observer data included the years 2003, 2004 and 2007-2011, but for limited coverage of auto-longline and dropline fishing (note that this latter is included within an "other line" gear category, which also includes "handline", "rod and reel", "trotline" and "trolling" gears, when undertaking logbook data summaries) activities only.

Given the lack of defined target species within the line, trawl and trap sectors, there are no species classified specifically as "bycatch species", either within the BRS Fishery Status Reports (eg Wilson *et al.*, 2010) or the ERA Scoping Documents. As such, a list of possible "bycatch" species could only be developed based on lists of species for which some (more typically) or all (rarely) of the catch may be discarded. Such lists were sourced from

- The 2009 BRS Fishery Status Report (Wilson *et al.*, 2010), which contained a broad summary/overview table of "main" species across all three sectors that included discarding information. The quoted data was presumably taken from logbook records, although the presented totals do not appear to correspond either to logbook or observer totals derived here. The relevant parts of this table are presented as Table 16.1 below.

- The ERA Scoping Documents (Anon. 2006)for each of the three sectors (and with the Line Sector broken down by Auto-longline, Demersal Longline, and Other Line sub-sectors). These documents contained comprehensive species lists of all possible discard species. Discarding practices were here considered to embrace bycatch, juveniles of target species, high-grading, and processing at sea. The species lists were composed based on both logbook data and observer reports, and SAN Landing logbook (SESS2) records (with the latter being important in enabling the identification of portions of the catch not retained) (Anon, 2006). These are reproduced for each sector (sub-sector in the case of the Line Sector) as Table 16.2 to Table 16.7 below.

    - Note that, as opposed to listing solely discard species, the Demersal Trawl Sector (Table 16.6) identifies byproduct/bycatch species specifically, with two discard species groups listed additionally.

    - Note that the "Other Line" sub-sector delineates between total discarding (Table 16.4) and graded discarding (Table 16.5).

Logbook data

For each species, species group or family cited in Table 16.1 to Table 16.7, a search of the logbook database was undertaken on both common name and scientific name (using the unique CSIRO species codes corresponding to each within the data base). If species was listed in Table 16.1 to Table 16.7 as a group or family, generally the same group or family appeared as a "species name" category within the logbook data, and it is under this category that all the catch information was generally found (to confirm this, individual species names in the same group/family that also appeared in the data base were cross-checked. These almost always had zero catches for the CSF).

Within the logbook data base, there were separate columns for “reported catch” and for “discards”. The reported catch (in kg) presumably includes both the marketable (target/byproduct) and, potentially, the bycatch total. Unfortunately, it is not possible to distinguish what fraction (if any) of the reported catch constitutes bycatch. The independent column for “discards” means that this catch is not necessarily a subset of the “reported catch”. As such, bycatch information may be contained within both the “discards” and “reported catch” columns. Furthermore, consistency in how “discards” and “reported catch” are delineated, and in the extent of bycatch included in the “reported catch”, cannot be assumed. Generally, the levels of reported discarding were very low and should be interpreted with caution, as they are highly likely to be underestimates[7].

It is important to note that the lack of quota or TAC in the CSF means that there is no disincentive to report discarding of marketable species in the logbook. Indeed, there are many records where the magnitude of the discards exceeded that of the “reported catch”.

For each species, species group or family cited in Table 16.1 to Table 16.7, both the “reported catch” and the “discard” totals were individually extracted against each unique fishing operation.

Many species, species groups or families listed in Table 16.1 to Table 16.7 had no reported logbook values in both the “reported catch” and “discard” columns (see the “no logbook record” column in Table 16.2, Table 16.4 and Table 16.7. Typically this occurred because the species/species group/family had been included on the lists of discard species solely on the basis of observer reports. These species/species groups/families were therefore eliminated from any subsequent analysis.

In order to summarise the information, “reported catch” and “discard” totals were obtained for each species, species group or family, by year and gear type. (N.B. the database extraction included all diving operations amongst the gear types. As these pertained to the Hand Collection Sector, the catches and discards reported against diving operations were excluded).

[7] The Catch Disposal Records and SAN Landing logbook (SESS2) can be used to show differences between logbook catch and the portion actually ‘landed’ – the difference being discard. The issue of ‘bycatch’ still remains to be clarified, although all discards would fall within the category of ‘bycatch’. The SAN Landing.logbook information was unable to be accessed for this report.

Gear type was summarised as 6 categories:

- Auto longline (Auto LL)
- Demersal longline (Demersal LL)
- Other line (comprising the subtotal of all catch and discard records reported against the database gear categories “dropline”, “handline”, “rod and reel”, “trotline” and “trolling”)
- Trawl
- Trap
- Unknown (reported as such in the data base)

For each species/species group/family, time plots of annual total “reported catch” and “discards” were prepared for each of the six gear type categories. Annual catch or discard totals of zero were not included on the plots.

From the lists of “discard” species/species groups/families presented in Table 16.1 to Table 16.7, there were 70 species/species groups/families for which non-zero logbook catch and/or discard information was reported.

Thus, 70 annual time series panels are presented (Section 16.7), each with 12 separate time series (6 gear categories x [catches, discards]).

Table 16.1 From Table 3.4 BRS Fishery Status Report 2009. Species with significant discards only are reproduced here. This table combines all sectors.

Species	**2007-08 catch (tonnes)**	**2007-08 discards (number of individuals)**	**2008-09 catch (tonnes)**	**2008-09 discards (number of individuals)**
Blacktip reef shark (*Carcharhinus melanopterus*)	13	11090	1	910
Whaler sharks (*Carcharhinus* spp.)	5	1210	0	410
Tiger shark (*Galeocerdo cuvier*)	4	560	0	120
Scalloped hammerhead shark (*Sphyrna lewini*)	2	300	0	90

Table 16.2 From ERA Scoping Document - Autolongline: Summary of discard species, including by-catch, juveniles of target species, high-grading, processing at sea. From CS01 logbook data and Observer Reports

Species name	Common name	N = no logbook record
Alopias superciliosus	Bigeye thresher	N
Carcharhinus altimus	Bignose shark	N
Congridae	Eel	
"Lutjanus malabaricus-unvalidated"	Large Mouth Nannygai	
Gymnothorax sp	moray eel	N
Gymnothorax sp 1	moray eel	N
Gymnothorax sp 2	moray eel	N
Paraulopus okamurai	Piedtip cucumberfish	N
Squalus megalops	Spurdog	
Squalus mitsukurii	Greeneye dogfish	
Cirrhigaleus barbifer	Mandarin shark	N
Squalus sp B	Dogfish	
Squalus sp F	Dogfish	
Erthrocles schlegeli		N

Table 16.3 From ERA Scoping Document - Demersal longline: Summary of discard species, including by-catch, juveniles of target species, high-grading, processing at sea. From CS01 logbook data; no observer data collected.

Species name	Common name
Squalus mitsukurii	Green-Eyed Dogfish
Squalus megalops	Spurdog
"Lutjanus malabaricus-unvalidated"	Large Mouth Nannygai
Nebrius ferrugineus	Tawny shark

Table 16.4 From ERA Scoping Document - Other line: Summary of species for which total discarding occurs (by-catch, juveniles of target species, high-grading, processing at sea). From CS01 logbook data; no observer data collected.

Species name	Common name	N = no logbook record
Nebrius ferrugineus	Tawny shark	
Lutjanus bohar	Red bass	
"Lutjanus malabaricus-unvalidated"	Large Mouth Nannygai	
Balistidae and Monacanthidae	Leatherjacket	
Triaenodon obesus	Whitetip Reef Shark	
Heniochus diphreutes	Schooling bannerfish	
Triakidae	Hound sharks	N
Congridae	Eel	
Gymnosarda unicolor	Dogtooth Tuna	
Seriolella brama	Blue warehou	
Rhinidae	Wedgefishes	N
Lutjanus erythropterus	Crimson snapper	
Bodianus flavipinnis	Yellowfin pigfish	
Brachaeluridae	Nurse/Zebra sharks	N
Siganidae	Rabbitfish	N.B. all records under "Spinefoot-Rabbitfish"
Lutjanus gibbus	Paddletail	
Auxis rochei	Frigate mackerel	
Ephippidae, Drepanidae	Batfish	N
Trachyscorpia sp	Ocean perch	
Acanthuridae, Zanclidae	Moorish idol/surgeonfish	
Tetraodontidae	Toadfishes	
Nelusetta ayraudi	Chinaman-Leatherjacket	
Lepidocybium flavobrunneum	Black Oilfish/escolar	
Caranx lugubris	Black Trevally	
Centrophorus moluccensis	Endeavour Dogfish	

Table 16.5 From ERA Scoping Document - Other line: Summary of species for which graded discarding occurs (by-catch, juveniles of target species, high-grading, processing at sea). From CS01 logbook data; no observer data collected.

Species name	Common name
Carcharhinus spp	Blacktip sharks
Carangidae	Trevally
Lutjanus spp.	Tropical snapper
Sharks – other	
Thyrsites atun	Barracouta
Abalistes stellaris	Starry Trigger Fish
Lethrinus laticaudis	Grass Emperor
Sphyrna lewini	Scalloped Hammerhead

Table 16.6a From ERA Scoping Document - Demersal trawl. Bycatch/byproduct sepcies: from CS01 Logbook and Catch Disposal Records (CDR)

Species_name	Common_name
Amusium spp.	Saucer scallops
Teuthoidea	Squids
Melicertus latisulcatus / plebejus / longistylus	King prawns
Panulirus spp except P. cygnus	Tropical rock lobsters
Carcharhinus spp	Unidentified carcharinid species
Squalidae	Dogfishes
Centrophorus moluccensis	Endeavour Dogfish
Squalus megalops	Spurdog
Squalus mitsukurii	Green-Eyed Dogfish
Etmopterus spp.	Lantern sharks
Congridae	Eel
Gephyroberyx darwinii	Darwin's Roughy
Centroberyx affinis	Redfish
Zeus faber	John Dory
Polyprion oxygeneios	Hapuku
Aethaloperca, Anyperodon, Epinephelus spp.	Rock cods
Polyprion spp	Hapuku and Bass Groper-NSW
Plectropomus and Variola spp.	Coral trout
Epinepbelus ergastularius / septemfasciatus	Bar Rockcod
Priacanthus spp	Red bullseye
Seriola hippos	Samsonfish
Plagiogeneion spp	Rubyfish
Lutjanus sebae	Red Emperor
Lutjanus malabaricus	Scarlet SeaPerch/Largemouth Nannygai
Etelis carbunculus	Northwest Ruby Fish
Aprion virescens	Green Jobfish
Pristipomoides filamentosus	Rosy Jobfish / King Snapper
Lutjanus adetii	Hussar
Pristipomoides multidens and P. typus	Goldband snappers
Lethrinus nebulosus	Spangled emperor
Pentacerotidae	Boarfish
Pentaceros decacanthus	Big-Spined Boarfish
Nemadactylus valenciennesi	Queen Snapper
Scomber scombrus	Mackerel
Scombridae spp.	Tunas
Balistidae and Monacanthidae	Leatherjacket
Sharks - other	Shark other

Table 16.6b From ERA Scoping Document - Demersal trawl. Discard species: from CS01 Logbook and Catch Disposal Records (CDR).

Species_name	Common name
N/A	Mixed reef fish
Dasyatididae family	Stingrays

Table 16.7 From ERA Scoping Document - Finfish Trap Trials. Discard species from Observer Reports/Logbooks combined.

Species_name	Common_name	Source	N = no logbook record
Abalistes stellaris	Starry Triggerfish	ObsRpt	
Balistidae and Monacanthidae	Leatherjacket	Obs/Lbk	
Bodianus sp [in Last et al. 1983]	Eastern Foxfish	Logbook	
Brachaelurus waddi	Blind Shark	ObsRpt	N
Caranx lugubris	Black trevally	ObsRpt	
Carcharhinus tilstoni	Black Tip Shark	ObsRpt	
Congridae "family"	Eel	Obs/Lbk	
Echeneis naucrates	Slender Suckerfish/sharksucker	ObsRpt	N
Family Triakidae	School and Gummy family	Logbook	
Fasciolariidae	Spindle Shell	ObsRpt	N
Gymnothorax favagineus	Black Blotched/tessellate Eel	ObsRpt	N
Gymnothorax nudivomer	yellowmouth Morey Eel	ObsRpt	N
Heniochus acuminatus	Featherfin/longfin Bullfish	ObsRpt	N
Heniochus diphreutes	Schooling Bannerfish	ObsRpt	
Lambis chiragra	Chiragra Conch	ObsRpt	N
Lethrinus variegatus	Variegated emperor	ObsRpt	
Lutjanus bohar	Red Bass	ObsRpt	
Lutjanus erythropterus	Saddle-tailed/crimson seaperch	Logbook	
Lutjanus gibbus	Paddletail	ObsRpt	
Lutjanus malabaracis	Scarlet seaperch/largemouth nannygai	Obs/Lbk	
Monacanthidae	Leatherjacket	ObsRpt	
Nautilus pompilius	Chambered/Emperor nautilus	ObsRpt	N
Nebrius ferrugineus	Tawny Shark	ObsRpt	
Pomacanthus imperator	Emperor angelfish	ObsRpt	N
Pterois volitans	Red Firefish/Common lionfish	ObsRpt	N
Rhynchobatidae	Sharkfin guitarfishes - Sand sharks	Logbook	
Scyllaridae	Bugs - Shovel nosed /slipper lobsters	Logbook	
Scyllarides squammosus	Slipper Lobster/Champagne crab	ObsRpt	N
Shells	Shells	Logbook	
Siganus sp.	Spinefoot	ObsRpt	
Strombidae	Stromb Shell	ObsRpt	N
Thamnaconus modestoides	Modest Leatherjacket	ObsRpt	N
Thyrsites atun	Barracouta	Logbook	
Trachyscorpia sp.	Deepsea Perch/Scorpionfish	Obs/Lbk	
	Hermit crab	ObsRpt	N
	Sea star	ObsRpt	N
	Darksnouth Houndshark	ObsRpt	N
	Leopard Moray	ObsRpt	N
	Sea fan	ObsRpt	N

Observer data

Observer data were provided as breakdowns of retained and discarded catch by numbers and weight. As so few observer data were available, and there was high inter-annual variability in the types of species recorded, the data was summarised for each year as:

- barplots of retained and discarded catch by species, but limited to species where the total (retained plus discarded) observed catch was greater than or equal to 10kg.
- annual pie charts of the total number of discarded fish by species (irrespective of total weight).

16.5.2 Results

Logbook data

An inter-annual time series of effort by gear type is presented as the number of fishing operations by day (Figure 16.1). Due to the wide range of gear types employed in the Coral Sea Fishery, the logbook data did not include effort by gear unit (e.g. number of hooks, hours of trawling). Figure 16.1 shows that effort in the CSF line, trawl and trap sectors was highest between 2003 and 2007, peaking at a total of over 600 days of fishing operations in 2007 (mostly attributed to "unknown", trawl and trap gears). Since 2007, total effort has remained below 120 days of operations, with negligible fishing in 2009 and 2012 (to date). "Unknown" gear types form the majority of fishing operations, with the remainder not dominated by any one gear type, with the exception of fish traps in 2005, and trawl and auto-longline in 2007.

Total annual catch increased steadily from less than 50t in 1998, to peak at over 250t in 2005. Catches subsequently decline and have remained at under 55t since 2008 (Figure 16.2). Reported discarding (recall that this is likely to be an underestimate of actual discards) followed a similar pattern, peaking at ~30t in 2005 before declining to the extent that no discarding has been reported in the logbooks since 2009 (Figure 16.2).

Annual summaries of total catch and total reported discards are presented for each gear type, and across all gear types, in Figure 16.3. Totals for reported catch and reported discards are presented both for *all* species reported in the logbooks, and for those 70 species designated as discard/bycatch species as per the above criteria. "Unknown", other line and auto-longline gears have the most consistent time series of catches, with demersal longline and trap catches peaking in 2005. There is little recorded trap catch outside of 2004-2005, and only 2004 and 2008 saw additional significant demersal longline catches. Trawling had the highest catches across all gear types between 2002 and 2004, and recorded significant catches from 2006-2007, but trawl catch was minimal in other years. Overall, catches peaked between 2002 and 2005, and again in 2007, but have been below 50000kg since 2007.

For most gear types in most years, it is interesting to note that the reported catches of the 70 species designated as bycatch/discard species (blue bars) form a significant (>50%) proportion of the total reported catch across all species (green

bars) (Figure 16.3). For demersal longline these 70 species embrace the majority of the catch. The exception is the trawl sector, for which only a small fraction of the catch comprises the 70 bycatch/discard species. For the remaining sectors, however, the fact that the apparent bycatch/discard species comprise a significant proportion of the reported catch is further weight to the argument that the term “bycatch” is not easily applicable to this fishery, and that identifying “typical” bycatch species is not straightforward. The issue of species mis-identification acknowledged to be prevalent in the logbook data (Dowling *et al.*, 2007) further complicates this issue. It should be noted, though, that the reported discard totals for the 70 assigned bycatch/discard species almost always comprise the entirety of the total reported discards across all species (Figure 16.3). This suggests that the list of 70 species does embrace those discards that are reported in the logbook records. Reported discards, however, are, for all gear types, extremely low in weight relative to the total reported catches (noting that the “reported discards” column in the logbook is not the same as the catch designated as bycatch, which is the total reported logbook catch of the 70 species identified as “bycatch” species from Table 16.1 - Table 16.7 (Figure 16.3).

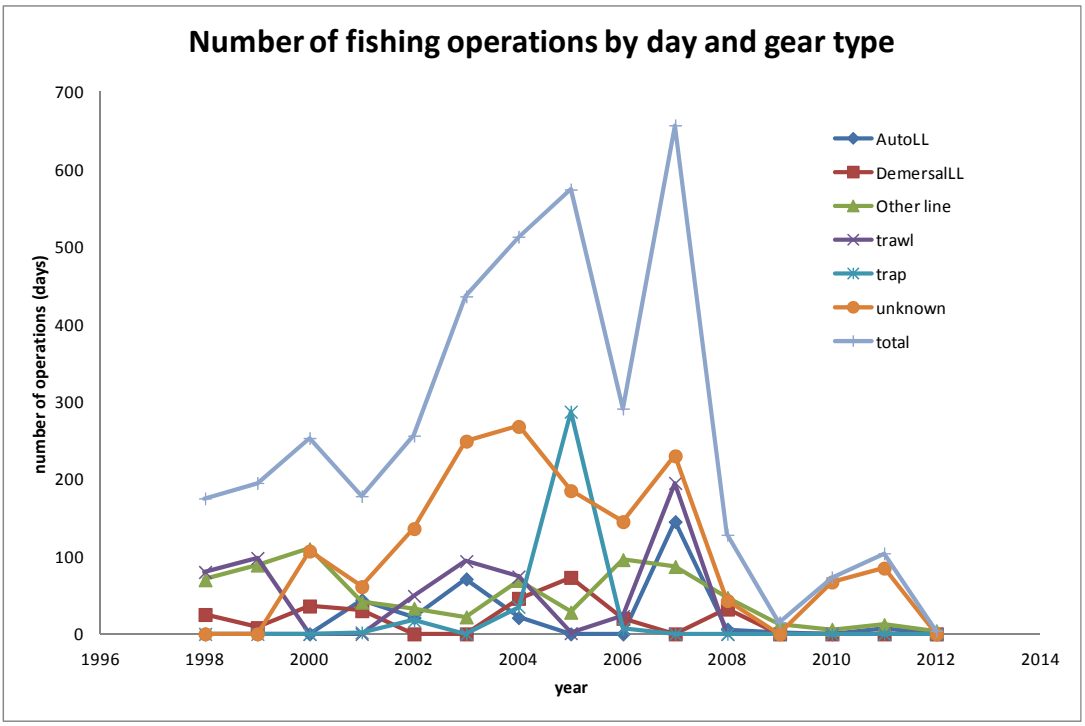


Figure 16.1 Annual number of fishing operations by day and gear type, derived from logbook records.

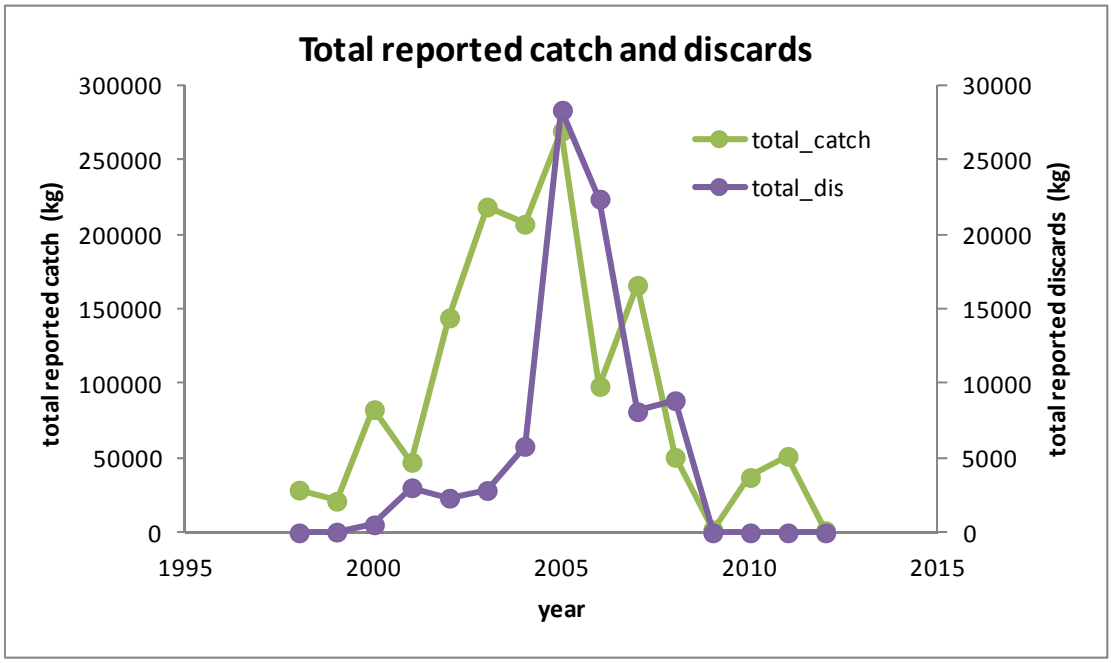
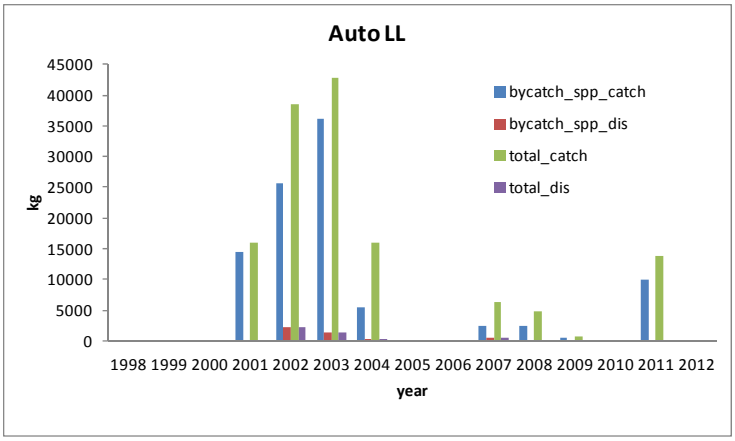
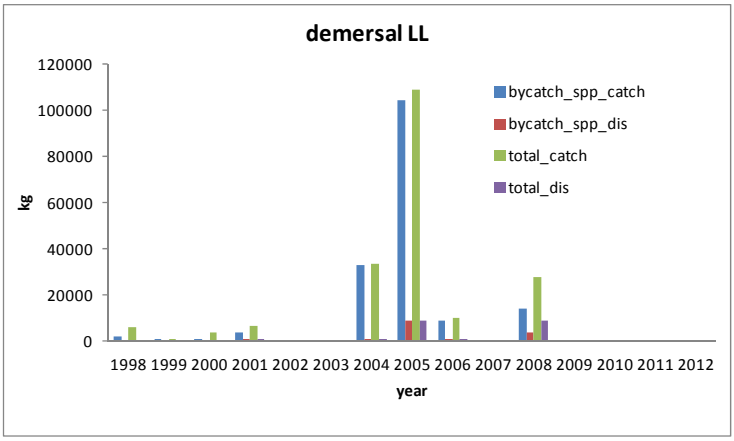
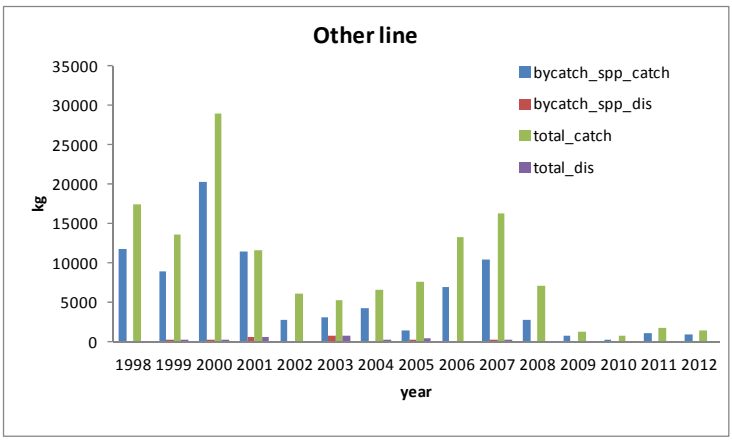
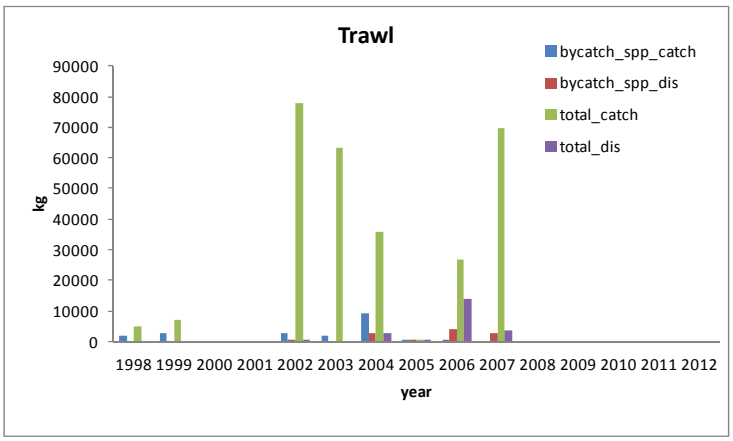


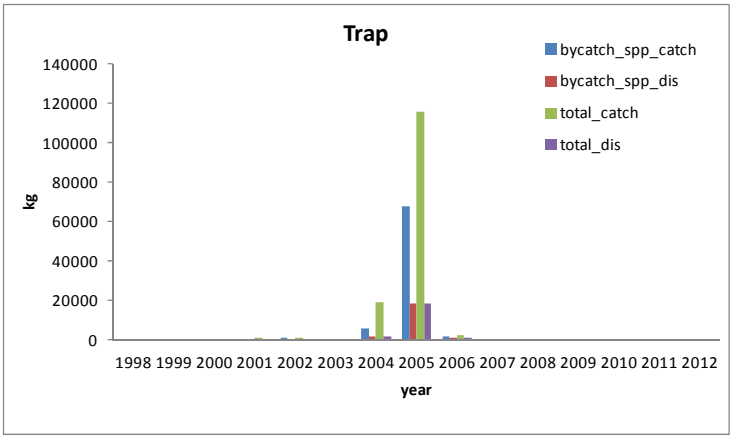
Figure 16.2 Annual time series of total reported catch and total reported discards, from logbook records.

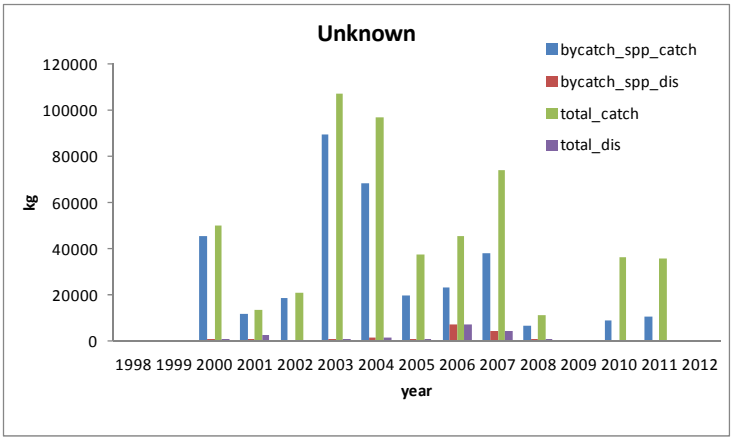












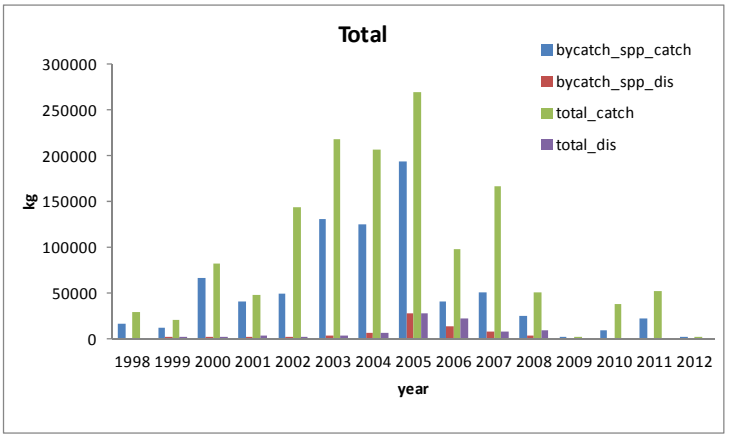


Figure 16.3 Annual logbook totals of total catch and total reported discards by gear type, for all reported species, and for those 70 species designated as discard/bycatch species as described in the text.

Section 16.7 presents the 70 species-specific panels annual time series of i) logbook reported catch and ii) logbook reported discards, each by the 6 gear categories. Gear category is indicated by the shape of the plotting character (see legend). Blue points and lines denote the reported catch[8] totals (see legend). Red points and lines denote the discard totals (see legend).

In order to provide a more succinct overview of the 70 panels presented in Section 16.7, Table 16.8 identifies the approximate peak annual reported catch and discard values and years, and main gear types, for the subset of species/species groups/families for which

- The annual logbook reported catch peaked at >1t and/or there were 2 or more years of appreciable catch, OR
- The annual logbook discards spanned 2 or more years, with an annual discard peak of >100kg.

[8] Recall that "reported catch" presumably includes both the marketable (target/byproduct) and, potentially, the bycatch total. Unfortunately, it is not possible to distinguish what fraction (if any) of the reported catch constitutes bycatch. The independent column for "discards" means that this catch is not necessarily a subset of the "reported catch". As such, bycatch information may be contained within both the "discards" and "reported catch" columns. Furthermore, consistency in how "discards" and "reported catch" are delineated, and in the extent of bycatch included in the "reported catch", cannot be assumed.

Table 16.8 Summary of i) approximate peak catch and discard values and ii) years, and iii) main gear types, for a subset of 31 species/species groups/families for which catch and discard annual values are as per the criteria described above.

Species	Approx peak catch (kg)	Peak catch year	Main gear - catch	Approx peak discard (kg)	Peak discard year	Main gear – discard
Whaler shark	>5000	2008	Demersal LL	~1500	2008	Demersal LL
Tiger shark	~25000	2005	Demersal LL	~1000	2008	Demersal LL
Blacktip shark	>35000	2005	Demersal LL	~1000	2008	Demersal LL
Scalloped hammerhead	>17500	2005	Demersal LL	<1000	2008	Demersal LL
Spurdog	~700	1998	Other line	~2000	2002	Auto LL
Greeneye dogfish	~320	2000	Other line	~450	2005	Unknown
Large mouth Nannygai	>7000	2000	Other line and unknown	~5000	2005	Trap
Tawny shark				>8000	2005	Demersal LL
Red bass	>3000	2010	Unknown	~12000	2005	Trap and demersal LL
Leatherjacket	~250	2007	Unknown	~500	2004	Trap and unknown
Whitetip reef shark	>20000	2005	Demersal LL	N/A (only low discards reported)		
Schooling bannerfish	N/A			~150	2005	Trap
Starry triggerfish	N/A (only low catches reported)			~1000	2005	Trap and unknown
Grass emperor	~3500	2005	Trap, unknown	N/A (only low discards reported)		
Tropical snapper/sea perch	~6500	2007	Unknown	~1000	2007	Unknown
Trevally	~1500	2006	Other line and unknown	~300	2003	Unknown
Shark - other	>9000	2001	Other line	N/A (only low discards reported)		
Hapuku	>4000	2003	Unknown	N/A		
Rock cods	>2000	2006	Unknown, other line	N/A		
Coral trout	~2500	2001	Mixed	N/A		
Bar rock cod	>10000	2004	Auto LL and	N/A		

Species	Approx peak catch (kg)	Peak catch year	Main gear - catch	Approx peak discard (kg)	Peak discard year	Main gear – discard
			unknown			
Samsonfish	~1100	2003	Unknown	N/A		
Red emperor	>28000	2005	Trap and unknown	N/A		
NW ruby fish	~25000	2003	Auto LL and unknown	N/A		
Green jobfish	>2000	2003	Mixed	N/A		
Rosy jobfish/king snapper	>60000	2003	Trap and unknown	N/A		
Goldband snappers	~8000	2003	unknown	N/A		
Spangled emperor	~1000	2000	Other line, trap, unknown	N/A		
Mackerel	~1500	2004	Trawl	>4000	2006	Trawl
Mixed reef fish	~3000	1998	Other line/mixed	~2700	2007	Trawl
Bugs – shovel nosed	>3000	2000	Other line and trawl	N/A		

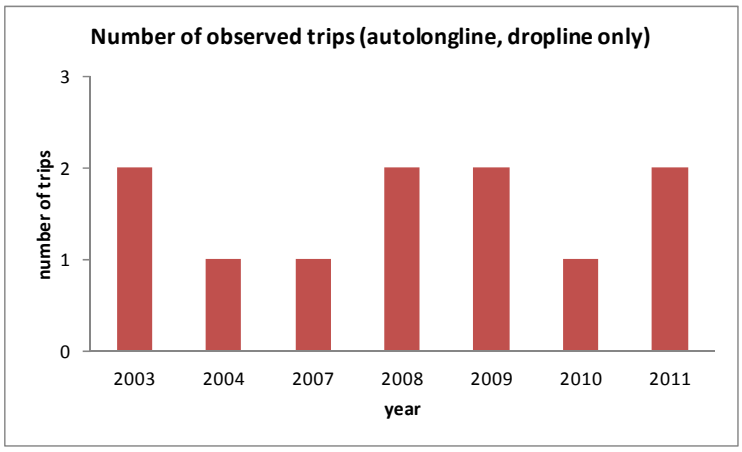
Observer data

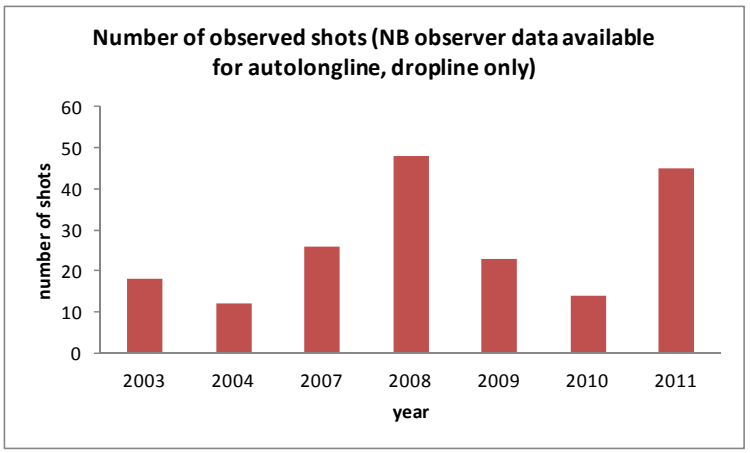
It cannot be emphasised strongly enough that summaries made from the existing observer data must be interpreted with extreme caution, since the coverage is so low and covers only two gear types across only seven years. No more than two trips were ever covered in any one year (Figure 16.4). In 2008 and 2011, more than 40 line shots were made on these trips, but less than 25 shots were made on trips covered by observers in any other year (Figure 16.4). The observed catch did embrace the majority of the logbook reported catch from 2009-2011 (being close to 100% in 2009 and 2011) (Figure 16.4), but it is reiterated that (i) only 1-2 trips were made in those years, (ii) only two gear types are included in the observer data; and (iii) the total catch for these gear types was low relative to that in other years (Figure 16.4).

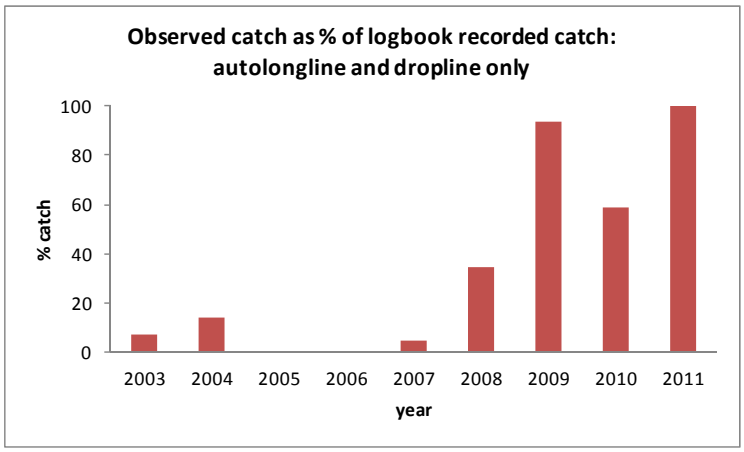
The observed retained auto-longline and dropline catch peaked at over 14000kg in 2011 (Figure 16.4), most of which was attributed to auto-longlining (Figure 16.3). Otherwise, observed retained catches for these two gears were less than 4000kg in any year (Figure 16.4). Observed discards were even lower, with the highest proportion of discards relative to the total take being ~ 26% in 2007, followed by ~21% in 2009, but otherwise being less than 15% (Figure 16.4).

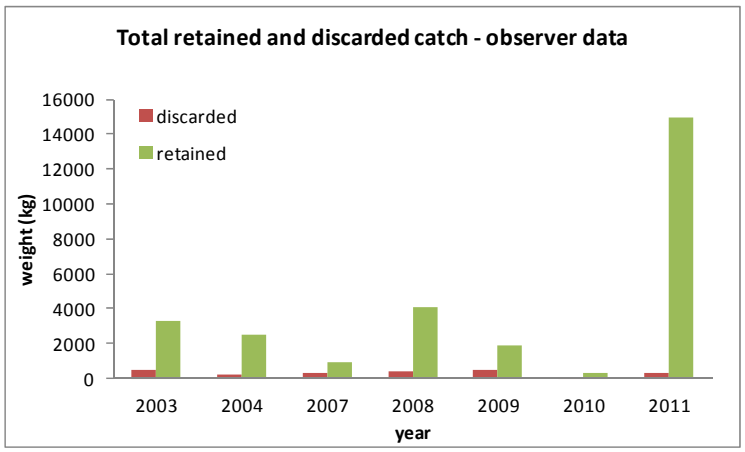
Section 16.8 presents:

- the barplots of retained and discarded catch by species (limited to species where the total (retained plus discarded) observed catch was greater than or equal to 10kg).
- annual pie charts of the total number of discarded fish by species (irrespective of total weight).









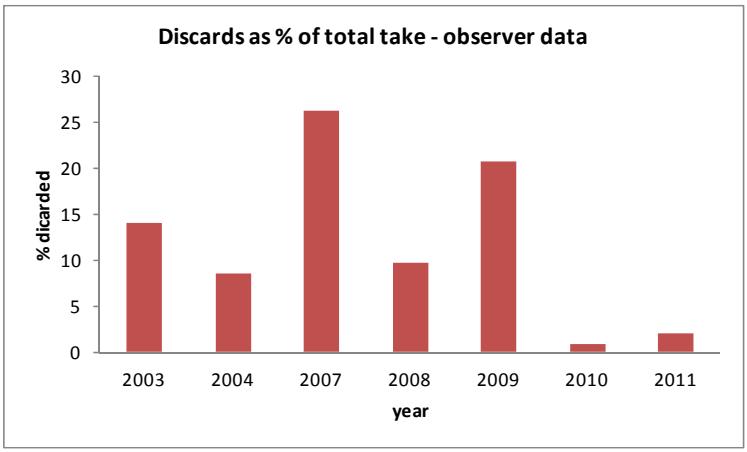


Figure 16.4 Annual barplots of i) number of observed trips; ii) number of observed shots; iii) observed catch as a percentage of the logbook auto-longline and dropline reported catch; iv) the total observed retained and discarded catch; v) observed discards as a percentage of the observed total take.

16.5.3 Interpretation of results

Logbook data

General observations from the 70 panels of time series plots of catch and discards (Section 16.7) are that:

- Logbook reported catches and discards are generally time- and gear-sporadic, with low tonnages. Of the 70 "discard" species/species groups/families with reported catches or discards, there were only 31 for which i) the annual logbook reported catch peaked at >1t and/or there were 2 or more years of appreciable catch, OR ii) the annual logbook discards spanned 2 or more years, with an annual discard peak of >100kg (as per Table 16.8).
- Annual reported discarding by species is generally low (<100kg) and temporally sporadic.
- Where reported discarding is higher (>100kg), this occurs in the years 2002-2008 only.
- All annual peaks in logbook catch or discarding occur prior to 2009. Commonwealth Harvest Strategies were implemented on July 1, 2008. However, since there was no introduction of quotas or TAC under the CSF Harvest Strategy, it is unlikely that the lower reported catches and discards post-2008 are related to the implementation of the Harvest Strategy.

More specifically, Table 16.8 shows that:

- The largest catches were reported against shark species (whaler, tiger, blacktip, scalloped hammerhead, white tip reef, other). Sharks are key species of concern according to the ERA outcomes. Shark catches and discards generally peaked in 2008 and 2005 (with the exception of "Shark – other" [peak catch 2001]). The primary gear was Demersal Longline. Trip limits for deepwater sharks were introduced in 2010, so this may partially explain why shark catches peaked prior to 2010.
- The majority of catch was reported against the Line Sector, although reported discarding was more evenly distributed between sectors.
- 2003 resulted in high reported catches for ruby jobfish/king snapper, and also for hapuka, samsonfish, northwest rubyfish, green jobfish and goldband snappers. Negligible discarding was reported against these species in any year.
- The Trawl Sector reported high levels of discard only against mackerel and the "mixed reef fish" species category.

Caveats in interpreting the above logbook data summaries:

- It is reiterated that the reported catch (in kg) may presumably include both the marketable (target/byproduct) and, potentially, the bycatch total. Unfortunately, it is not possible to distinguish what fraction (if any) of the reported catch constitutes bycatch. The independent column for "discards" means that this catch is not necessarily a subset of the "reported catch". As such, bycatch information may be contained within both the "discards" and "reported catch" columns. Furthermore, consistency in how "discards" and "reported catch" are delineated, and in the

extent of bycatch included in the “reported catch”, cannot be assumed. Logbook reported catches could be reconciled against the landing records from the SAN Landing logbook to obtain more accurate estimates of the discarded component of the catch, although the SAN Landing logbook data was unable to be accessed for this report.

- There is an issue not only with delineating bycatch from reported total catch and logbook discard information (as per the above point), but with unreported bycatch and discarding. Logbook figures may not be reflective of the true situation. Species mis-identification in the logbooks has also been flagged as an issue in the CSF (and, as evidenced in the above summaries, there are many instances where species are reported in logbooks by species groups or family).
- *Even if* the logbook data summaries could be considered reflective of the bycatch patterns in the Coral Sea Fishery Line, Trawl and Trap Sectors, due to the highly varied nature of the fishery in terms of:
    - gear type,
    - the high number of species captured
    - spatial extent
    - the exploratory nature of the fishery
    - the low Gross Value of Production (GVP) and number of operators
    - the lack of target species
    - the lack of hard management measures (e.g. quotas)

any patterns in the above data summaries are unlikely to reflect mandated gear constraints, or changing effort distributions. They are most likely simply due to low sample sizes and the highly varied and unconstrained nature of the fishery.

Observer data

The observer data is extremely sporadic in nature and covers only auto-longline and dropline gear types, across only 7 years. However, the following is noted from the figures presented in Section 16.8:

- The observer list of discarded species varies considerably between years and from the list of 70 discard/bycatch species that was derived from the 2009 BRS Fishery Status Report and the ERA Scoping Documents (Wilson *et al.*, 2010).
- The observer list of retained species varies considerably between years. Since 2008, flame snapper, rosy snapper and paddletail seabream consistently form a high proportion of the observed retained catch, while high retained catches of blue-eye trevalla were observed in 2004 and 2011.
- Observed discards by weight are relatively low compared to observed retained catches. The peak amount of discarding by species was 271kg of Eastern Highfin Spurdog in 2003. There is no observed single species discarding in any year in excess of 165kg.

- A common feature across years for the observed auto-longline and dropline discards is that shark and dogfish species typically comprise a large fraction (if not the majority) of the species discarded by weight. Red bass (2007-2009) and yellowfin tuna (2008, 2011) also feature prominently in the observed discards. Recall that the take of tuna species by the CSF line sector is not permitted. Trip limits for deepwater sharks were introduced in 2010, but the observer coverage of shark discarding in the single year of 2011 is insufficient to determine their effectiveness.

Given the relatively high level of observer coverage, particularly in recent years (at least 25%), it may be thought that greater insight into bycatch patterns could be obtained from observer reports. However, the temporally sporadic and generally low-value discarding/bycatch patterns obtained from logbook data, across a wide range of species, suggest otherwise, as does the fact that the available observer data includes only auto-longline and dropline gears, and generally (with the exception of the low-catch years of 2009 and 2011), only a low fraction of the recorded logbook catches from these gears. As flawed though the extent of and consistency in logbook reporting may be, logbooks nonetheless provide records against every fishing operation.

While the observer reports may more clearly delineate between marketable catch and bycatch (i.e. discards, although discarding may occur for other reasons), the highly varied nature of the fishery and the extremely low sample sizes from a limited number of gear types imply that bycatch data summaries from observer reports should be interpreted with extreme caution. They are, however, likely to provide a more accurate summary of discarding practices for the auto-longline and dropline gears for which observer data are available.

The main message from the available observer data is that shark and dogfish species are suggested to feature prominently in auto-longline and dropline discards. Even so, discards cannot be assumed to equate to the total amount of bycatch, as not all of what would be considered bycatch is necessarily discarded. Note also that there are unexplained discrepancies between the data summarised here and that presented elsewhere. For example, Wilson *et al.* (2010) cites a total of 560 kg of tiger shark discard in 2007-08 and 120kg in 2008-09. While there is no mention of the source of this information, the extracted logbook reports for these years do not reflect these quantities (second panel in Section 16.7), but neither do the available observer data (no records of tiger shark catch or discards from 2007-2009).

16.6 References

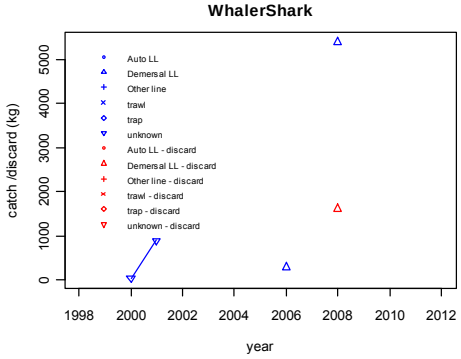
AFMA 2010. Bycatch and Discarding Workplan 1 July 2010 to 30 June 2012. Australian Fisheries Management Authority, Canberra.

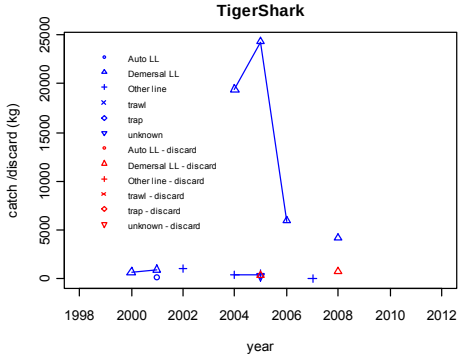
Anon. 2006. ERA Scoping Documents in Furlani, D., Dowdney, J., Bulman, C., Sporcic, M. and Fuller, M. 2006. Ecological Risk Assessment for the Effects of Fishing: Report for the Aquarium, the Sea Cucumber and the Lobster and Trochus Sub-fisheries of the Coral Sea Fishery. Report for the Australian Fisheries Management Authority, Canberra.

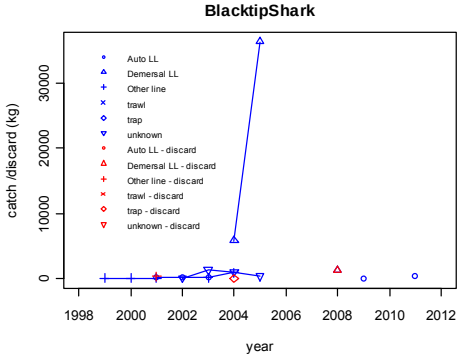
Dowling, N.A., Smith, D.C. and Smith, A.D.M. 2007. Finalisation of Harvest Strategies for AFMA's Small Fisheries. Final report for Project 2007/834 to the Australian Fisheries Management Authority, Canberra

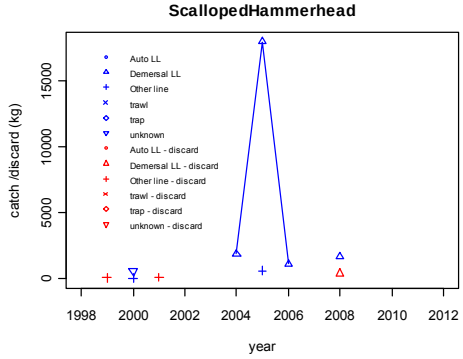
Wilson, D.T., Curtotti, R. and Begg, G. (eds) 2010. Fishery status reports 2009. Status of fish stocks managed by the Australian Government, Australian Bureau of Agricultural and Resource Economics – Bureau of Rural Sciences, Canberra.

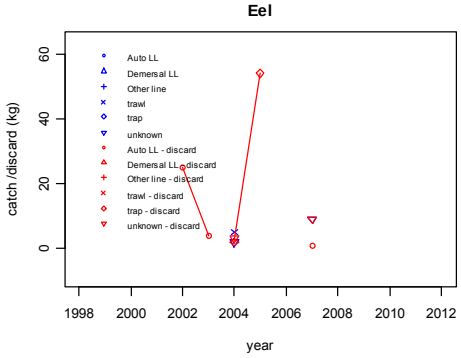
16.7 Bycatch data summaries from logbook records

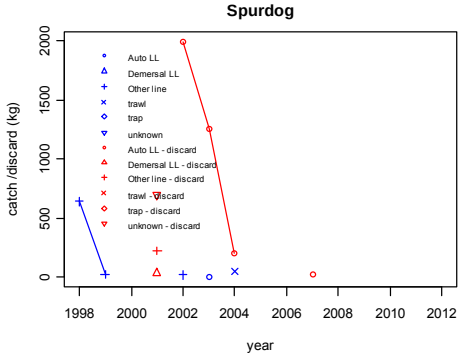


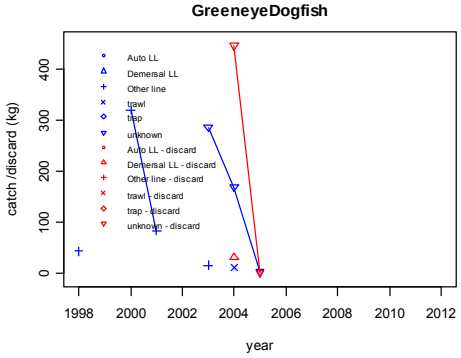


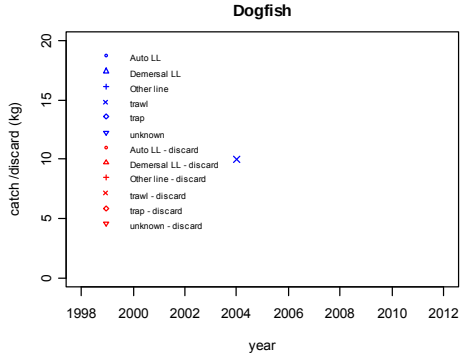


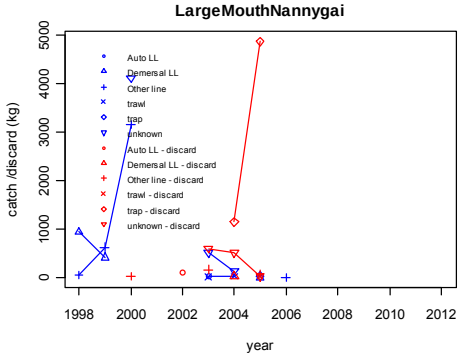


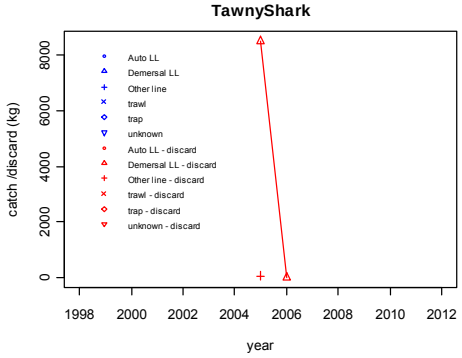


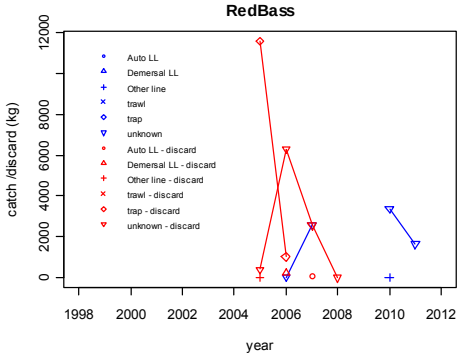


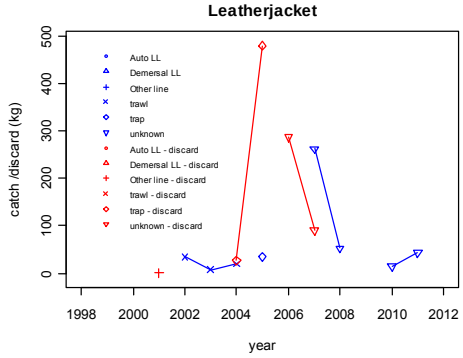


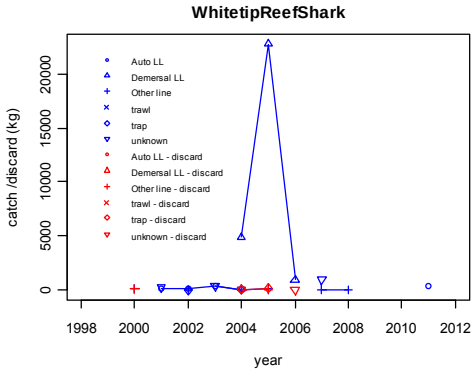


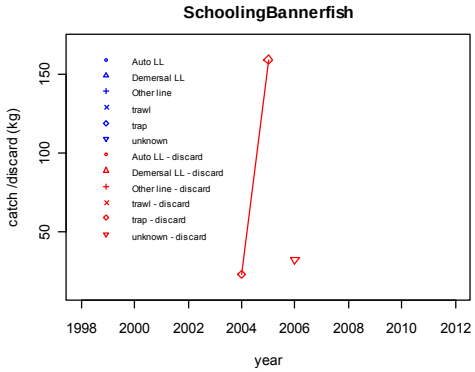


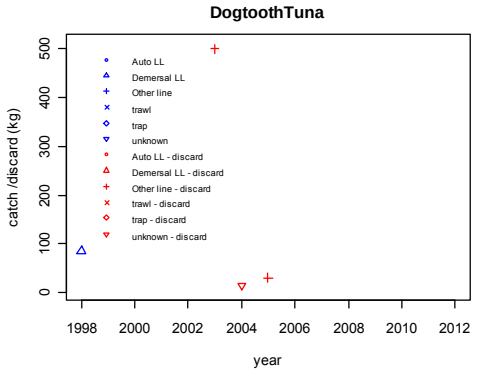


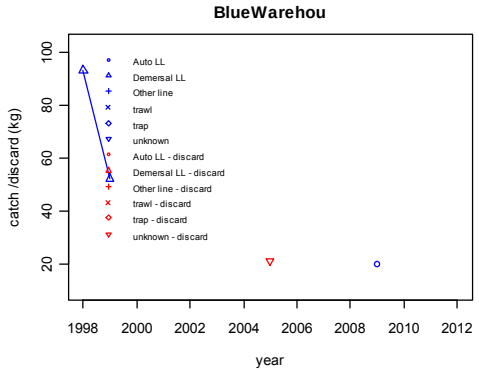





WhitetipReefShark
catch /discard (kg)
year
Auto LL
Demersal LL
Other line
trawl
trap
unknown
Auto LL - discard
Demersal LL - discard
Other line - discard
trawl - discard
trap - discard
unknown - discard


SchoolingBannerfish
catch /discard (kg)
year
Auto LL
Demersal LL
Other line
trawl
trap
unknown
Auto LL - discard
Demersal LL - discard
Other line - discard
trawl - discard
trap - discard
unknown - discard


DogtoothTuna
catch /discard (kg)
year
Auto LL
Demersal LL
Other line
trawl
trap
unknown
Auto LL - discard
Demersal LL - discard
Other line - discard
trawl - discard
trap - discard
unknown - discard


BlueWarehou
catch /discard (kg)
year
Auto LL
Demersal LL
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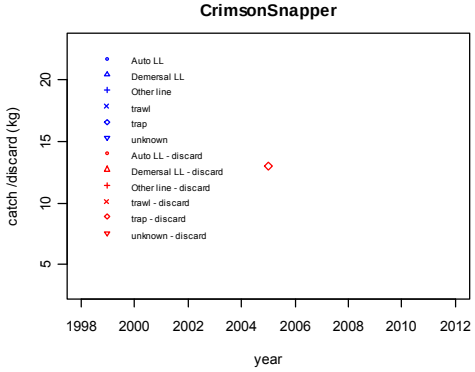
trawl
trap
unknown
Auto LL - discard
Demersal LL - discard
Other line - discard
trawl - discard
trap - discard
unknown - discard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catch /discard (kg)
year
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Other line - discard
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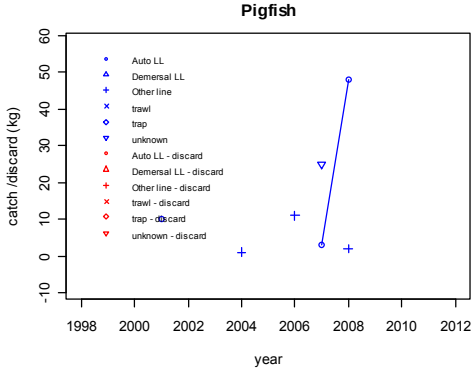
trap - discard
unknown - discard


Pigfish
catch /discard (kg)
year
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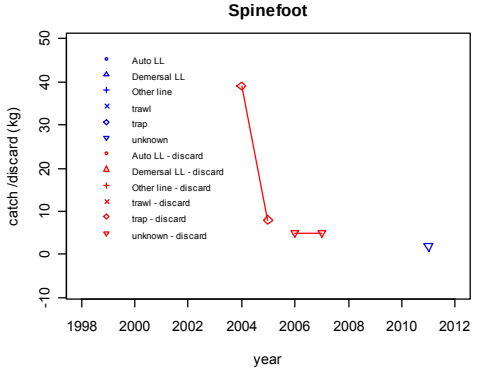
trap - discard
unknown - discard


Spinefoot
catch /discard (kg)
year
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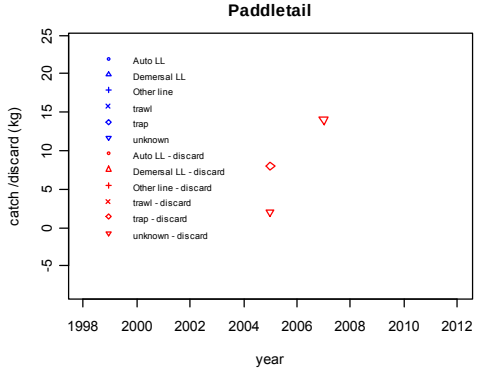
Demersal LL - discard
Other line - discard
trawl - discard
trap - discard
unknown - discard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trap - discard
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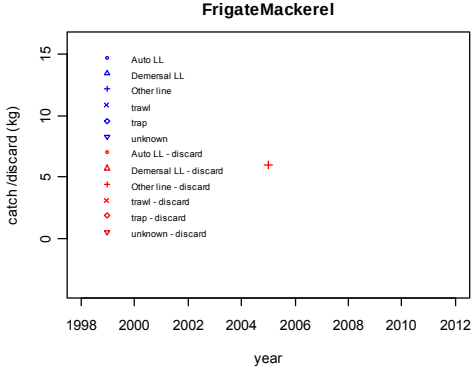
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catch /discard (kg)
year
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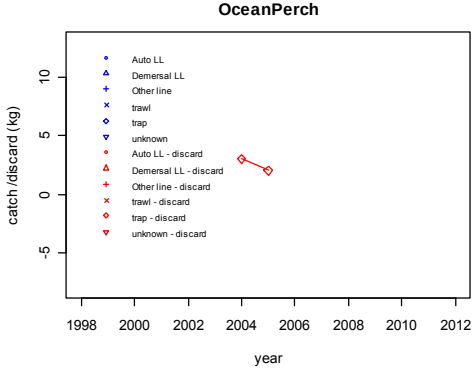
trawl - discard
trap - discard
unknown - discard


OceanPerch
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year
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trap
unknown
Auto LL - discard
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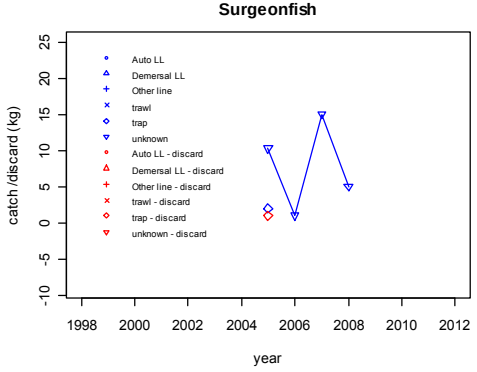
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Other line - discard
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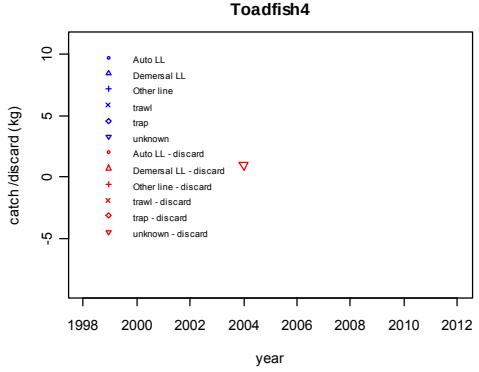
trap - discard
unknown - discard


Toadfish4
catch /discard (kg)
year
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trap
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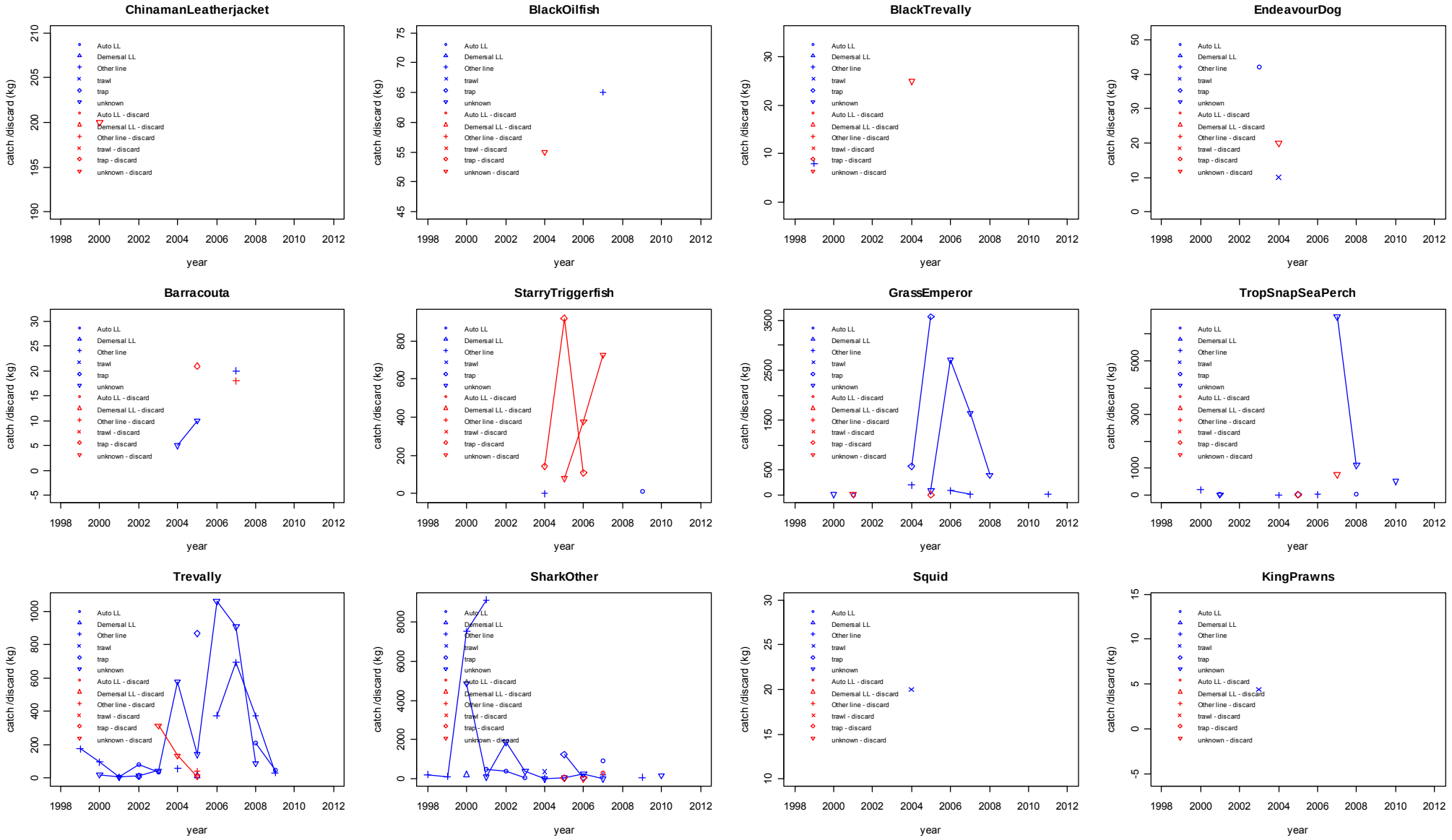
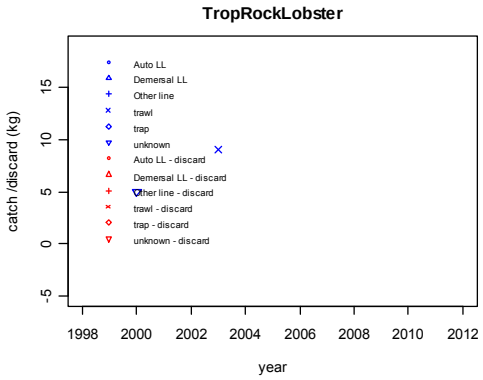
Other line - discard
trawl - discard
trap - discard
unknown - discard


ChinamanLeatherjacket
BlackOilfish
BlackTrevally
EndeavourDog
Barracouta
StarryTriggerfish
GrassEmperor
TropSnapSeaPerch
Trevally
SharkOther
Squid
KingPrawns
catch /discard (kg)
year
Auto LL
Demersal LL
Other line
trawl
trap
unknown
Auto LL - discard
Demersal LL - discard
Other line - discard
trawl - discard
trap - discard
unknown - discard


TropRockLobster
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year
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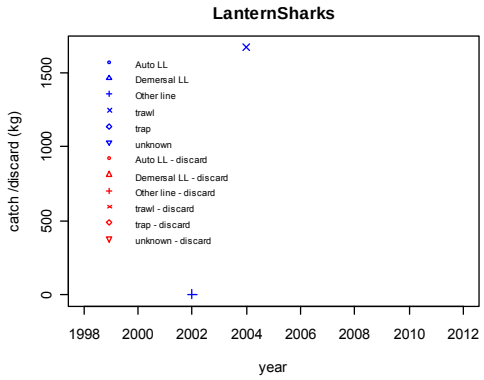
Demersal LL
Other line
trawl
trap
unknown
Auto LL - discard
Demersal LL - discard
Other line - discard
trawl - discard
trap - discard
unknown - discard


LanternSharks
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trap
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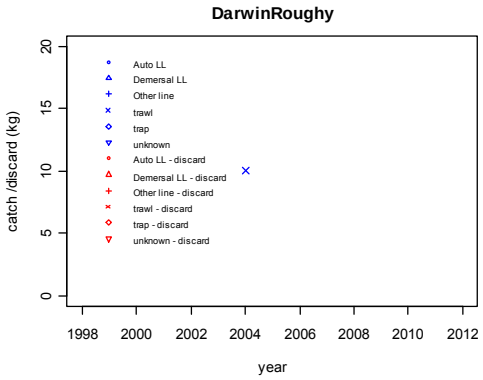
Other line - discard
trawl - discard
trap - discard
unknown - discard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trap
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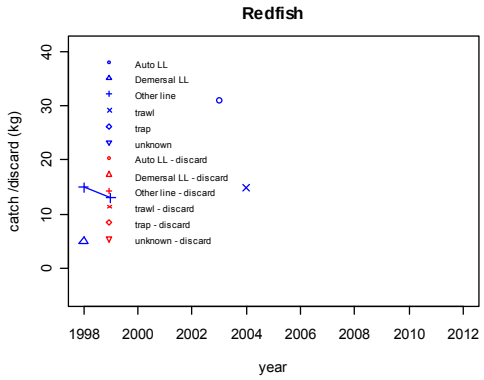
Other line - discard
trawl - discard
trap - discard
unknown - discard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year
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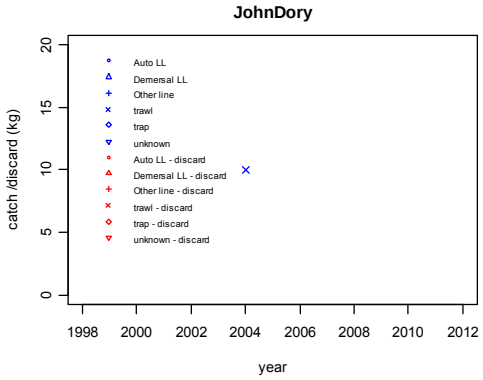
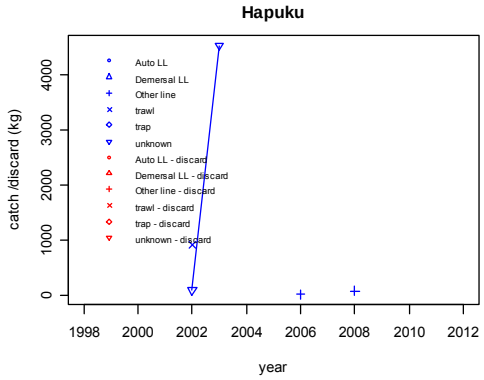
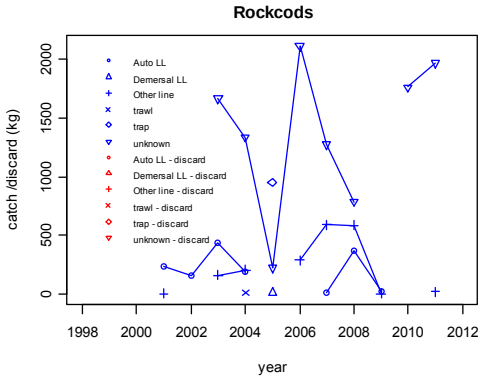
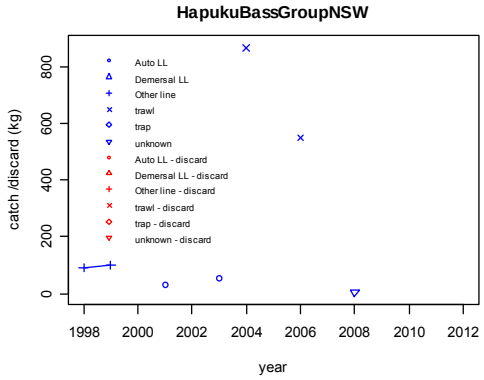
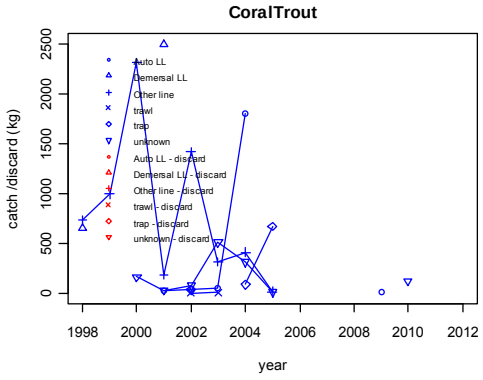
Other line - discard
trawl - discard
trap - discard
unknown - discard

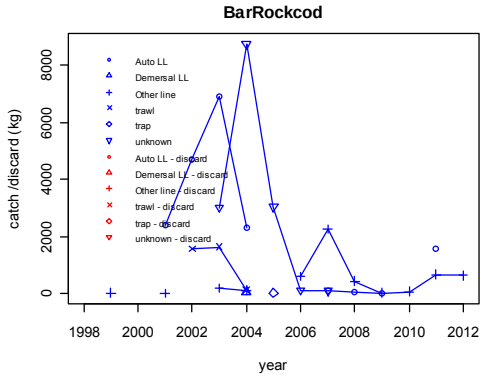

JohnDory
catch /discard (kg)
year
Auto LL
Demersal LL
Other line
trawl
trap
unknown
Auto LL - discard
Demersal LL - discard
Other line - discard
trawl - discard
trap - discard
unknown - discard

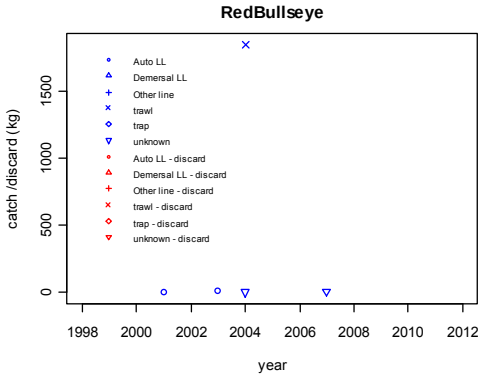

Hapuku
catch /discard (kg)
year
Auto LL
Demersal LL
Other line
trawl
trap
unknown
Auto LL - discard
Demersal LL - discard
Other line - discard
trawl - discard
trap - discard
unknown - discard

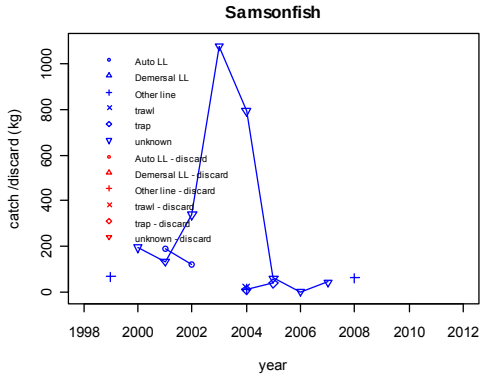

Rockcods
catch /discard (kg)
year
Auto LL
Demersal LL
Other line
trawl
trap
unknown
Auto LL - discard
Demersal LL - discard
Other line - discard
trawl - discard
trap - discard
unknown - discard

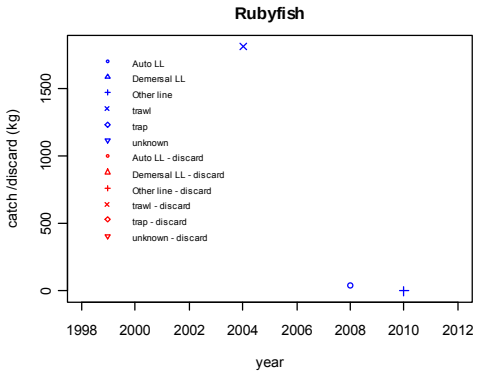

HapukuBassGroupNSW
catch /discard (kg)
year
Auto LL
Demersal LL
Other line
trawl
trap
unknown
Auto LL - discard
Demersal LL - discard
Other line - discard
trawl - discard
trap - discard
unknown - discard

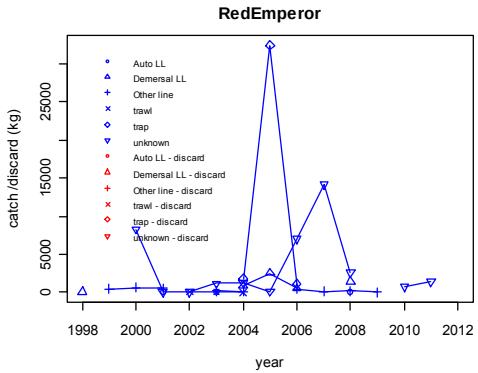

CoralTrout
catch /discard (kg)
year
Auto LL
Demersal LL
Other line
trawl
trap
unknown
Auto LL - discard
Demersal LL - discard
Other line - discard
trawl - discard
trap - discard
unknown - discard

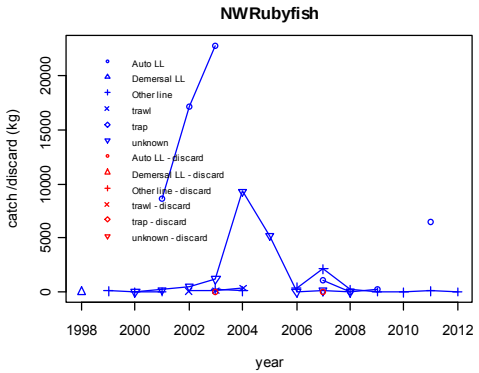

BarRockcod
catch /discard (kg)
year
Auto LL
Demersal LL
Other line
trawl
trap
unknown
Auto LL - discard
Demersal LL - discard
Other line - discard
trawl - discard
trap - discard
unknown - discard

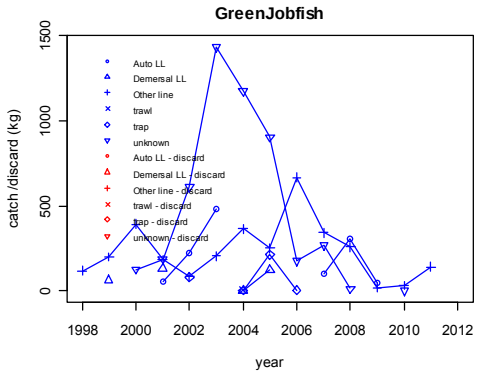

RedBullseye
catch /discard (kg)
year
Auto LL
Demersal LL
Other line
trawl
trap
unknown
Auto LL - discard
Demersal LL - discard
Other line - discard
trawl - discard
trap - discard
unknown - discard

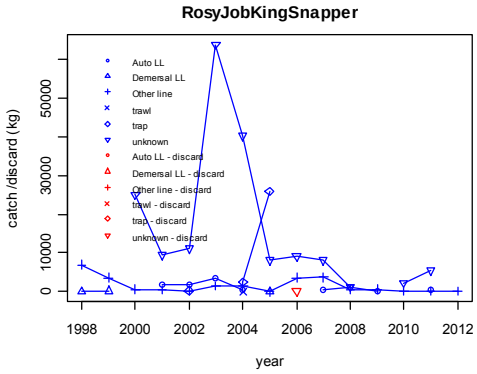

Samsonfish
catch /discard (kg)
year
Auto LL
Demersal LL
Other line
trawl
trap
unknown
Auto LL - discard
Demersal LL - discard
Other line - discard
trawl - discard
trap - discard
unknown - discard

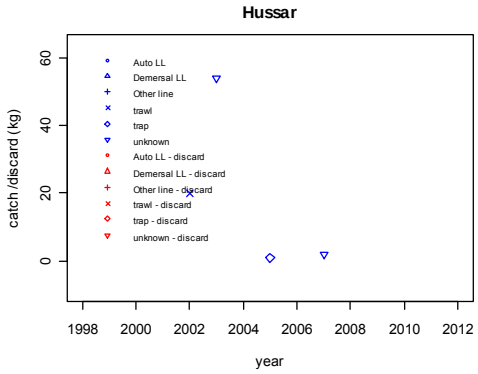

Rubyfish
catch /discard (kg)
year
Auto LL
Demersal LL
Other line
trawl
trap
unknown
Auto LL - discard
Demersal LL - discard
Other line - discard
trawl - discard
trap - discard
unknown - discard

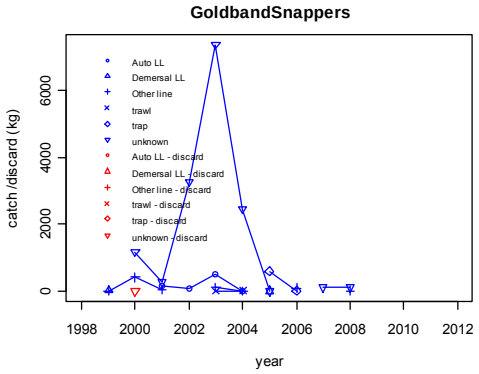

RedEmperor
catch /discard (kg)
year
Auto LL
Demersal LL
Other line
trawl
trap
unknown
Auto LL - discard
Demersal LL - discard
Other line - discard
trawl - discard
trap - discard
unknown - discard

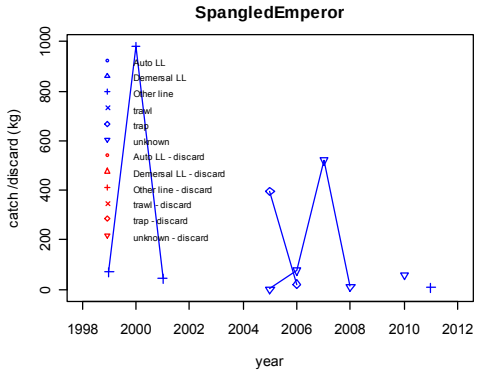

NWRubyfish
catch /discard (kg)
year
Auto LL
Demersal LL
Other line
trawl
trap
unknown
Auto LL - discard
Demersal LL - discard
Other line - discard
trawl - discard
trap - discard
unknown - discard

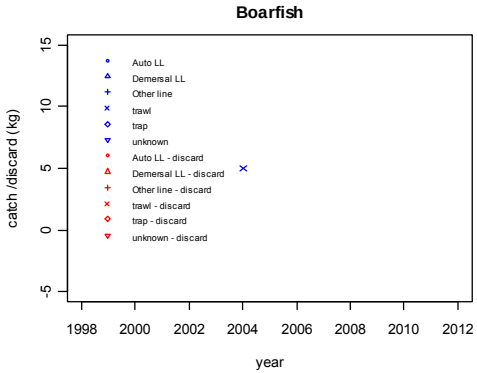

GreenJobfish
catch /discard (kg)
year
Auto LL
Demersal LL
Other line
trawl
trap
unknown
Auto LL - discard
Demersal LL - discard
Other line - discard
trawl - discard
trap - discard
unknown - discard

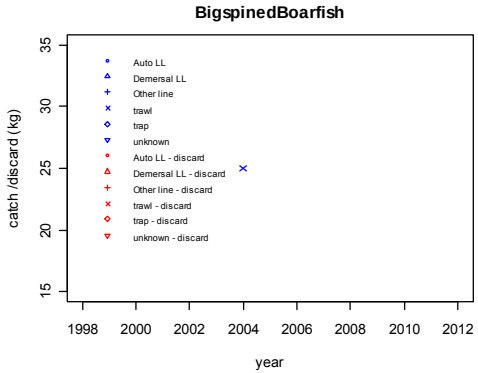

RosyJobKingSnapper
catch /discard (kg)
year
Auto LL
Demersal LL
Other line
trawl
trap
unknown
Auto LL - discard
Demersal LL - discard
Other line - discard
trawl - discard
trap - discard
unknown - discard

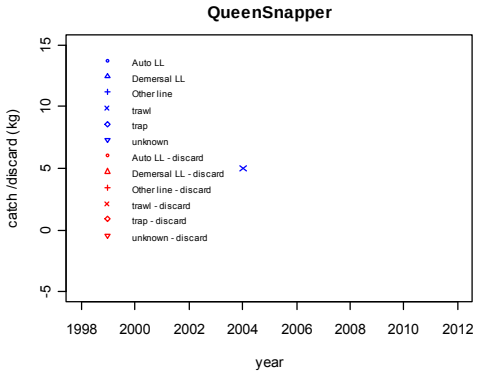

Hussar
catch /discard (kg)
year
Auto LL
Demersal LL
Other line
trawl
trap
unknown
Auto LL - discard
Demersal LL - discard
Other line - discard
trawl - discard
trap - discard
unknown - discard

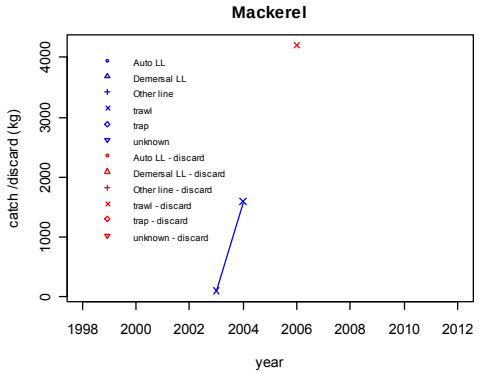

GoldbandSnappers
catch /discard (kg)
year
Auto LL
Demersal LL
Other line
trawl
trap
unknown
Auto LL - discard
Demersal LL - discard
Other line - discard
trawl - discard
trap - discard
unknown - discard

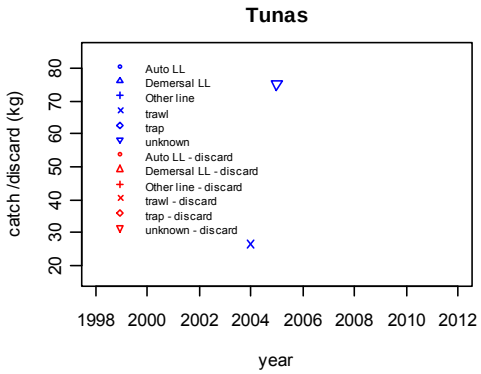

SpangledEmperor
catch /discard (kg)
year
Auto LL
Demersal LL
Other line
trawl
trap
unknown
Auto LL - discard
Demersal LL - discard
Other line - discard
trawl - discard
trap - discard
unknown - discard

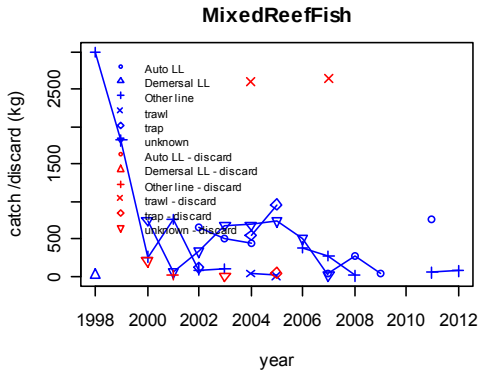

Boarfish
catch /discard (kg)
year
Auto LL
Demersal LL
Other line
trawl
trap
unknown
Auto LL - discard
Demersal LL - discard
Other line - discard
trawl - discard
trap - discard
unknown - discard

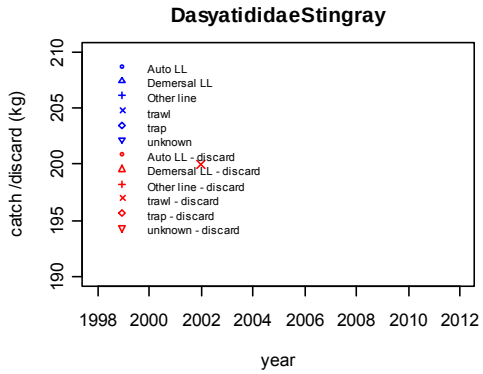

BigspinedBoarfish
catch /discard (kg)
year
Auto LL
Demersal LL
Other line
trawl
trap
unknown
Auto LL - discard
Demersal LL - discard
Other line - discard
trawl - discard
trap - discard
unknown - discard

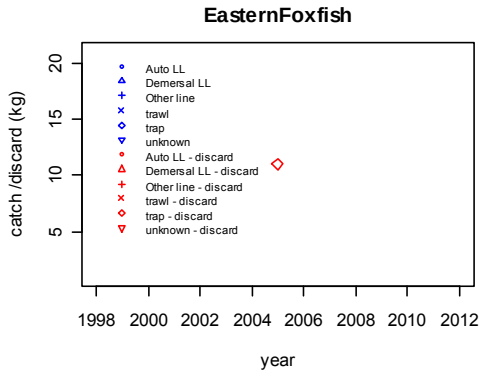

QueenSnapper
catch /discard (kg)
year
Auto LL
Demersal LL
Other line
trawl
trap
unknown
Auto LL - discard
Demersal LL - discard
Other line - discard
trawl - discard
trap - discard
unknown - discard

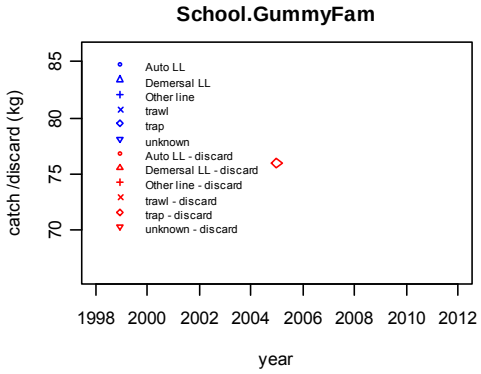

Mackerel
catch /discard (kg)
year
Auto LL
Demersal LL
Other line
trawl
trap
unknown
Auto LL - discard
Demersal LL - discard
Other line - discard
trawl - discard
trap - discard
unknown - discard

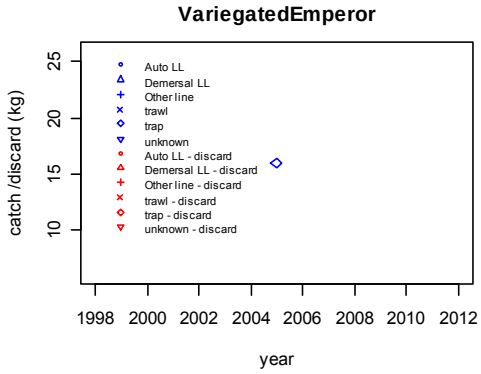

Tunas
catch /discard (kg)
year
Auto LL
Demersal LL
Other line
trawl
trap
unknown
Auto LL - discard
Demersal LL - discard
Other line - discard
trawl - discard
trap - discard
unknown - discard

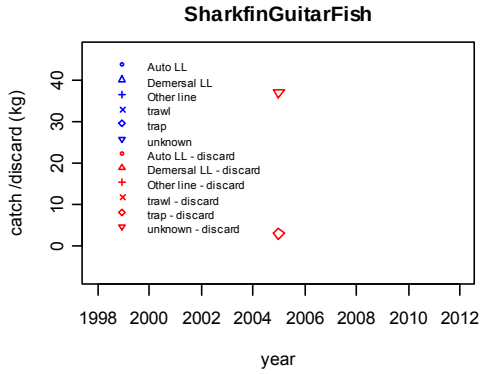

MixedReefFish
catch /discard (kg)
year
Auto LL
Demersal LL
Other line
trawl
trap
unknown
Auto LL - discard
Demersal LL - discard
Other line - discard
trawl - discard
trap - discard
unknown - discard

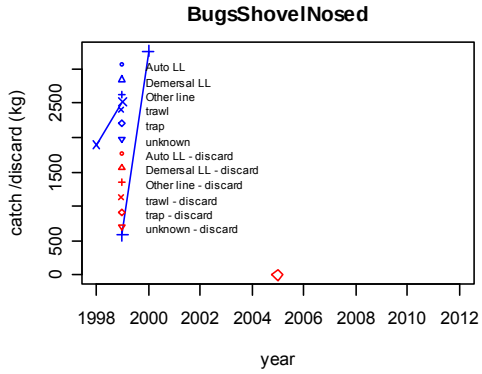

DasyatididaeStingray
catch /discard (kg)
year
Auto LL
Demersal LL
Other line
trawl
trap
unknown
Auto LL - discard
Demersal LL - discard
Other line - discard
trawl - discard
trap - discard
unknown - discard

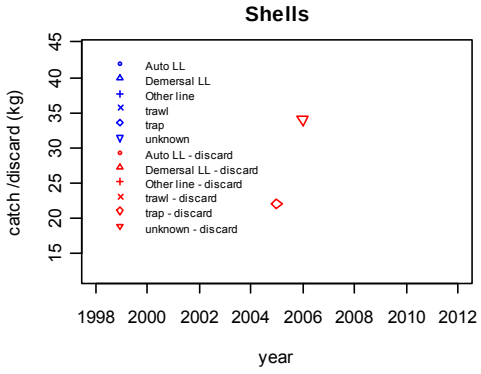

EasternFoxfish
catch /discard (kg)
year
Auto LL
Demersal LL
Other line
trawl
trap
unknown
Auto LL - discard
Demersal LL - discard
Other line - discard
trawl - discard
trap - discard
unknown - discard

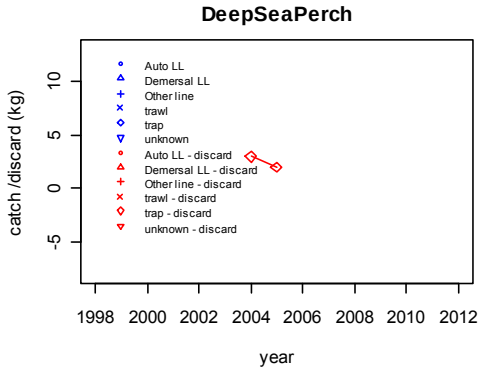

School.GummyFam
catch /discard (kg)
year
Auto LL
Demersal LL
Other line
trawl
trap
unknown
Auto LL - discard
Demersal LL - discard
Other line - discard
trawl - discard
trap - discard
unknown - discard


VariegatedEmperor
catch /discard (kg)
year
Auto LL
Demersal LL
Other line
trawl
trap
unknown
Auto LL - discard
Demersal LL - discard
Other line - discard
trawl - discard
trap - discard
unknown - discard

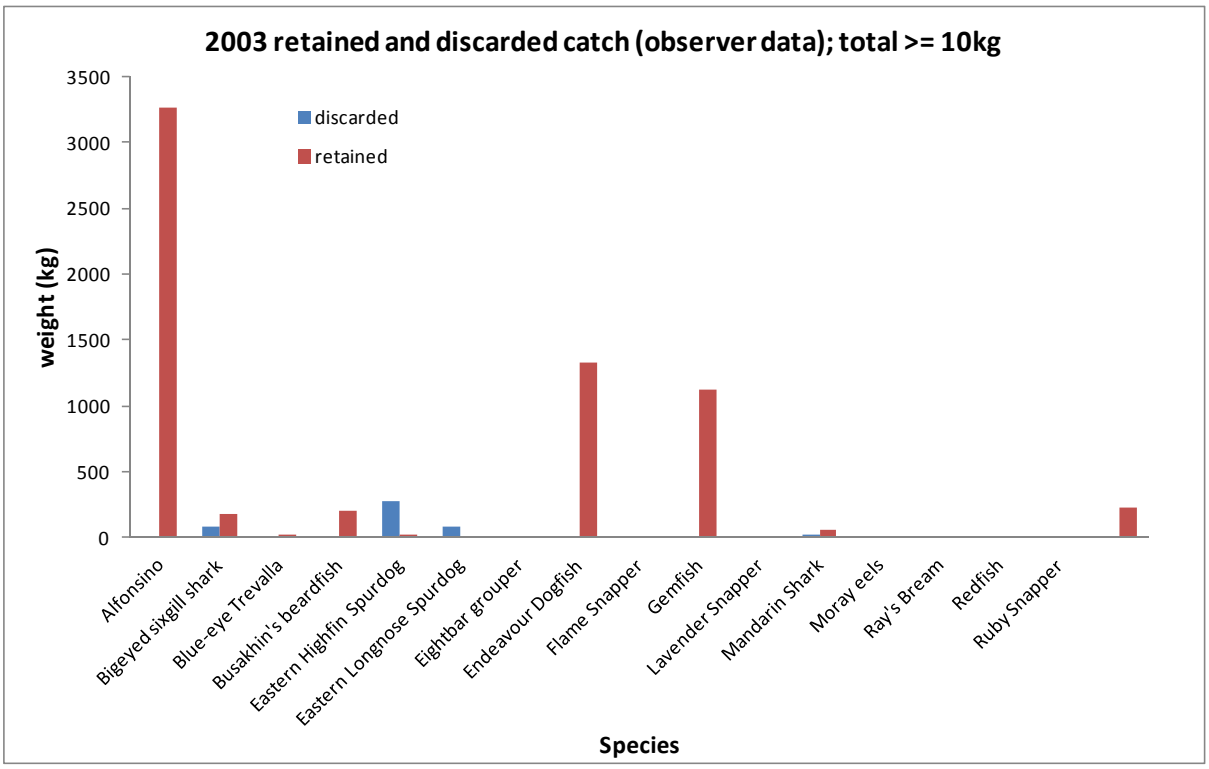

SharkfinGuitarFish
catch /discard (kg)
year
Auto LL
Demersal LL
Other line
trawl
trap
unknown
Auto LL - discard
Demersal LL - discard
Other line - discard
trawl - discard
trap - discard
unknown - discard

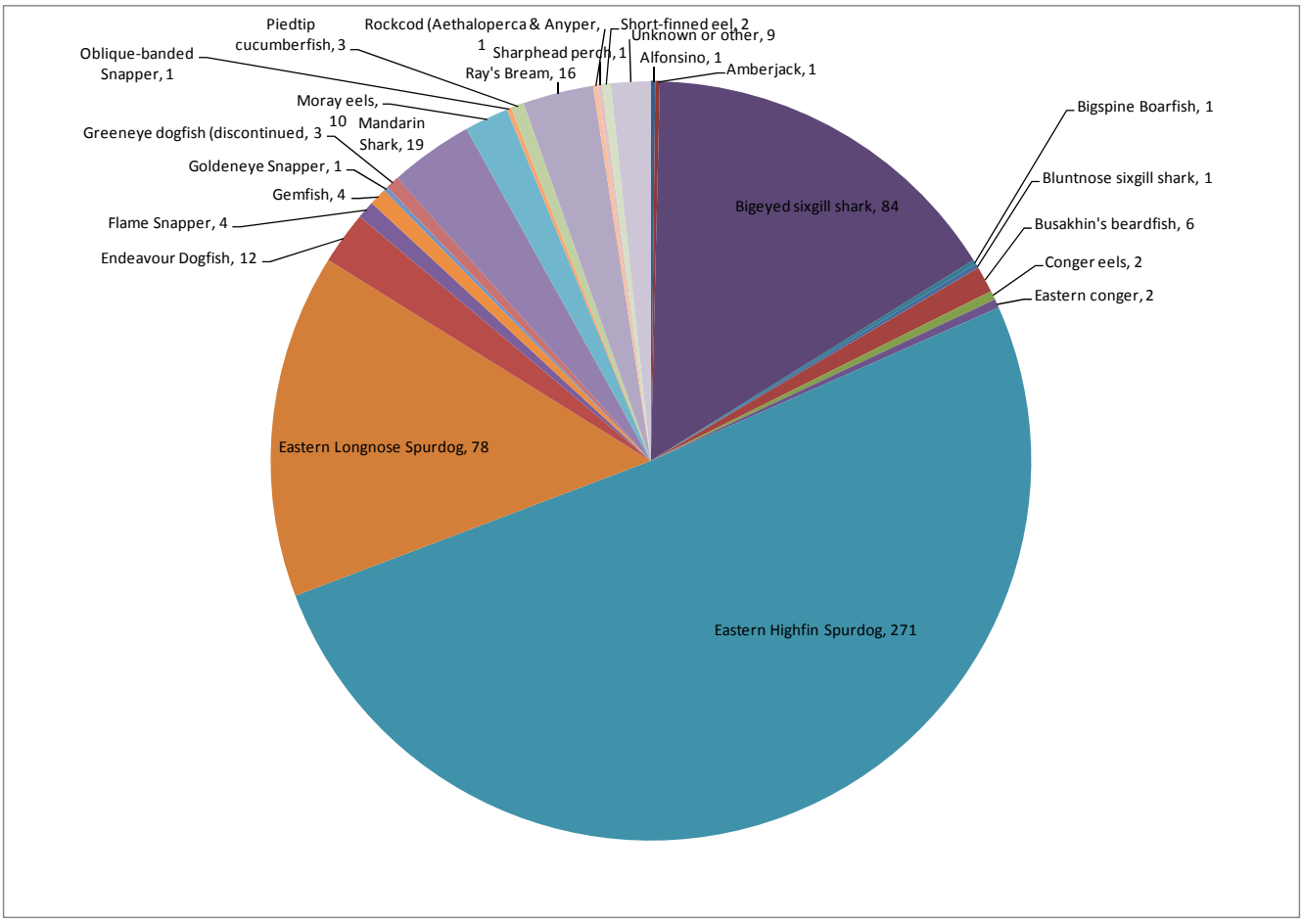

BugsShovelNosed
catch /discard (kg)
year
Auto LL
Demersal LL
Other line
trawl
trap
unknown
Auto LL - discard
Demersal LL - discard
Other line - discard
trawl - discard
trap - discard
unknown - discard


Shells
catch /discard (kg)
year
Auto LL
Demersal LL
Other line
trawl
trap
unknown
Auto LL - discard
Demersal LL - discard
Other line - discard
trawl - discard
trap - discard
unknown - discard

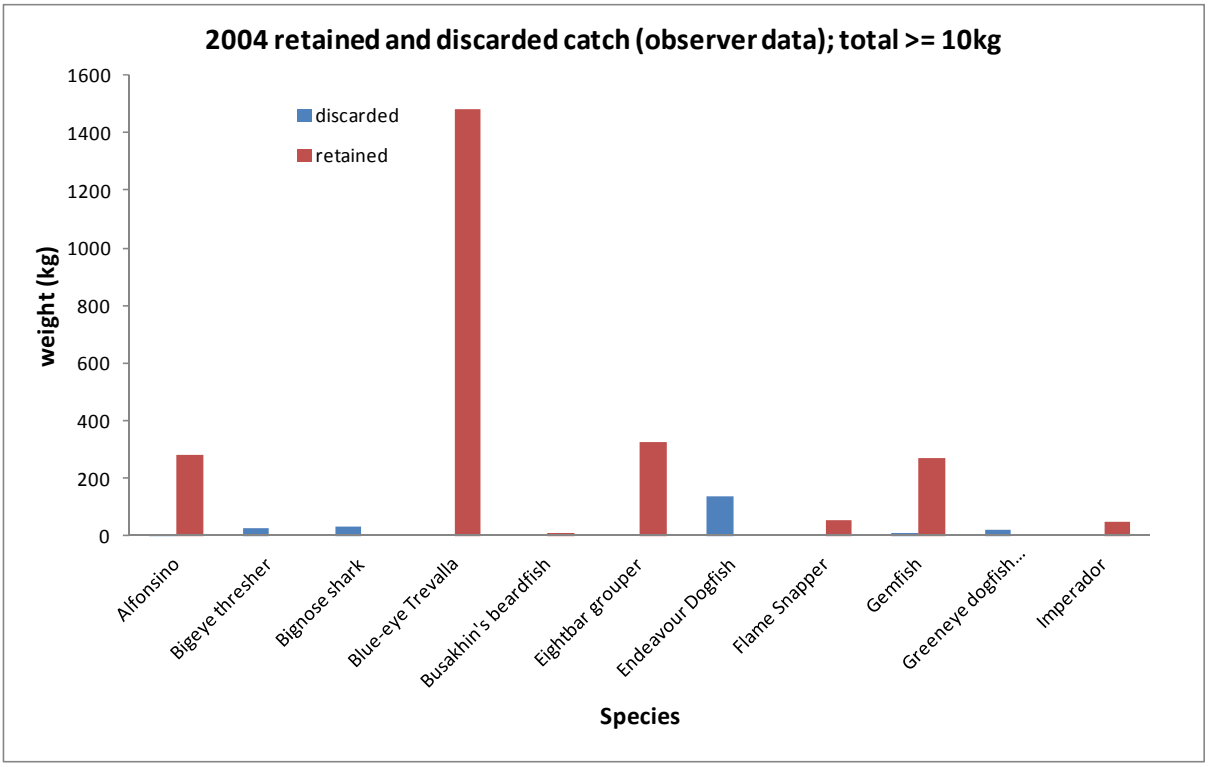

DeepSeaPerch
catch /discard (kg)
year
Auto LL
Demersal LL
Other line
trawl
trap
unknown
Auto LL - discard
Demersal LL - discard
Other line - discard
trawl - discard
trap - discard
unknown - discard

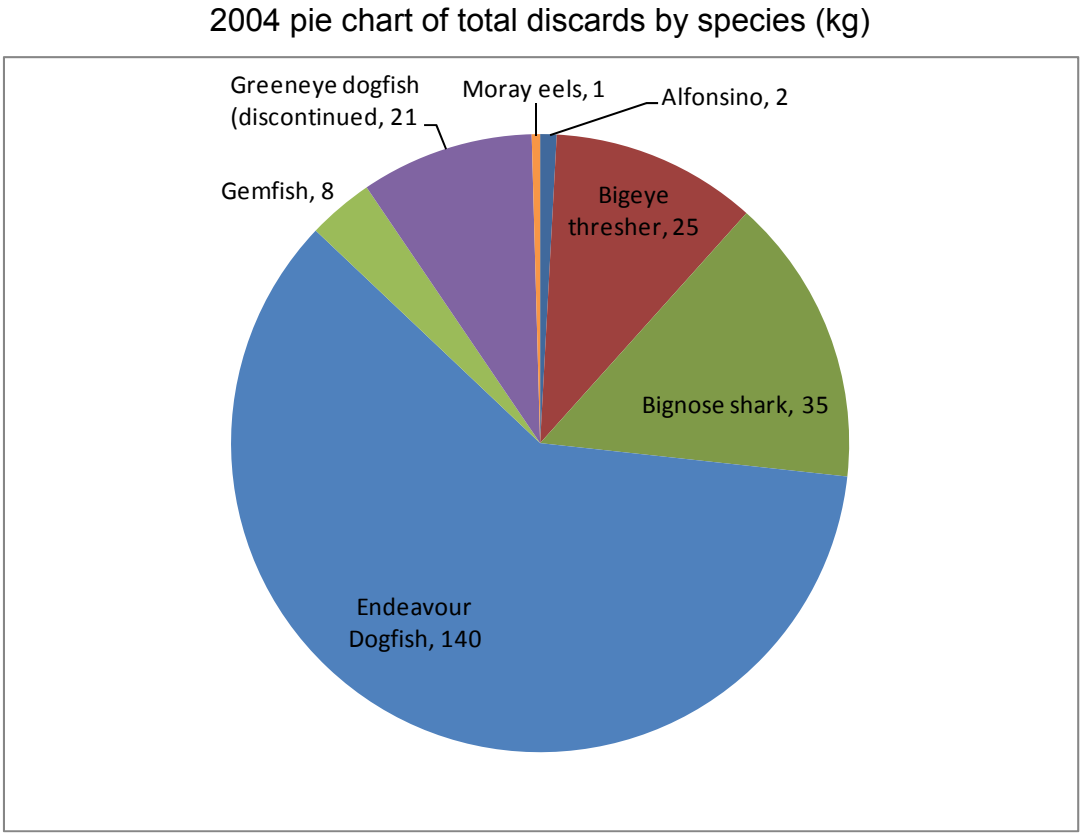
16.8 Summaries of catch and discards from observer records

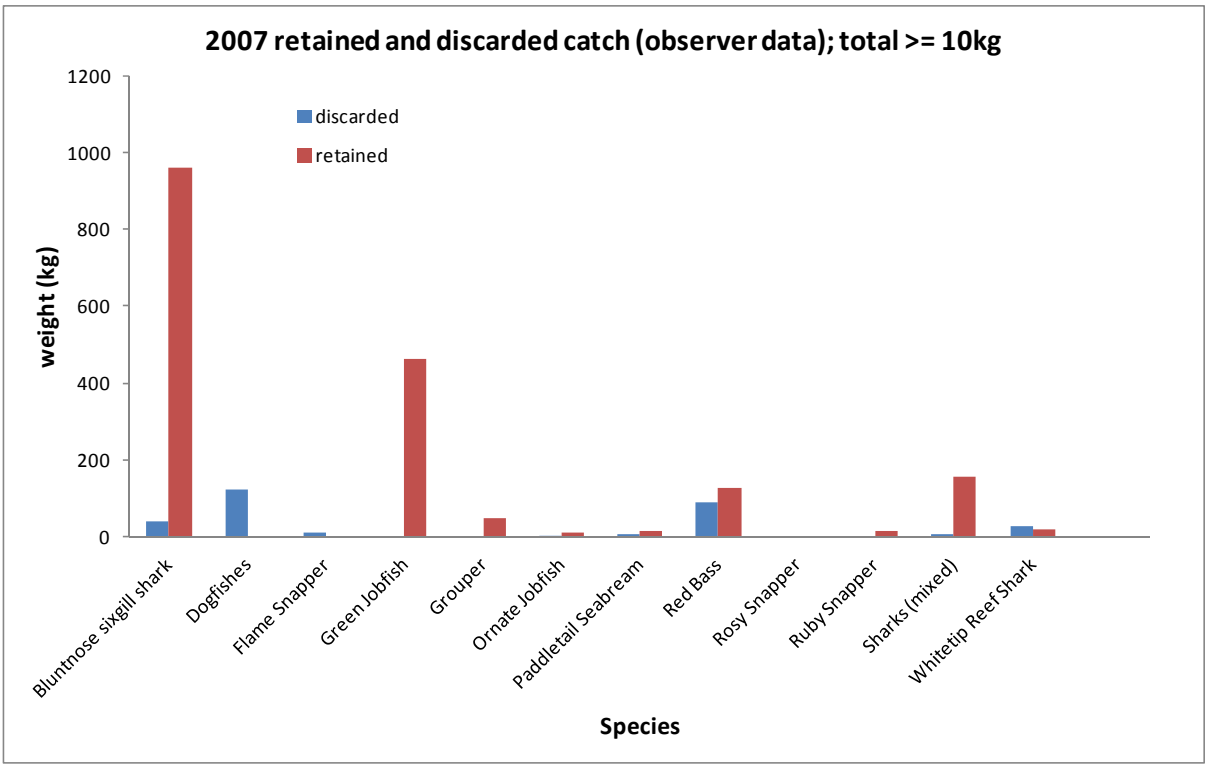




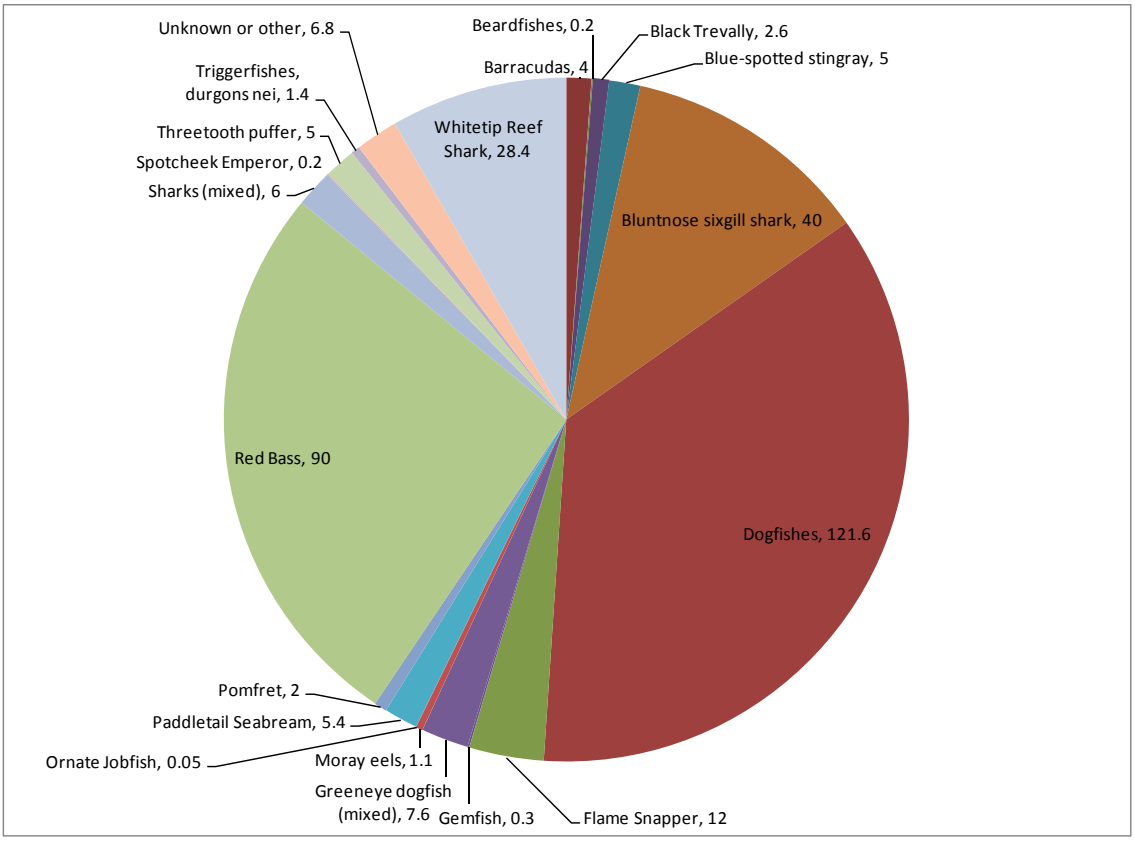
2003 pie chart of total discards by species (kg)

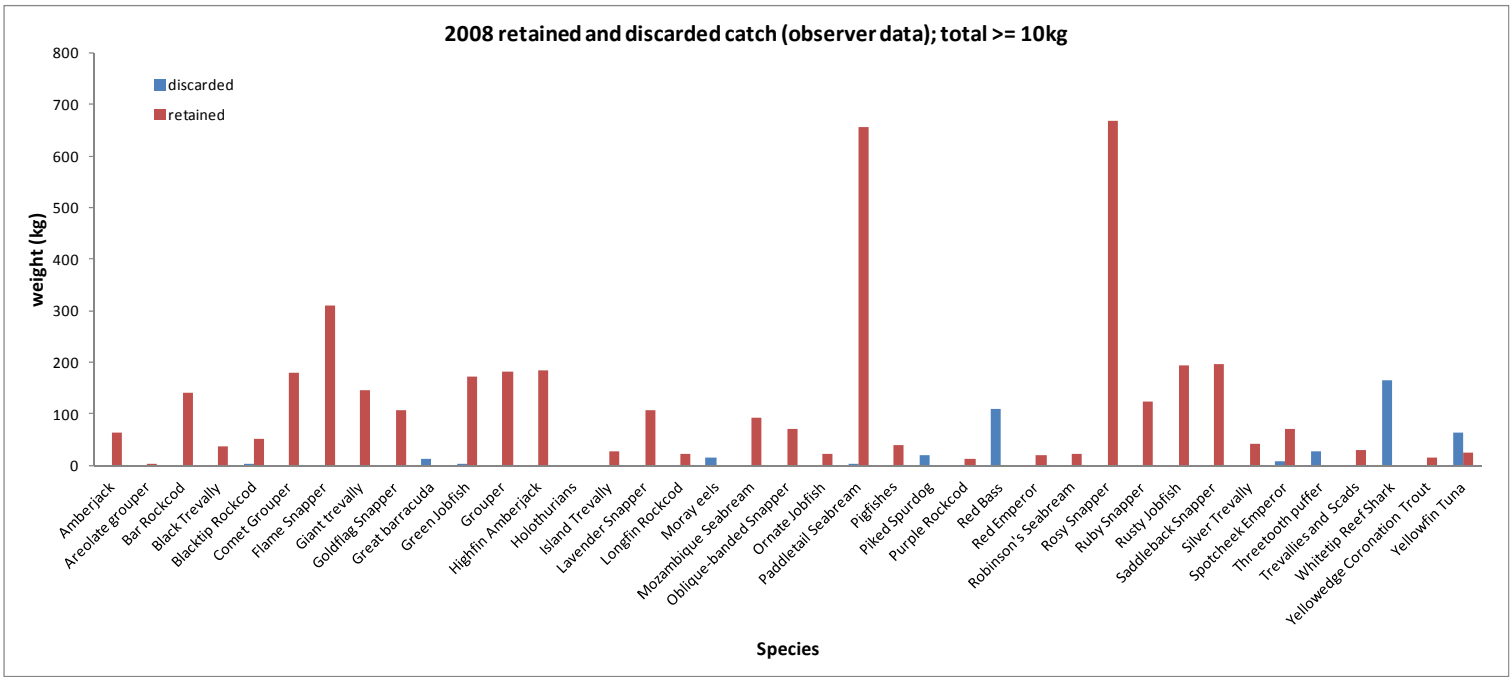

2004 retained and discarded catch (observer data); total >= 10kg
1600
1400
1200
1000
800
600
400
200
0
weight (kg)
discarded
retained
Alfonsino
Bigeye thresher
Bignose shark
Blue-eye Trevalla
Busakhin's beardfish
Eightbar grouper
Endeavour Dogfish
Flame Snapper
Gemfish
Greeneye dogfish...
Imperador
Species


2004 pie chart of total discards by species (kg)
Greeneye dogfish (discontinued, 21
Moray eels, 1
Alfonsino, 2
Gemfish, 8
Bigeye thresher, 25
Bignose shark, 35
Endeavour Dogfish, 140

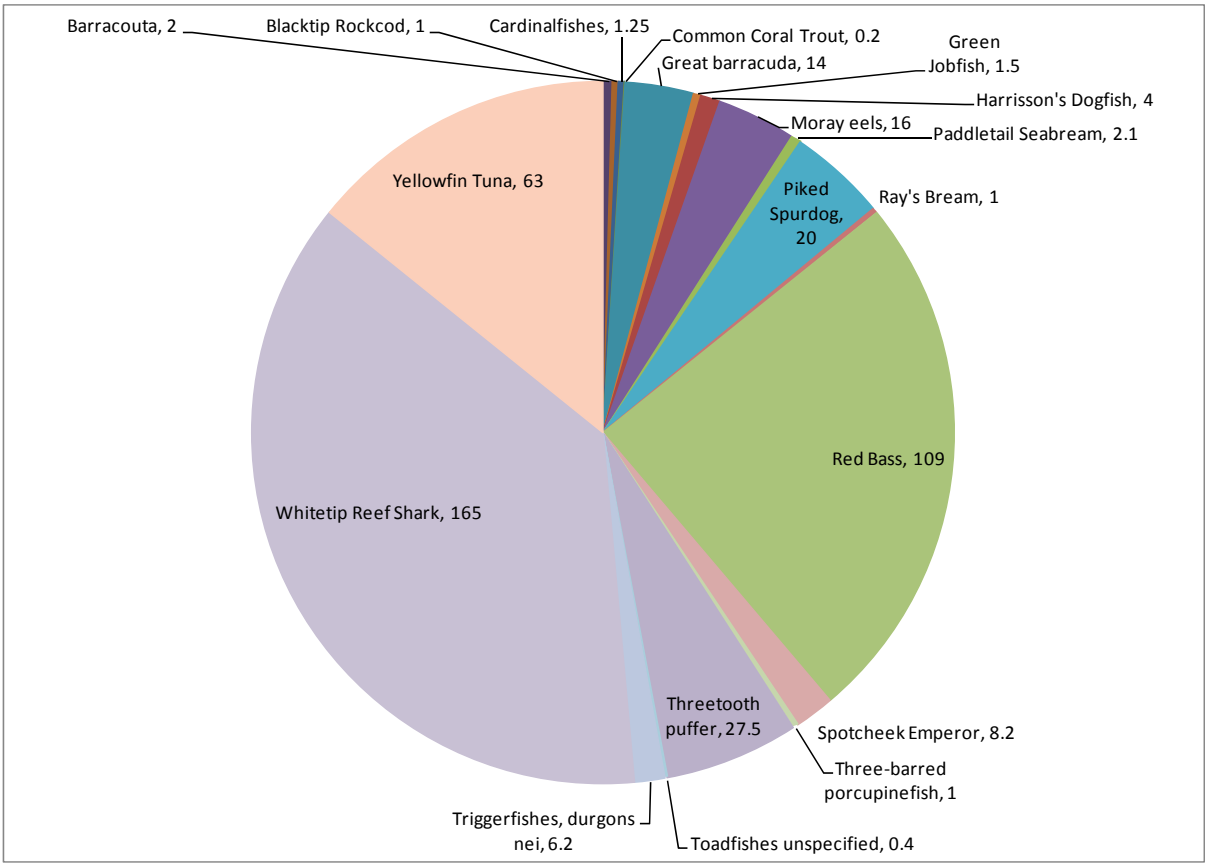


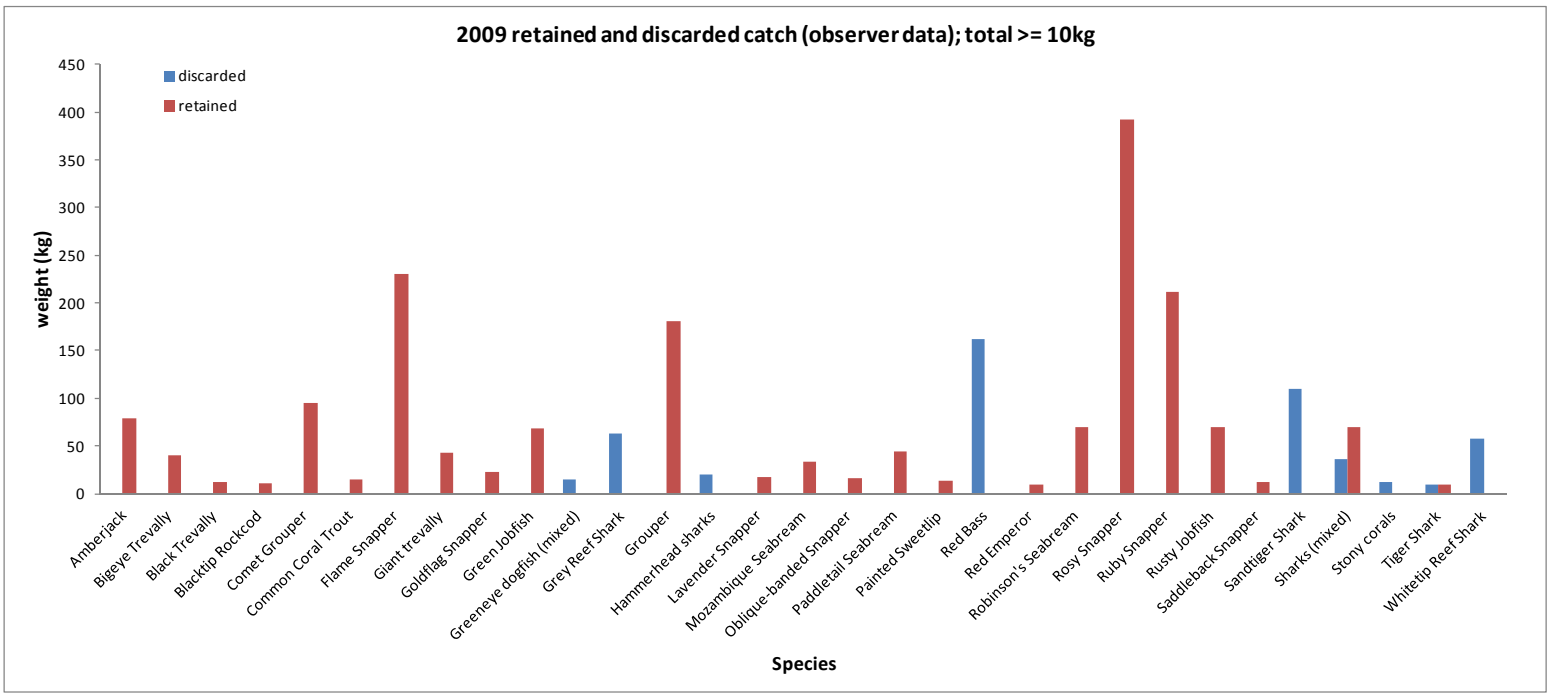
2007 pie chart of total discards by species (kg)

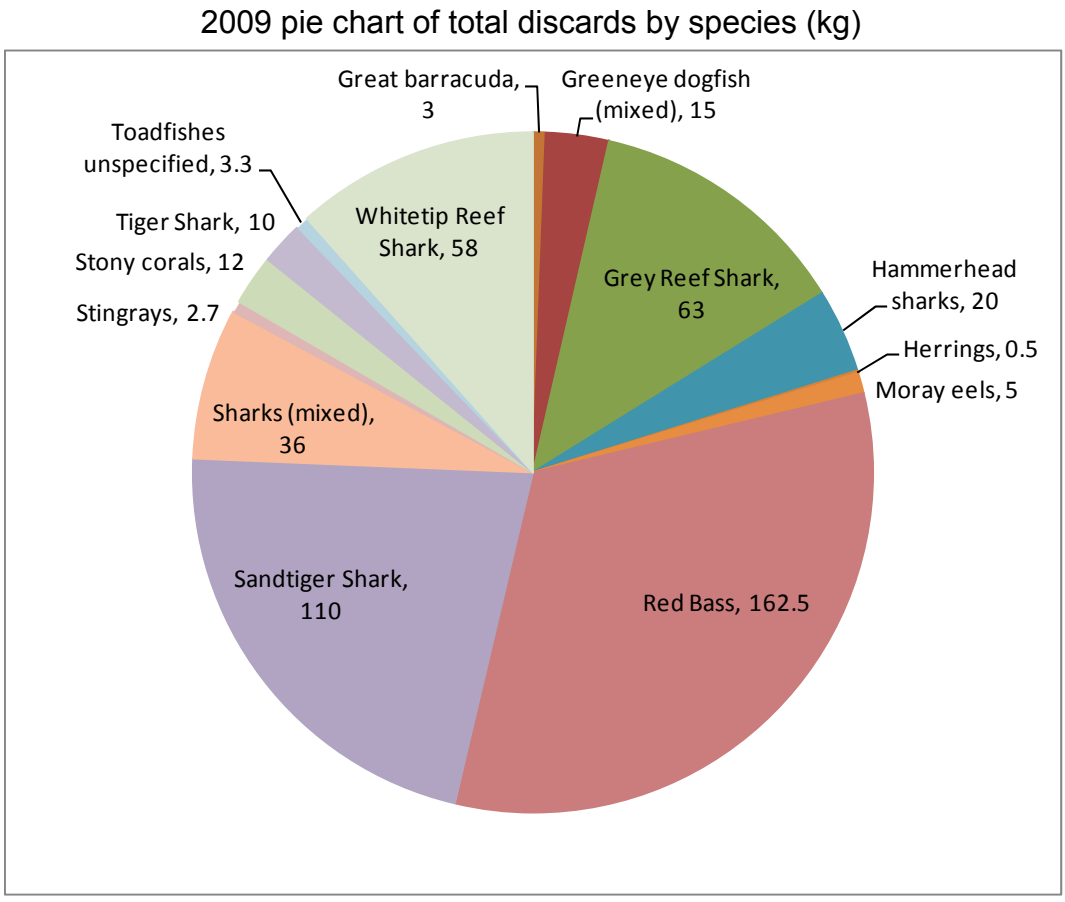


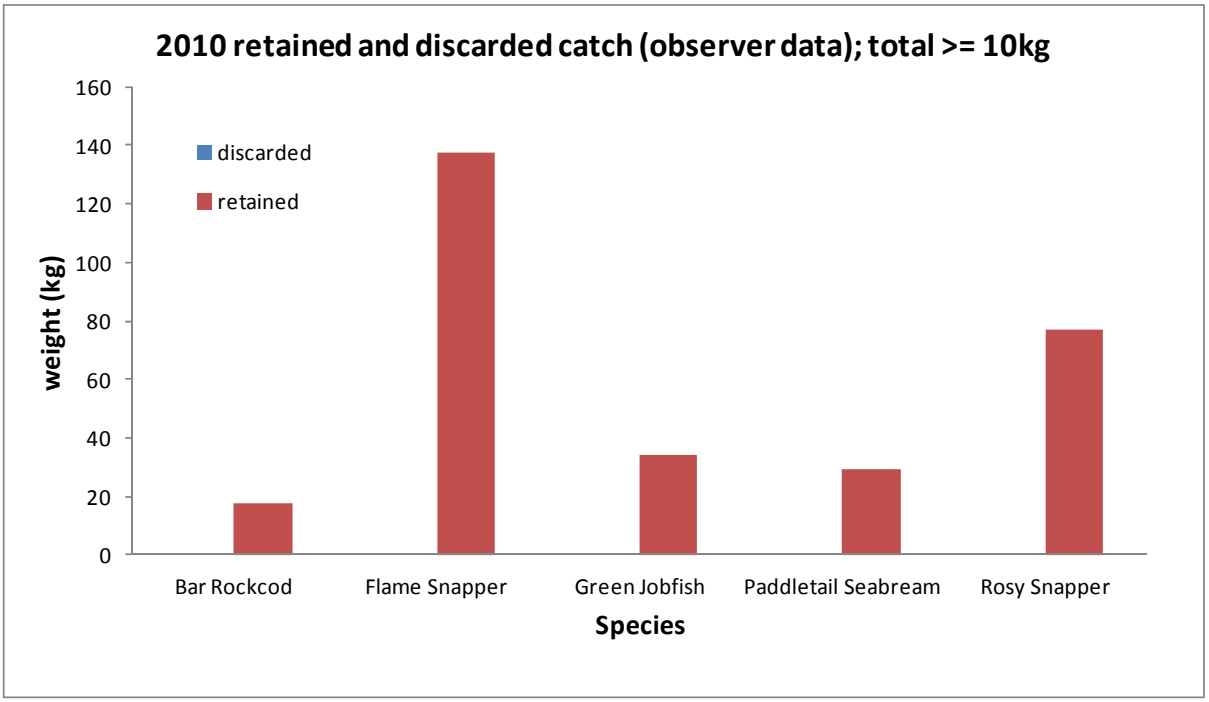


2008 pie chart of total discards by species (kg)

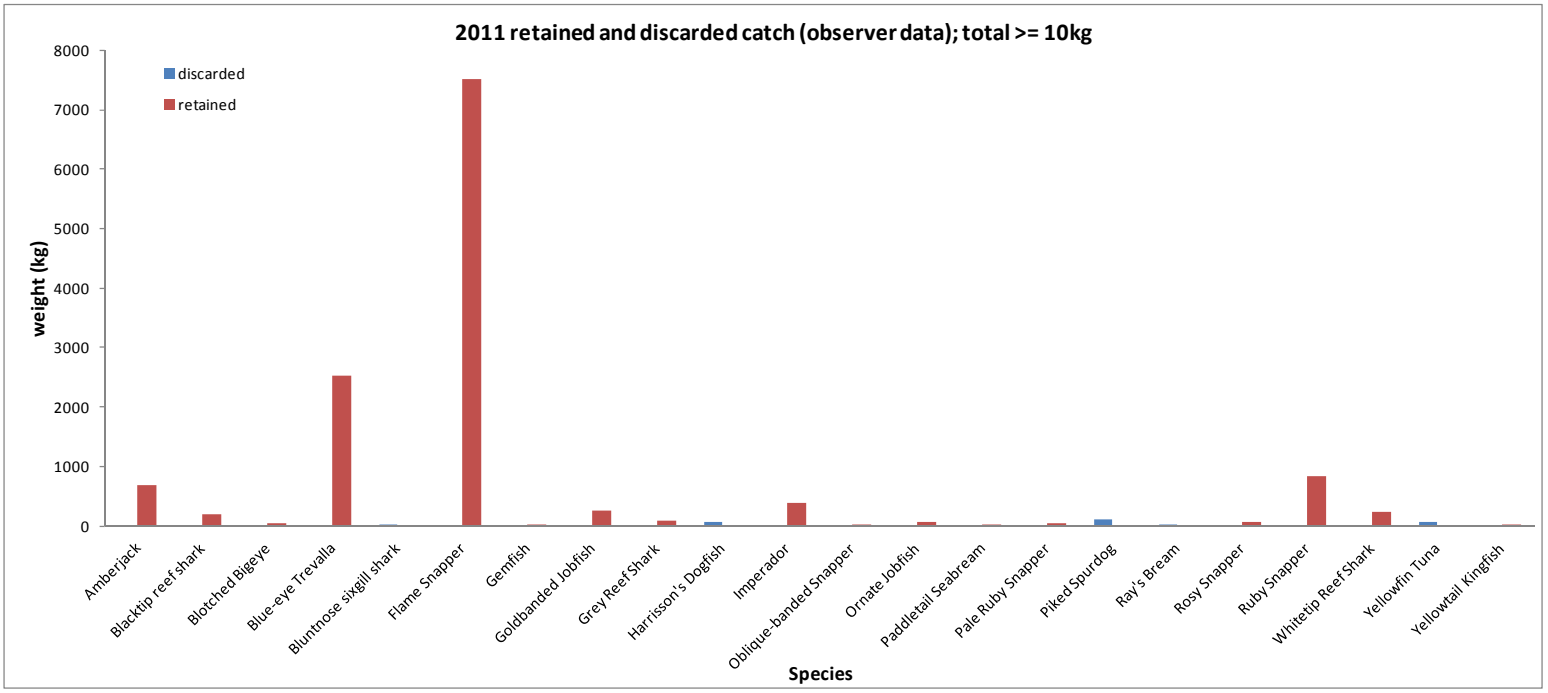



2009 retained and discarded catch (observer data); total >= 10kg
discarded
retained
weight (kg)
450
400
350
300
250
200
150
100
50
0
Amberjack
Bigeye Trevally
Black Trevally
Blacktip Rockcod
Comet Grouper
Common Coral Trout
Flame Snapper
Giant trevally
Goldflag Snapper
Green Jobfish
Greeneye dogfish (mixed)
Grey Reef Shark
Grouper
Hammerhead sharks
Lavender Snapper
Mozambique Seabream
Oblique-banded Snapper
Paddletail Seabream
Painted Sweetlip
Red Bass
Red Emperor
Robinson's Seabream
Rosy Snapper
Ruby Snapper
Rusty Jobfish
Saddleback Snapper
Sandtiger Shark
Sharks (mixed)
Stony corals
Tiger Shark
Whitetip Reef Shark
Species

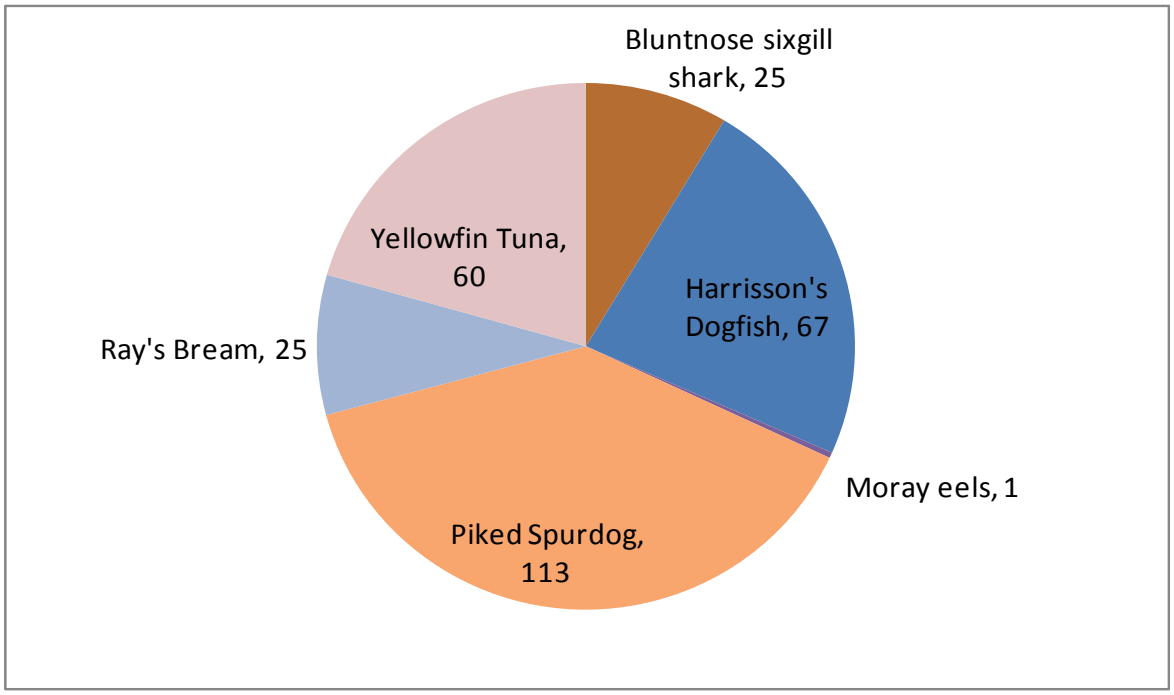

2009 pie chart of total discards by species (kg)
Great barracuda, 3
Greeneye dogfish (mixed), 15
Toadfishes unspecified, 3.3
Tiger Shark, 10
Stony corals, 12
Stingrays, 2.7
Whitetip Reef Shark, 58
Grey Reef Shark, 63
Hammerhead sharks, 20
Herrings, 0.5
Moray eels, 5
Sharks (mixed), 36
Sandtiger Shark, 110
Red Bass, 162.5



(N.B. no pie chart for 2010 as only observed discarding was 3kg of Sickle Pomfret).



2011 pie chart of total discards by species (kg)



17 APPENDIX 6: EASTERN TUNA AND BILLFISH FISHERY

Robert Campbell

CSIRO Wealth from Oceans Flagship and Marine and Atmospheric Research

17.1 Summary

The Eastern Tuna and Billfish Fishery (ETBF) extends from the tip of Cape York to the South Australia/Victoria border. The great majority of the catch is taken with pelagic longline; however, a small quantity is taken using minor-line methods (trolling, hand lining and rod and reel fishing). Longline effort peaked in 2003 at 12.7 million hooks but has since declined reaching 6.6 million hooks in 2011. According to logbook data, a total of 3,441,021 fish (consisting of 105 species) were caught by longline sets since August 2000 while 492,835 (14.32%) of these fish were discarded. Of this total catch, tunas, billfish, byproduct, sharks and other bycatch species made up 56.6%, 11.2%, 19.7%, 3.6% and 8.8% respectively. Furthermore, of the nine tuna and seven billfish species caught, 3.84% and 7.03% respectively were discarded, while of seven byproduct species 2.17% were discarded. On the other hand, of the 28 shark and 54 other bycatch species 61.4% and 99.2% of the fish caught were discarded respectively.

Observer data indicates a total of 235 species have been caught by pelagic longline operations in the ETBF since 2001 consisting of 10, 8, 7, 39 and 171 tunas, billfish, byproduct, shark and other bycatch species respectively of which 7.9%, 14.3%, 5.8%, 72.8% and 96.4% have been discarded. As with the logbook data, for each of these catch categories there is no significant trend in discard rates over the past decade. Of the 235 species observed caught, for 136 species fewer than 10 fish were caught on average each year while between 10 and 100 fish were caught on average for 56 species. The observed catch of seabirds has decreased since 2007 with no birds recorded or observed caught since the start of 2010. On the other hand, the annual observed interaction rate with marine turtles varied between 12.8 and 31.1 per million books over the period 2007-2011 while the interaction rate with marine mammals varied between zero and 7.14 per million books over the same period.

17.2 Fishery Description

The Eastern Tuna and Billfish Fishery (ETBF) extends from the tip of Cape York to the South Australia/Victoria border (141^{o}E) and includes waters around Tasmania and Lord Howe Island and the area of the high seas under the region of concern of the Western and Central Pacific Fisheries Commission (WCPFC). Most of the catch is taken with pelagic longline; however, a small quantity is taken using minor-line methods (trolling, hand lining and rod and reel fishing). The principal target species of the longline sector are yellowfin tuna (*Thuunus albacares*), bigeye tuna (*Thunnus obesus*), albacore tuna (*Thunnus alalunga*), broadbill swordfish (*Xiphius gladius*) and striped marlin (*Kajikia audax*) though a number of other non-target species such as mahi mahi (*Coryphaena hippurus*), wahoo (*Acanthocybium solandri*) and rudderfish (*Centrolophus niger*) are retained and sold because they have market value and as such form an important byproduct component of the catch. The minor line sector also targets these and other species.

The fishery is managed by the Australian Fisheries Management Authority (AFMA) under the Eastern Tuna and Billfish Fishery Management Plan 2010. The Plan came into effect on 1 March 2011 and the fishery is now managed by catch quota. Before this time the fishery was managed by input controls with a limit on the number of vessels licensed to fish and a transitional total allowable effort of 12 million hooks was in place between 1 November 2009 and 28 February 2011. Total Allowable Commercial Catch (TACC) limits now apply to the five principal target species (with a combined quota of 7,522 mt for the 2012/13 quota year). Fishers have been allocated statutory fishing rights in the form of individual transferrable quotas as a portion of the overall TACC for each quota species. Management measures in the ETBF are required to be compatible with international management measures agreed by the WCPFC which came into force on 19 June 2004.

There are presently 109 vessels permits plus 10 Coral Sea zone (formally Area E) permits, although during 2011 only 49 vessels, which deployed 6.61 million hooks, were active. The catch of the five quota species during the 2011 calendar year was 4,783mt. Vessels are currently monitored through logbooks, an on-board observer program (since 2003, though incidental project based observer reports are available since 2001), verified landing records (since 2006) and vessel monitoring systems (since 2007). The total annual longline effort and catch of the five principal target species in the fishery are listed in Table 17.1 and shown in Figure 17.1. Longline effort peaked in 2003 at 12.7 million hooks but has since declined to 6.6 million hooks in 2011. Catch of the five principal target species peaked at 8,196 tonnes in 2001 and has declined to 4,783 tonnes in 2011. The distribution of annual effort within each 5-degree band of latitude off eastern Australia is also shown in Figure 17.2. The spatial distribution of effort is relatively consistent across years with the highest effort levels being between 25-30^{o}S. The proportion of total effort between 15-20^{o}S was elevated during the years 2006-2010 associated with an increased targeting of albacore in this region.

The fishery overlaps geographically with the Southern Bluefin Tuna Fishery. Some ETBF longliners target southern bluefin tuna (*Thunnus maccoyii*) off New South Wales during winter, after fishing for tropical tunas and billfish earlier in the year, while others take them incidentally when targeting other tunas. All southern bluefin tuna taken must be covered by quota and landed in accordance with the Southern Bluefin Tuna Fishery Management Plan (AFMA 1995, amended 2010).

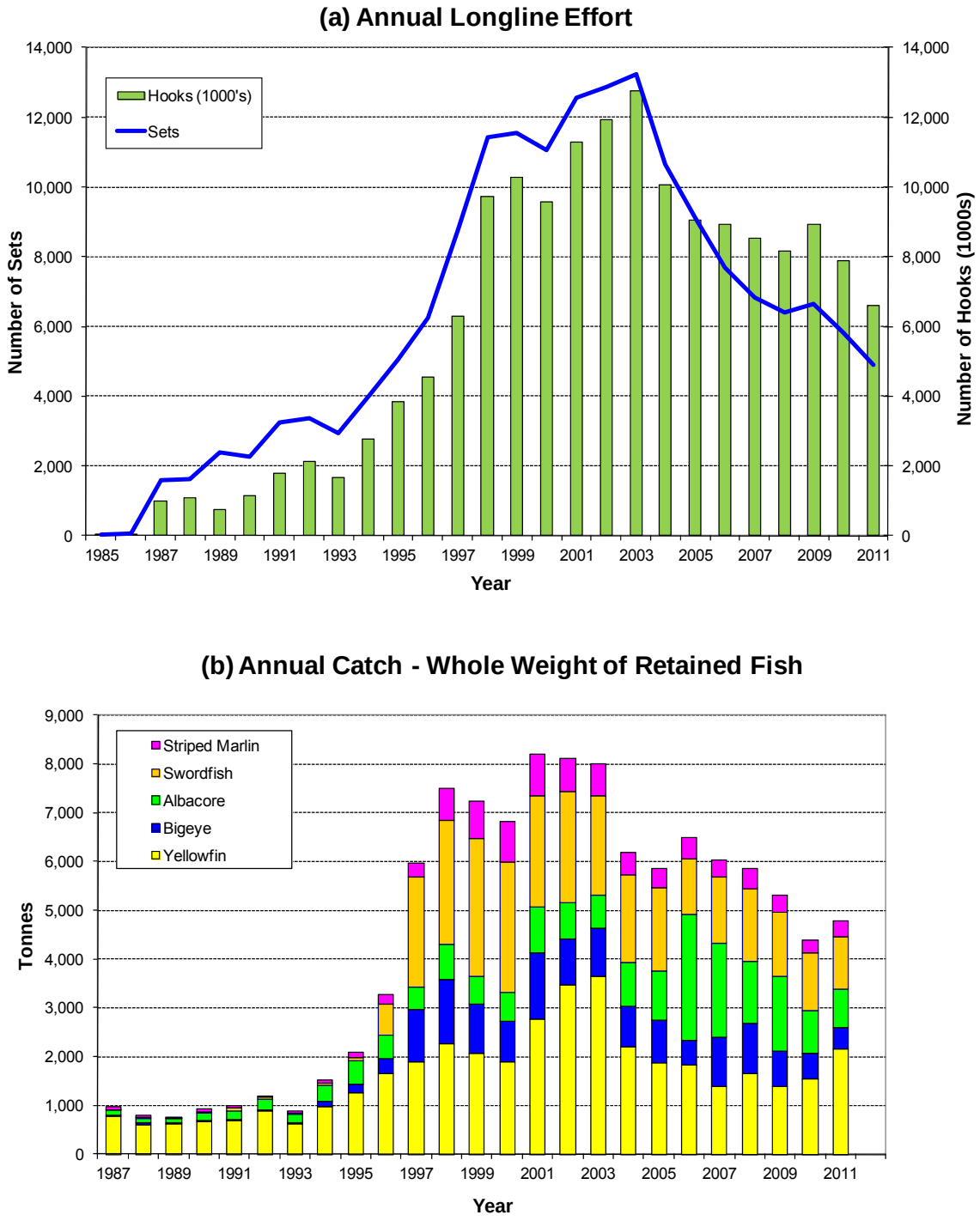


Figure 17.1 Annual longline effort and catch within the ETBF: (a) effort in both number of sets and hooks deployed, and (b) catch in tonnes of the whole weight of retained fish for the five principal target fish.

Table 17.1 Annual longline effort (number of hooks deployed) and catch (whole weight of retained fish in metric tonnes) of the five principal target species in the ETBF. (Note: YFT=yellowfin tuna, BET=bigeye tuna, ALB=albacore tuna, SWO=broadbill swordfish, STM=striped marlin).

	Number	Hooks	Catch Weight : Target Species (1)					
YEAR	Boats	1000s	YFT	BET	ALB	SWO	STM	Total
1987	68	994	768	36	101	14	45	964
1988	69	1,090	607	30	99	13	52	801
1989	94	764	628	14	82	14	7	745
1990	97	1,151	677	22	138	23	78	938
1991	96	1,786	695	27	174	58	39	993
1992	105	2,114	884	34	207	48	28	1,201
1993	83	1,679	627	21	165	32	35	879
1994	88	2,764	978	108	332	38	68	1,524
1995	104	3,833	1,255	178	477	68	112	2,090
1996	117	4,551	1,650	307	488	632	188	3,265
1997	134	6,288	1,890	1,068	471	2,244	289	5,962
1998	150	9,727	2,275	1,301	724	2,551	658	7,509
1999	151	10,286	2,072	1,003	567	2,822	782	7,247
2000	140	9,560	1,902	818	591	2,689	824	6,824
2001	141	11,297	2,778	1,341	942	2,276	859	8,196
2002	144	11,930	3,466	954	743	2,280	666	8,109
2003	136	12,758	3,640	982	685	2,029	661	7,997
2004	123	10,066	2,204	833	887	1,791	472	6,187
2005	98	9,052	1,876	866	1,006	1,715	389	5,852
2006	80	8,925	1,831	499	2,592	1,136	441	6,499
2007	61	8,517	1,390	1,008	1,925	1,353	359	6,034
2008	54	8,150	1,650	1,027	1,277	1,483	425	5,862
2009	55	8,921	1,387	726	1,523	1,315	361	5,312
2010	52	7,888	1,549	522	872	1,176	279	4,398
2011	49	6,613	2,156	445	771	1,080	330	4,783

(1) Catch weight = logbook recorded weight of retained fish 1987-1996; processor recorded weight of landed fish 1996-2005, catch-disposal-recorded weight of landed fish 2006-2011.

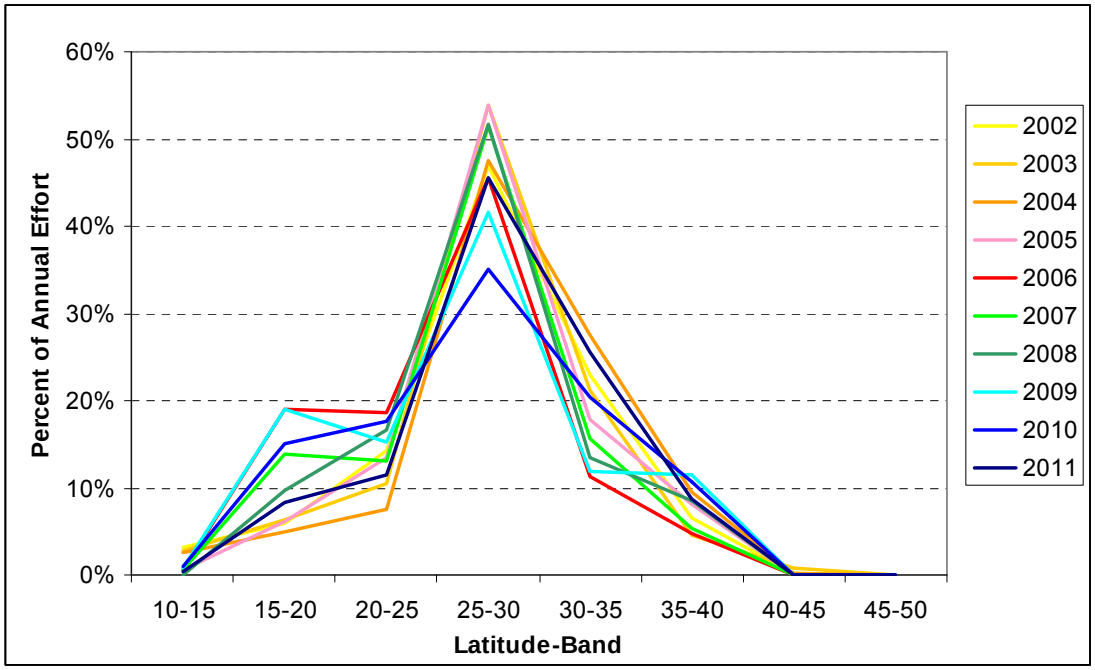


Figure 17.2 Distribution of total annual ETBF longline effort within each 5-degree band of latitude off eastern Australia.

Recreational anglers and game fishers also target tuna and billfish in the area of the ETBF with many game fishers tagging and releasing their catch, especially marlins. Because of the importance of several species to recreational anglers, the retention of blue (*Makaira nigricans*) and black marlin (*Makaira indica*) has been banned in commercial fisheries since 1998, and an annual TACC of 35 t on the commercial catch of longtail tuna (*Thunnus tonggol*), plus a 10-fish trip limit in excess of 35mt, has been in place since 2007. Few data are available on recreational participation levels, catches or fishing effort directed at tuna and billfish.

The ETBF catches a range of non-target and chondrichthyan species and on occasion interacts with a variety of seabirds, marine turtles and marine mammals. All species of marine birds, turtles, mammals and several species of sharks (porbeagle shark, shortfin mako and longfin mako) are presently listed as migratory species under the EPBC Act whilst the great white shark is listed as a protected species.

All Commonwealth fisheries are committed to minimise bycatch under the Australian Government's Commonwealth Policy on Fisheries Bycatch (DAFF 2000). According to this policy "bycatch" is defined as any "part of the fisher's catch which is returned to the sea either because it has no commercial value or because regulations preclude it being retained, and any part of the catch that does not reach the deck of the fishing vessel but is affected by interactions with the fishing gear."

17.3 Bycatch Data Collection and Holdings

17.3.1 Logbook Data

The copy of logbook data pertaining to the ETBF is stored in a number of database tables within the ORACLE database at the CSIRO laboratories in Hobart. The data extracted for this project is contained within the following three tables:

Operational Information	tuna.AFZ_FOP_AUS
Catch Information	tuna.AFZ_CATCH_AGGREGATE_AUS
Species Information	tuna.SPECIES

Operational information is recorded is following three series of logbooks:
AL = Australian Pelagic Longline Daily Fishing Log
OT = Australian Tuna Minor Line Daily Fishing Log
LN = Commonwealth Line Daily Fishing Log (supersedes OT logbook)

The number of fishing operations (FOPs) for each logbook, and for which data is stored in the ORACLE database, is summarised in Table 17.2. In order to provide a summary of the species caught by fishing strategies used over the past decade, only the data pertaining to fishing operations recorded in the AL05, AL06, LN01, LN01A and OT03 series of logbooks were used[9]. There were also some difficulties in using the AL02-AL04 logbooks as more than one method was recorded for some fishing operations in the catch table. As these logbooks also include data pertaining to the Western Tuna and Billfish Fishery the data were limited to those recorded by vessels operating within the ETBF, i.e. those vessels which completed an Australian Pelagic

[9] During 2000 and 2001 respectively 71.3% and 0.1% of FOPs were recorded in the AL04 logbook.

Longline Daily Fishing Logbook (i.e. AL05 or AL06) where the start longitude of the FOP was east of 141^{o}E.

Table 17.2 The number of fishing operations (FOPs), together with the first and last date of an operation, recorded for each logbook used in the ETBF. The number of fishing operations selected for this project is also shown.

Logbook Type	Number of FOPs	Earliest FOP-Date	Latest FOP-Date	Selected for this Project
AL01	169	9-Feb-61	2-Apr-66	
AL02	40,355	1-Mar-85	12-Sep-97	
AL03	13,617	1-Jan-95	1-Jul-00	
AL04	46,592	20-Jan-97	25-May-01	
AL05	94,369	6-Aug-00	20-May-09	76,010
AL06	26,195	3-Nov-07	31-Mar-12	24,962
OT03	1,384	5-Feb-00	26-Jan-08	252
LN01	4,466	2-Jan-06	6-Nov-11	589
LN01A	8,254	21-Jul-07	17-Mar-12	646
Total	235,401			102,459

Table 17.3 The numbers of fishing operations (with and without a catch) for each logbook type and fishing method used in the ETBF together with the total number of recorded retained and discarded fish.

Logbook Type	Fishing Method	FOPS No Catch	FOPS With Catch	Number of Fish Retained	Number of Fish Discarded
AL05 & AL06	Pelagic longline	634	99,861	2,948,186	492,835
	Pole and line	0	2	20	0
	Rod and Reel	38	10	12	0
	Trolling	63	32	238	4
	Handline	132	200	4,872	686
OT03	Pole and line	0	11	3	0
	Trolling	5	75	485	0
	Handline	2	159	10,406	479
LN01/A	Line	34	1,201	43,328	0
Total	All	908	101,551	3,007,550	494,004

(Note, this also included 3 FOPS where the start longitude was not recorded). In total 102,459 fishing operations were selected.

For each of the selected logbooks, the numbers of fishing operations (with and without a catch) against each fishing method used in the ETBF is listed together with the total number of recorded retained and discarded fish in Table 17.3. Summaries of the number of fish retained and discarded for all recorded species are provided by logbook type (i.e. AL, OT and LN) in Table 17.20 to Table 17.23 in the Supplementary Tables. For each logbook type, the species caught were grouped into the following five categories:

TUNAS	Includes all tunas
BILLFISH	Includes all marlins, spearfishes, sailfish and swordfish.
BYPRODUCT	Includes non-tuna and non-billfish species where the number caught (retained + discarded) on the AL logbook using a pelagic longline was greater than 1000 and the percent discarded was less than 50 percent.
SHARKS	Includes all sharks and dogfish
BYCATCH	All species not included in the above categories.

A summary of the total catch information (i.e. across all years) by species-group is given in Table 17.4. As expected the percentage of fish discarded varies significantly by species group. For fishing operations using a pelagic longline recorded on the AL logbooks, the overall discard percentage is generally less than 7% for the main target and byproduct species (3.84% for the 9 tuna species, 7.03% for the 7 billfish species, and 2.2% for the 7 byproduct species) but increases to 61% for the 28 shark species and is almost 100% for the 54 bycatch species. Overall, the discard rate for all longline caught fish is estimated to be 14.3%. For fish caught by other methods, the overall discard rate varies from around 12% for those operations recorded on the AL logbooks to 4.2% for those recorded on the OT logbooks. Discards do not seem to have been recorded on the LN logbooks. Note, with these and other catches and discard rates reported in this chapter it is important to remember that they only relate to the reported catch (i.e. those recorded in logbooks) and their reliability may vary over time or between operators if fishers have perceived incentives not to report discards.

Table 17.4 Number of species reported (since 2000) caught within each species grouping for each logbook type, together with the number of fish retained and discarded.

Logbook Type	Species Group	Number of Species	Number Retained	Number Discarded	Total Number Caught	Percent Fish Discarded
AL Longline	TUNA	9	1,873,638	74,853	1,948,491	3.84%
	BYPRODUCT	7	664,616	14,715	679,331	2.17%
	BILLFISH	7	359,703	27,196	386,899	7.03%
	SHARK	28	47,736	76,061	123,797	61.44%
	BYCATCH	54	2,493	300,010	302,503	99.18%
	Total	105	2,948,186	492,835	3,441,021	14.32%
AL Other Methods	TUNA	6	4,917	668	5,585	11.96%
	BILLFISH	4	9	8	17	47.06%
	BYPRODUCT	3	148	3	151	1.99%
	SHARK	5	15	4	19	21.05%
	BYCATCH	6	53	7	60	11.67%
	Total	24	5,142	690	5,832	11.83%
OT Other Methods	TUNA	4	4,413	476	4,889	9.74%
	BILLFISH	1	1	0	1	0.00%
	BYPRODUCT	1	5	1	6	16.67%
	SHARK	3	50	2	52	3.85%
	BYCATCH	9	6,425	0	6,425	0.00%
	Total	18	10,894	479	11,373	4.21%
LN Line Methods	TUNA	5	13,817	0	13,817	0.00%
	BILLFISH	1	2	0	2	0.00%
	BYPRODUCT	3	59	0	59	0.00%
	SHARK	28	7,464	0	7,464	0.00%
	BYCATCH	68	21,986	0	21,986	0.00%
	Total	120	43,328	0	43,328	0.00%

The number of species reported caught within each species group for each logbook type, together with the total number of fish retained and discarded within each species group, is provided in Table 17.4. In total 189 different species have been recorded across the three logbook types, and the distribution of the number of species shared across each logbook type shown in Figure 17.3.

Table 17.5 Listing by species of the combined catch (number of fish, both retained and discarded) for all FOPS recorded in the AL series of logbooks using all methods (i.e. pelagic longline, pole and line, rod and reel, trolling, handline). Species ordered by total catch.

(a) Retained Catch

SPC_TYPE	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	TOTAL
TUNA	22,905	156,834	180,948	181,501	165,716	135,987	244,960	203,848	179,838	170,044	115,080	115,028	5,866	1,878,555
BILLFISH	14,363	43,277	44,772	38,549	32,784	31,352	25,987	26,302	27,464	25,023	23,779	21,812	4,248	359,712
BYPRODUCT	8,381	61,267	73,034	57,692	65,754	63,299	42,273	79,372	71,900	59,646	47,306	31,296	3,544	664,764
SHARK	1,994	7,122	6,486	5,249	4,900	3,537	2,674	2,118	2,562	4,659	3,134	2,933	383	47,751
BYCATCH	370	294	375	186	313	208	149	138	27	375	40	70	1	2,546
Total	48,013	268,794	305,615	283,177	269,467	234,383	316,043	311,778	281,791	259,747	189,339	171,139	14,042	2,953,328

(b) Discarded Catch

SPC_TYPE	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	TOTAL
TUNA	539	4,112	6,229	10,638	6,391	6,358	9,537	6,721	5,496	9,203	6,333	3,564	400	75,521
BILLFISH	1,517	3,064	3,192	4,657	2,960	2,913	2,171	1,290	1,457	1,163	1,202	1,307	311	27,204
BYPRODUCT	56	534	5,123	2,959	1,163	876	728	818	546	629	414	636	236	14,718
SHARK	1,242	6,752	11,354	13,336	8,092	7,530	4,112	3,356	2,960	5,064	5,893	5,420	954	76,065
BYCATCH	4,147	9,954	15,994	28,945	32,288	31,477	52,926	35,948	31,194	30,555	16,424	8,943	1,222	300,017
Total	7,501	24,416	41,892	60,535	50,894	49,154	69,474	48,133	41,653	46,614	30,266	19,870	3,123	493,525

(c) Total Catch

SPC_TYPE	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	TOTAL
Tuna	23,444	160,946	187,177	192,139	172,107	142,345	254,497	210,569	185,334	179,247	121,413	118,592	6,266	1,954,076
Billfish	15,880	46,341	47,964	43,206	35,744	34,265	28,158	27,592	28,921	26,186	24,981	23,119	4,559	386,916
Byproduct	8,437	61,801	78,157	60,651	66,917	64,175	43,001	80,190	72,446	60,275	47,720	31,932	3,780	679,482
Shark	3,236	13,874	17,840	18,585	12,992	11,067	6,786	5,474	5,522	9,723	9,027	8,353	1,337	123,816
Bycatch	4,517	10,248	16,369	29,131	32,601	31,685	53,075	36,086	31,221	30,930	16,464	9,013	1,223	302,563
Total	55,514	293,210	347,507	343,712	320,361	283,537	385,517	359,911	323,444	306,361	219,605	191,009	17,165	3,446,853

(d) Percent Discarded

SPC_TYPE	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	TOTAL
TUNA	2.30%	2.55%	3.33%	5.54%	3.71%	4.47%	3.75%	3.19%	2.97%	5.13%	5.22%	3.01%	6.38%	3.86%
BILLFISH	9.55%	6.61%	6.65%	10.78%	8.28%	8.50%	7.71%	4.68%	5.04%	4.44%	4.81%	5.65%	6.82%	7.03%
BYPRODUCT	0.66%	0.86%	6.55%	4.88%	1.74%	1.37%	1.69%	1.02%	0.75%	1.04%	0.87%	1.99%	6.24%	2.17%
SHARK	38.38%	48.67%	63.64%	71.76%	62.28%	68.04%	60.60%	61.31%	53.60%	52.08%	65.28%	64.89%	71.35%	61.43%
BYCATCH	91.81%	97.13%	97.71%	99.36%	99.04%	99.34%	99.72%	99.62%	99.91%	98.79%	99.76%	99.22%	99.92%	99.16%
Total	13.51%	8.33%	12.06%	17.61%	15.89%	17.34%	18.02%	13.37%	12.88%	15.22%	13.78%	10.40%	18.19%	14.32%

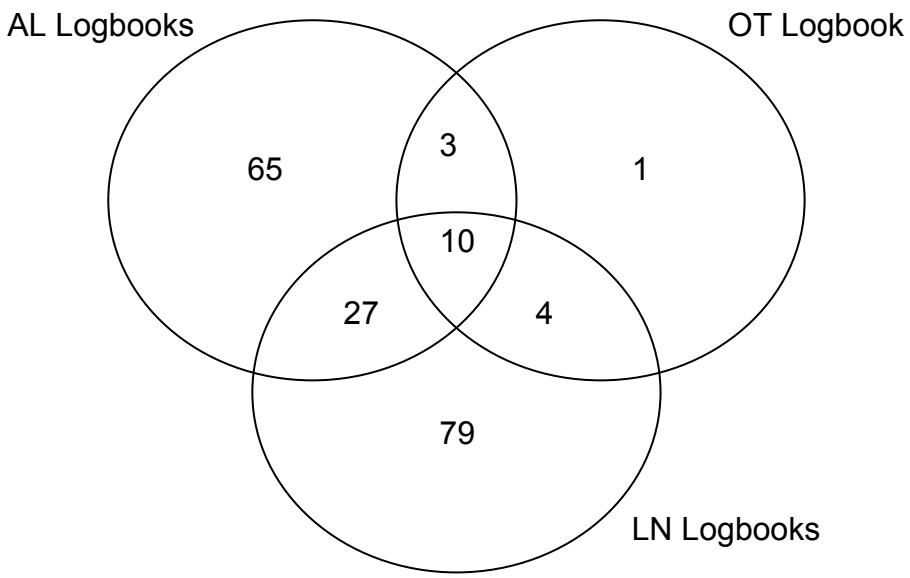


Figure 17.3 Distribution of the number of different species shared across the different logbook type used in the ETBF during the past decade.

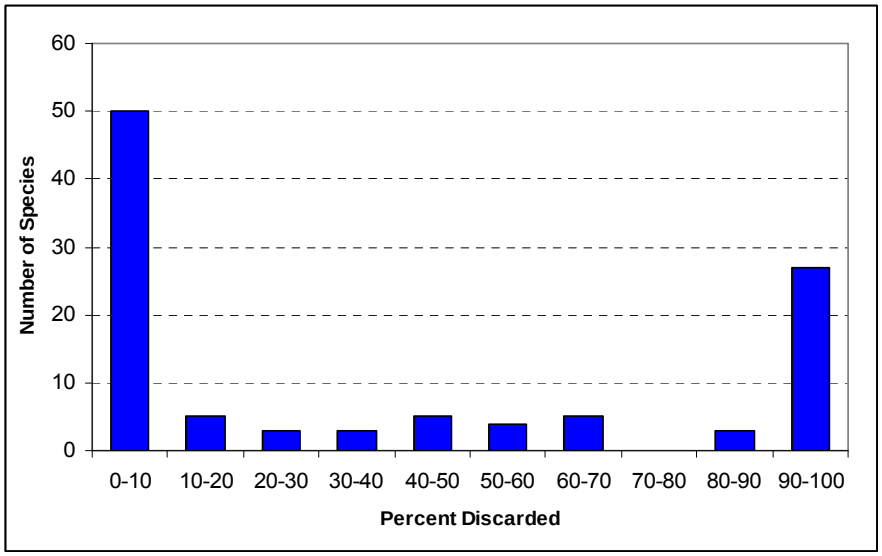


Figure 17.4 Distribution of the number of species against the overall discard rate category for fishing operations using a pelagic longline and the AL05 or AL06 logbooks.

Of the 105 different species recorded on the AL05/06 logbooks using a pelagic longline, the distribution of the number of species categorised against overall discard rate is shown in Figure 17.4. Of the 105 species recorded on these logbooks, the discard rate is 10 percent or less for 50 species and greater than 90 percent for 27 species.

For these same fishing operations, the number of fish retained and discarded by species group and year is shown in Table 17.5 while the total number of fish caught (i.e. recorded as either retained or discarded) by species group and year is shown in Figure 17.5 and the annual percentage of fish discarded by species group is shown in Figure 17.6.

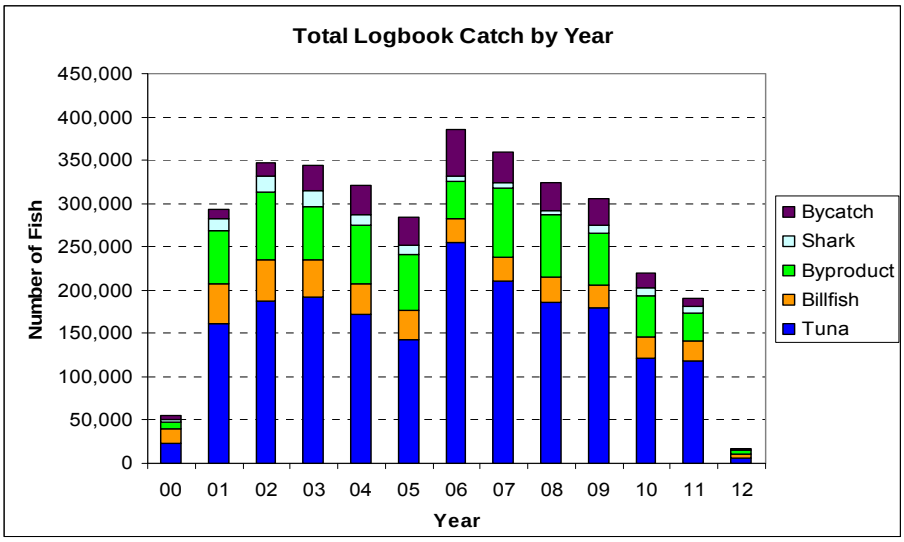


Figure 17.5 Total number of fish caught (i.e. recorded as either retained or discarded) by species group and year for fishing operations using a pelagic longline and the AL05 or AL06 logbooks.

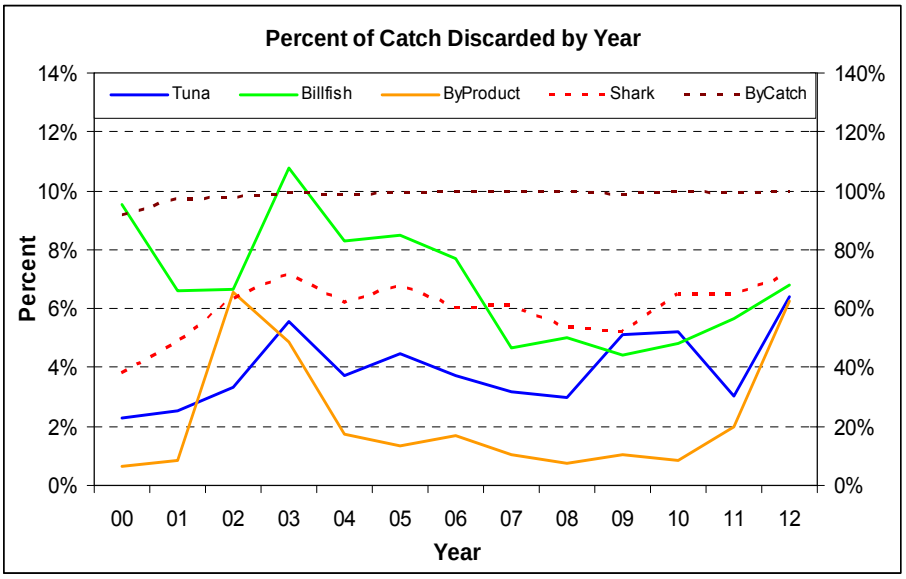


Figure 17.6 Annual percentage of fish discarded for each species group for fishing operations using a pelagic longline and the AL05 or AL06 logbooks. Note, the left hand axis refers to the three species shown with a solid line while the right hand axis refers to the two species groups shown with dashed lines (i.e. sharks and byproduct species).

For most species groups there is some inter-annual variation in the discard rate though no clear temporal trend is apparent, with the exception that there appears to be a decrease in the percentage of billfish discarded.

17.3.2 Logbook Recorded Wildlife Interactions

With the introduction of the AL05 logbook, fishers were requested to record interactions with EPBC Listed Marine and Threatened Species on a separate form at the back of the logbook. A summary of this data, listing the number interactions with each species together with the related information on whether this interaction occurred during the setting or hauling of the longline and the life-status of the species after being returned to the sea, is given Table 17.24 in the Supplementary Tables, while a summary of this information categorised by the main species groups is given in Table 17.6. Overall, an interaction has been recorded for around 0.5% of all fishing

operations, with seabird, turtles and cetaceans accounting for 52%, 39% and 5% respectively of all recorded interactions (based on the total released data).

The number of interactions recorded against time of the operation (e.g. set or haul) is less than the number of interactions recorded against the life-status of the animal upon release indicating that the former (and perhaps some of the latter) data is incomplete. In order to overcome this problem, for each species the number of interactions was taken to be the higher of the number of interactions recorded by time and the number of the interactions recorded by release-status. The number of interactions by species was then calculated for each year and this is given in Table 17.25 in the Supplementary Tables, while a summary of this information by the main species groups is given in Table 17.7. Of the total of 835 recorded interactions, the majority (736) occurred before 2008 with only 12% being recorded since 2008. Histograms of the total number of interactions per year by species-group are shown in Figure 17.7 a while histograms of the total number of interactions per year by species for cetacean, turtles and seabirds are shown in Figure 17.7 b-d respectively.

The annual time-series of the catch of cetaceans indicates that between 1 and 6 animals are reported caught each year with fewer interactions reported since 2007. Pilot whales are the most commonly caught whale and no dolphins have been reported caught since 2006. Between 2001 and 2005 the number of turtles reported caught each year averaged 44 but since 2006 this has declined to 16. While 28% of the 328 turtles reported caught remained unidentified, leatherback turtles are the most common species reported caught followed by green turtles. There has also been a large decline in the number of seabirds reported caught, decreasing from between 54 and 138 before 2005 to 16 or less since that time. This large decrease is also solely due to the decline in the reported catch of shearwaters with the catch of albatrosses remaining relatively constant (mean of 7.5 birds) over the total period.

Table 17.6 Number of logbook recorded interactions with Listed Marine and Threatened Species (by species group) together with related information the number of interaction which occurred during the setting or hauling of the longline and the life-status of the species after being released. Note, the data on the number observed caught appears to be incomplete as for most species it is less than the number released.

Logbook	SPECIES GROUP	Number of Species	FOPS with Catch	% FOPS with Catch	Catch while Setting	Catch while Hauling	Total Number Caught	Released Alive	Released Dead	Total Number Released
AL05 and AL06 Total number of FOPS 100495	CETACEAN	11	38	0.038%	5	27	32	36	5	41
	FISH - OTHER	2	2	0.002%	0	0	0	9	0	9
	FISH - RAYS	3	15	0.015%	2	9	11	18	0	18
	SEABIRD - ALBATROSS	5	49	0.049%	43	20	63	33	45	78
	SEABIRD - JAEGER	1	1	0.001%	1	0	1	0	1	1
	SEABIRD - PETREL	4	7	0.007%	5	1	6	2	5	7
	SEABIRD - SHEARWATER	6	155	0.154%	158	36	194	30	304	334
	SEABIRD - UNKNOWN	1	8	0.008%	6	3	9	3	6	9
	TURTLE	6	315	0.313%	19	225	244	303	23	326
	UNKNOWN	2	4	0.004%	0	0	0	0	1	1
		41	575	0.572%	239	321	560	434	390	824
LN01	SEAL	1	2	0.162%	0	2	2	4	0	4

Table 17.7 Number of logbook recorded interactions with Listed Marine and Threatened Species (by species group) by year. Note, as explained in the text to adjust for missing data the total number recorded here is based on the maximum of the number recorded caught or released.

	00	01	02	03	04	05	06	07	08	09	10	11	12	
SPECIES GROUP	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	TOTAL
CETACEAN	2	6	2	5	5	2	3	2	1	2	4	2	0	41
FISH - OTHER	0	0	0	1	8	0	0	0	0	0	0	0	0	9
FISH - RAYS	5	8	0	1	3	1	0	0	0	5	0	0	0	18
SEABIRD - ALBATROSS	10	2	16	5	9	6	8	8	9	10	2	0	0	79
SEABIRD - JAEGER	0	0	1	0	0	0	0	0	0	0	0	0	0	1
SEABIRD - PETREL	2	0	2	1	1	0	0	0	0	2	0	0	0	7
SEABIRD - SHEARWATER	1	111	116	51	44	5	6	0	1	1	2	0	0	337
SEABIRD - UNKNOWN	2	0	2	1	0	2	2	1	0	2	0	0	0	10
SEAL	0	0	0	0	0	0	0	0	4	0	0	0	0	4
TURTLE	6	44	52	41	49	36	21	17	9	6	26	8	2	328
UNKNOWN	0	1	0	0	0	0	0	0	0	0	0	0	0	1
	28	172	191	106	119	52	40	28	24	28	34	10	2	835

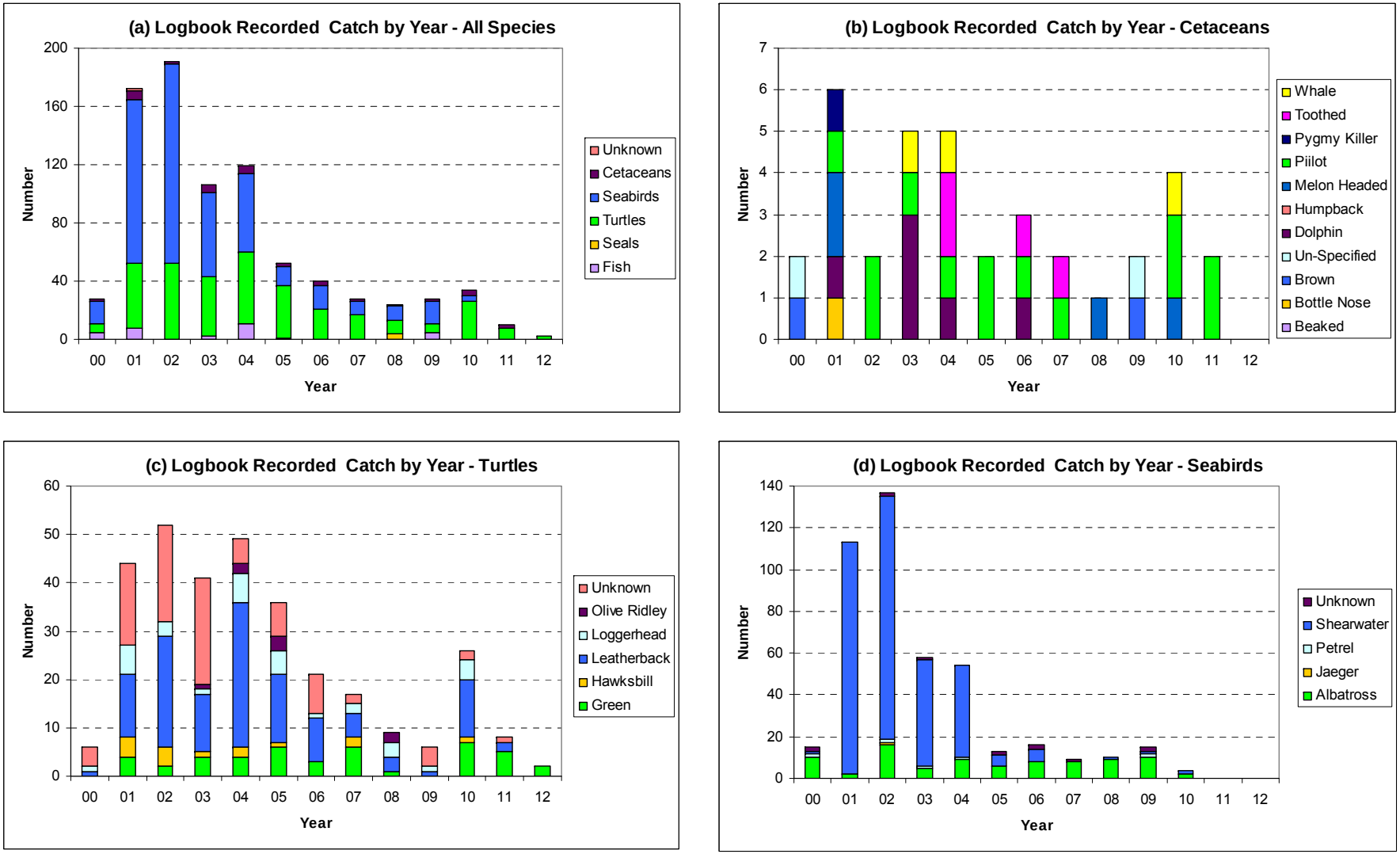


Figure 17.7 Plots by year of the number of interactions with Listed Marine and Threatened Species recorded on AL05 and AL06 logbooks.

17.3.3 Observer Data Catch Data

Observer data related to pelagic longline fishing operations within the ETBF are available since 2001. Due to the comprehensive nature of the data collected these data are stored in a large collection of database tables. As well as the ongoing generic observer program managed by AFMA in the ETBF since 2003, the observer data for the ETBF has also been collected from a number of different projects conducted in the fishery since 2001. These projects include longline chute trial, longline tori-pole trials, lead-weight trials and circle-hook trials. In total, catch information has been re-coded for 1499 fishing trips and 4314 fishing operations involving the use of pelagic longlines covering the use of the AL04, AL05, AL06 logbooks (annual coverage rates are provided later). For this project, catch by shot and species details information were retrieved from the following tables:
OPN_BIOLOGICAL
VW_M_SPECIES
VW_CD_SPECIES

The species of each fish observed caught is recorded by a three-letter code and this code was used to retrieve the species name from the related species tables. In total there were 306 distinct species codes in the observer data though only 234 were able to be matched to a related species name. Whether or not the remaining 72 species codes are in error remains unknown and for this project the catch for these records (806 fish out of a total of 207,806, or 0.41%) were combined into a single record named “Unknown”.

The fate of fish is also recorded by observers according to one of six categories:

1) discarded: landed and not retained;
2) escaped, bitten off;
3) jerked free, crew jerked free; cut-free without landing;
4) retained, kept for commercial or crew consumption;
5) tagged fish and returned to sea;
6) unknown – did not observe.

Based on these categories, the fate of each fish was then classified within one of the following three types:

1) Retained – all fish in category 4 above;
2) Discarded - all fish in categories 1,2,3 and 5 above;
3) Fate Unknown - all fish in category 6 above, including a small number of fish where the fate was not recorded.

The percentage of fish discarded for each species was then calculated as the ratio of the number Discarded to the total number either Retained or Discarded (i.e. the number of fish where the fate was unknown was not used). Finally, as for the logbook catch data, each species were grouped into the following five categories:

TUNAS	Includes all tunas
BILLFISH	Includes all marlins, spearfishes, sailfish and swordfish.
BYPRODUCT	Includes all species where the number caught (retained + discarded) on the AL logbook using a pelagic longline was greater than 500 and the percent discarded was less than 50 percent. (Note, this gave the same list of species are identified on the logbook data).
SHARKS	Includes all sharks and dogfish
BYCATCH	Everything not included in the above categories.

Table 17.8 Summary of the catch information, group by species-type, recorded by on-board observer for pelagic longline operations in the ETBF.

Species Group	Number of Species	Number Retained	Number Discarded	Percent Fish Discarded	Fate Unknown	Total Number Caught
TUNA	10	117482	10061	7.9%	321	127864
BILLFISH	7	15138	2517	14.3%	146	17801
BYPRODUCT	7	30640	1904	5.9%	101	32645
SHARK	39	2509	6714	72.8%	33	9256
BYCATCH *	171	727	19253	96.4%	260	20240
Total	234	166,496	40,449	19.5%	861	207,806

Summaries of the number of fish retained and discarded by species are provided in Table 17.26 in the Supplementary Tables while a summary by species-type is given in Table 17.8. Of the 234 different species recorded by observers, the distribution of the number of species against the overall discard rate is shown in Figure 17.8. Of the 234 species recorded by observers, the discard rate is 10 percent or less for 70 species (30%) and greater than 90 percent for 101 species (43%). Apart from the greater number of species within this last discard category, the distribution of species within each category is similar to that reported on logbooks (c.f. Figure 17.4).

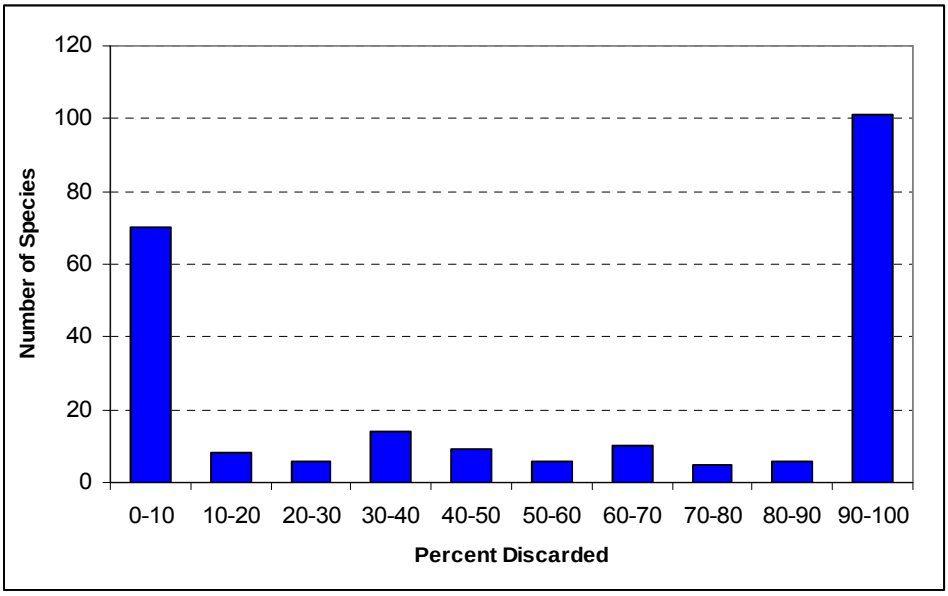


Figure 17.8 Distribution of the number of species against the overall discard rate category for observed fishing operations using a pelagic longline.

The number of observed fish retained and discarded by species group and year is shown in Table 17.9 while the total number of fish caught (i.e. recorded as either retained or discarded) by species group and year is shown in Figure 17.9 and the annual percentage of fish discarded by species group is shown in Figure 17.10. For the tuna species groups there is a large degree of inter-annual variation in the percentage discarded, though no apparent trend over the years shown, while the percentage of billfish discarded generally decreased over the years to 2008 before increasing again (with a high of 19% in 2010). Discards of sharks displays a general increase over time while there has also been a large increase in the discards of byproduct species in recent years (though the data from 2012 is very limited).

Table 17.9 Number of fish retained and discarded recorded by observers in the ETBF by species group and year.

(a) Retained Catch

SPC_TYPE	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	TOTAL
TUNA	586	9396	9211	7387	9435	18423	10324	26106	13138	5919	7273	284	117482
BILLFISH	144	931	832	2079	1577	1571	1643	2468	1368	735	1564	226	15138
BYPRODUCT	224	3580	2174	2398	3861	2112	2155	7138	3355	1875	1560	208	30640
SHARK	38	345	285	227	308	229	148	402	240	114	154	16	2509
BYCATCH	9	70	27	36	28	94	51	125	107	134	45	1	727
Total	1001	14322	12529	12127	15209	22429	14321	36239	18208	8777	10596	735	166496

(b) Discarded Catch

SPC_TYPE	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	TOTAL
TUNA	77	758	634	613	970	962	594	1230	1811	1459	923	30	10061
BILLFISH	17	185	179	304	438	342	148	187	122	214	339	42	2517
BYPRODUCT	26	143	93	125	143	268	117	265	218	156	241	109	1904
SHARK	48	293	248	486	610	600	588	905	854	914	1076	92	6714
BYCATCH	365	1684	998	1820	2441	3014	1661	1755	2495	1304	1570	146	19253
Total	533	3063	2152	3348	4602	5186	3108	4342	5500	4047	4149	419	40449

(c) Unknown Fate

SPC_TYPE	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	TOTAL
TUNA	7	75	111	2	3	0	23	39	9	25	27	0	321
BILLFISH	7	53	16	5	0	0	20	33	6	4	2	0	146
BYPRODUCT	5	30	26	3	0	0	11	9	10	3	3	1	101
SHARK	3	5	3	0	2	0	1	5	6	4	4	0	33
BYCATCH	12	99	23	48	22	16	13	10	5	4	8	0	260
Total	34	262	179	58	27	16	68	96	36	40	44	1	861

(d) Total Catch

SPC_TYPE	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	TOTAL
Tuna	670	10229	9956	8002	10408	19385	10941	27375	14958	7403	8223	314	127864
Billfish	168	1169	1027	2388	2015	1913	1811	2688	1496	953	1905	268	17801
Byproduct	255	3753	2293	2526	4004	2380	2283	7412	3583	2034	1804	318	32645
Shark	89	643	536	713	920	829	737	1315	1100	1032	1234	108	9256
Bycatch	386	1853	1048	1904	2491	3124	1725	1890	2607	1442	1623	147	20240
Total	1568	17647	14860	15533	19838	27631	17497	40680	23744	12864	14789	1155	207806

(e) Percent Discarded

SPC_TYPE	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	TOTAL
TUNA	11.61%	7.47%	6.44%	7.66%	9.32%	4.96%	5.44%	4.50%	12.11%	19.78%	11.26%	9.55%	7.89%
BILLFISH	10.56%	16.58%	17.71%	12.76%	21.74%	17.88%	8.26%	7.04%	8.19%	22.55%	17.81%	15.67%	14.26%
BYPRODUCT	10.40%	3.84%	4.10%	4.95%	3.57%	11.26%	5.15%	3.58%	6.10%	7.68%	13.38%	34.38%	5.85%
SHARK	55.81%	45.92%	46.53%	68.16%	66.45%	72.38%	79.89%	69.08%	78.06%	88.91%	87.48%	85.19%	72.80%
BYCATCH	97.59%	96.01%	97.37%	98.06%	98.87%	96.98%	97.02%	93.35%	95.89%	90.68%	97.21%	99.32%	96.36%

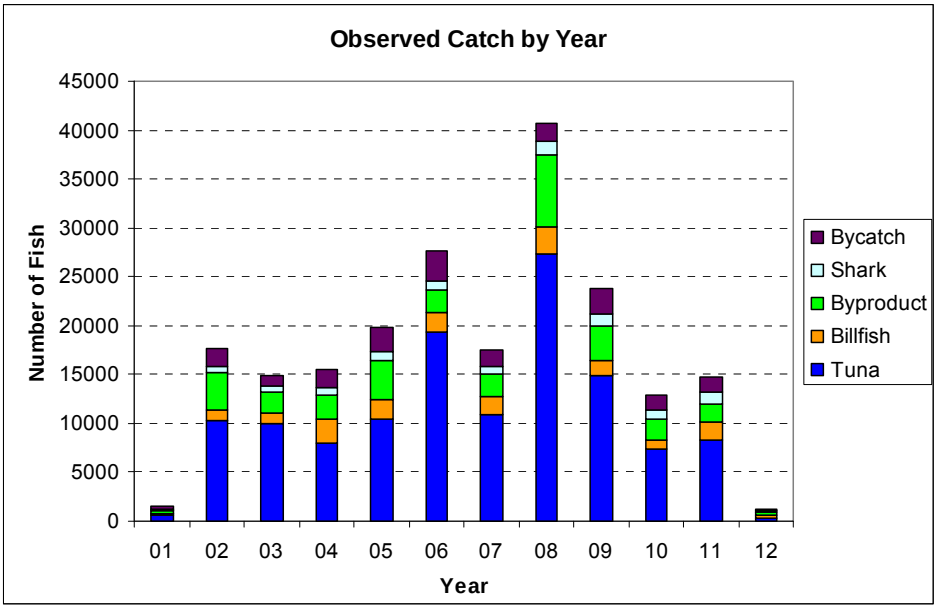


Figure 17.9 Total number of fish caught (i.e. recorded as either retained or discarded) by species group and year for fishing operations using a pelagic longline and the AL05 or AL06 logbooks.

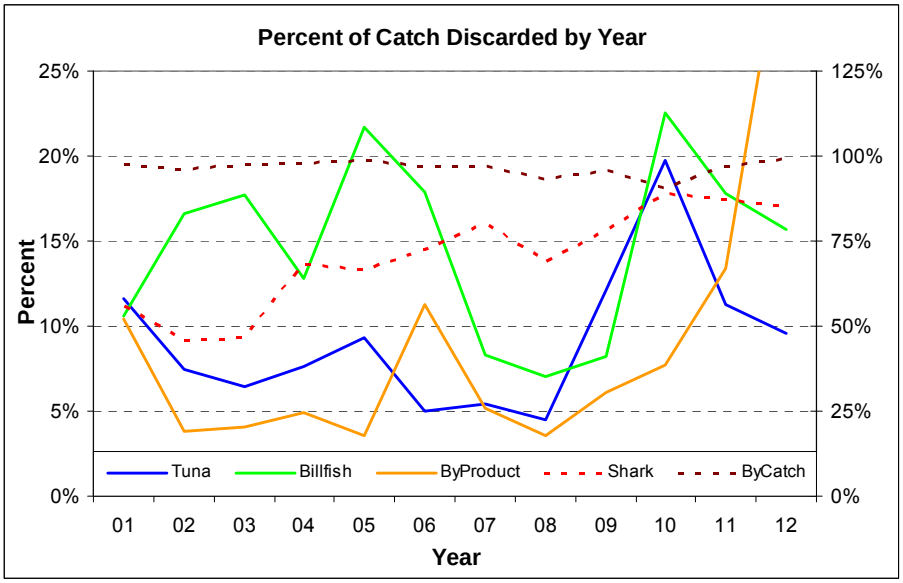


Figure 17.10 Annual percentage of fish discarded for each species group for fishing operations using a pelagic longline and the AL05 or AL06 logbooks. Note, the left hand axis refers to the three species shown with a solid line while the right hand axis refers to the two species groups shown with dashed lines (i.e. sharks and byproduct species).

A comparison of the discard rate (across all years) for each species-group for pelagic longlining based on both the logbook-recorded data and observer-recorded data is shown in Figure 17.11. Except for the byproduct group, the discard rate recorded by observers is higher than that recorded on logbooks. While this may be expected to some extent, a more detailed spatial and temporal examination of the data is warranted as the observer data used in this project is not a random sample of all ETBF operations and as such may not be truly representative across all fishing operations within the ETBF. For example, the percentage of observed sets is considerably higher in the southern part of the ETBF (averaging 9.9% between 32-38^{o}S for the years 2001 to 2012) than in either the central section (3.0% between 25-

31°S) or the northern section (2.8% between 15-24°S). As such species that are predominately caught in either the southern or northern parts of the fishery are likely to be over represented or under-represented in the observer catch data respectively. For a discussion on the relationship between observer coverage rates and the precision of observer based catch estimates for bycatch species the reader is referred to Bravington *et al* (2003).

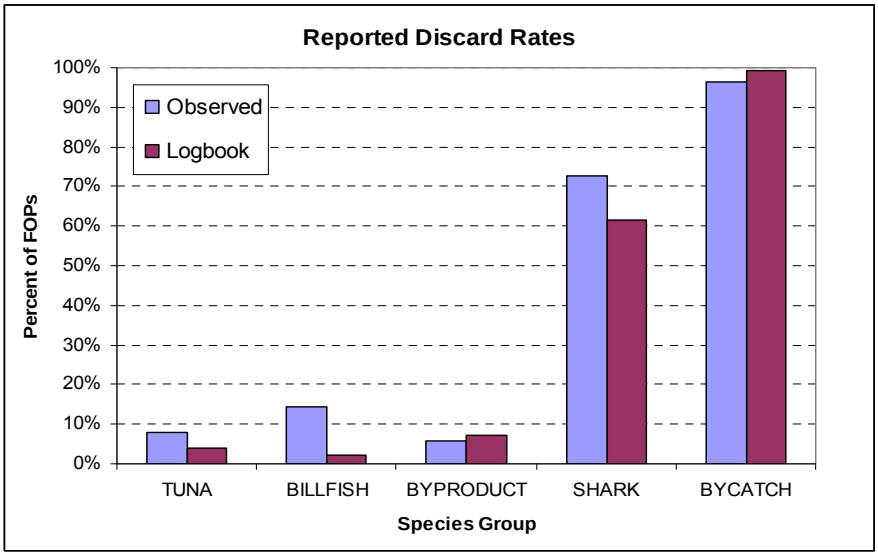


Figure 17.11 Comparison of the discard rate by species-group for fish caught by pelagic longlining based on logbook-recorded data and observer-recorded data.

Note: Of the 4314 observed sets in the ETBF, the number of hooks observed (or the percentage of total hooks deployed that were observed) for a given set is recorded in the database for only 3028 sets (i.e. ~ 70%). The reasons that the observed effort is missing for the remaining 1286 sets remains unknown. The number of observed sets each year with and without the number of observed hooks recorded is shown in Figure 17.12a, while the percentage of total effort in the ETBF which has been observed each year (dependent on the recorded status of the observed hooks effort) is shown inFigure 17.12 b. The percentage of observed sets in the ETBF reached a maximum of around 8.5% in 2008, whilst the percentage of observed hooks in the ETBF (i.e. the ratio of total hooks deployed in the ETBF to the ratio of observed hooks in the database) peaked at just over 6% in 2005, 2009 and 2011 though was less than 2% in 2008. In order to maximise the utility of the observer data it is recommended AFMA enter the missing data into the Observer database (i.e. the number of observed hooks per observed set).

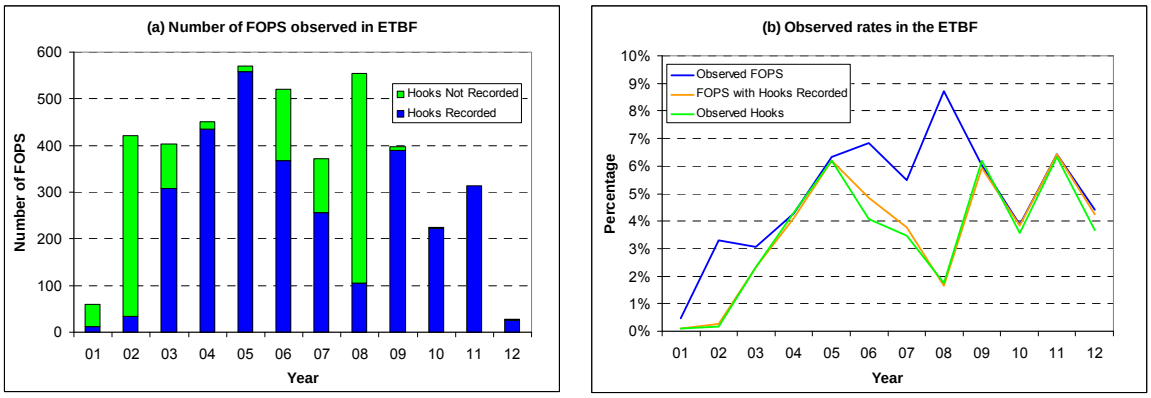


Figure 17.12 (a) Number of pelagic longline fishing operations (FOPs) observed in the ETBF by year with and without the observed number of hooks being recorded in the database, and (b) the percentage of total effort in the ETBF observed each year dependent on the recorded status of observed hooks.

17.3.4 Observer Recorded Wildlife Interactions

The number of interactions recorded by observers of Listed Marine and Threatened Species was retrieved from the WLDLF_INTRCTN table in the database. Each observed interaction is classified as one of the following nine types:

1) Bird Flying, Light Contact;
2) Bird Flying, Heavy Contact;
3) Wildlife On/In Water, Heavy Contact;
4) Wildlife On/In Water, Light Contact;
5) Wildlife Hooked, Caught or Entangled in Net;
6) Wildlife Chasing, Diving for Non Target Species;
7) Wildlife Chasing, Diving for Baits or Target Species;
8) Wildlife Snagged or Entangled Not Hooked;
9) Dived and took bait.

For the following analysis only those interactions where the wildlife was hooked were used (i.e. type 5 above). A summary of these data listing the number of interactions with each species together with the related information on whether this interaction occurred during the setting or hauling of the longline and the life-status of the species after being returned to the sea is given in Table 17.27 in the Supplementary Tables while a summary of this information by the main species groups, combined across all years, is given in Table 17.10. Overall, an interaction has been recorded for around 5% of all fishing operations, though sharks (mainly shortfin makos) account for around half of these recorded interactions, with seabird, turtles and whales accounting for 32%, 12% and 1% of interactions respectively. Finally, the number of interactions by year for each observed species is provided in Table 17.28 in the Supplementary Tables while a summary by species-group is given in Table 17.11. Of the total of 383 interactions, the majority (65%) have been recorded since 2008. This increase since 2008 is related to the inclusion of 192 shark interactions all of which are mako and porbeagle sharks which were included as Listed Species under the EPBC Act in 2009. Removing these interactions gives the opposite trend with a split of 70%:30% in the number of interactions pre- and post-2008. A histogram of the

total number of observed interactions per year for each species-group (except sharks) is shown in Figure 17.13. This shows that the overwhelming majority of interactions pre-2008 (and certainly pre-2005) was with shearwaters.

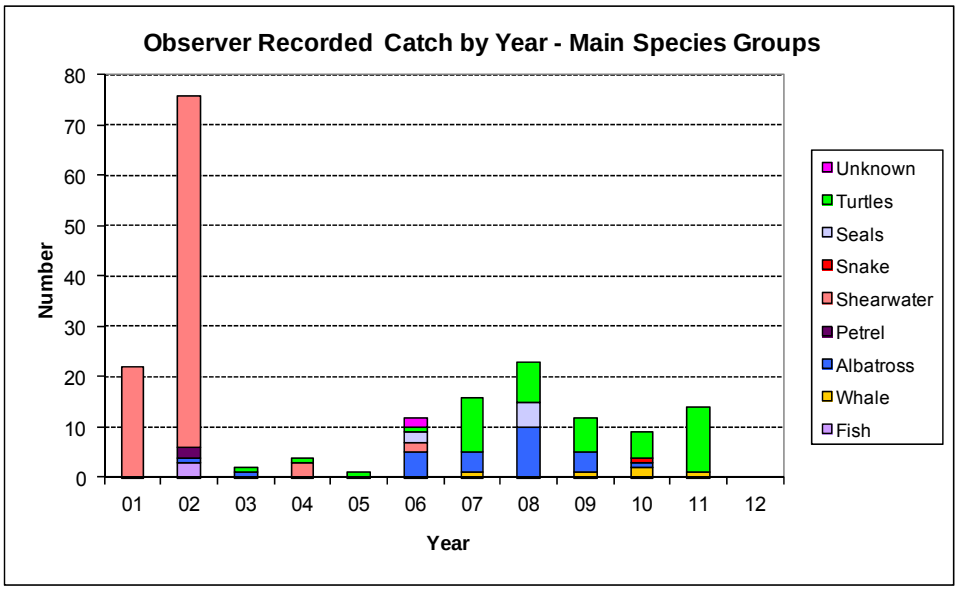


Figure 17.13 Histogram of the total number of observed interactions per year by species group.

Table 17.10 Number of observer recorded interactions with Listed Marine and Threatened Species (by species group) together with related information the number of interaction which occurred during the setting or hauling of the longline and the life-status of the species after being returned to the sea.

SPECIES GROUP	FOPS with Catch	% FOPS with Catch	Catch while Setting	Catch while Hauling	Catch Unknown Time	Released Dead	Released Alive	Unknown Status	Total
FISH	2	0.05%	2	0	1	0	0	3	3
SEABIRD	59	1.37%	83	35	7	12	5	108	125
SEAL	5	0.12%	0	7	0	0	2	5	7
SHARK	111	2.57%	2	190	0	82	104	6	192
SNAKE	1	0.02%	0	1	0	0	1	0	1
TURTLE	46	1.07%	1	47	0	6	39	3	48
UNKNOWN	2	0.05%	0	2	0	0	1	1	2
WHALE	5	0.12%	0	5	0	0	4	1	5
TOTAL	226	5.24%	88	287	8	100	156	127	383
Number of Observed FOPS	4314								

Table 17.11 Number of observer recorded interactions with Listed Marine and Threatened Species (by species group) by year.

SPECIES GROUP	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	TOTAL
CETACEAN	0	0	0	0	0	0	1	0	1	2	1	0	5
FISH	0	3	0	0	0	0	0	0	0	0	0	0	3
SHARK	0	0	0	0	0	0	0	0	1	62	117	12	192
SEABIRD - ALBATROSS	0	1	1	0	0	5	4	10	4	1	0	0	26
SEABIRD - PETREL	0	2	0	0	0	0	0	0	0	0	0	0	2
SEABIRD - SHEARWATER	22	70	0	3	0	2	0	0	0	0	0	0	97
SNAKE	0	0	0	0	0	0	0	0	0	1	0	0	1
SEAL	0	0	0	0	0	2	0	5	0	0	0	0	7
TURTLE	0	0	1	1	1	1	11	8	7	5	13	0	48
UNKNOWN	0	0	0	0	0	2	0	0	0	0	0	0	2
	22	76	2	4	1	12	16	23	13	71	131	12	383

A comparison of the wildlife interaction rates for longline operations in the ETBF for the main species-group based on both the logbook-recorded data and observer-recorded data is shown in Figure 17.14. Note that for this comparison the interaction rate is based on the percentage of fishing operations which report an interaction (and not catch per hooks as the number of hooks observed is not recorded for 36% of sets). For the four species groups shown the reporting rate recorded by observers is significantly higher than that recorded on logbooks. While this may be expected to some extent, further analysis of the data is warranted as the observer data used in this exercise is not likely to be a random sample of all ETBF operations and as such may not be truly representative across all fishing operations within the ETBF. Indeed, many of the observed sets were related to trials investigating seabird mitigation techniques and are therefore likely to have been conducted in areas and at times where the potential for seabird interactions is high.

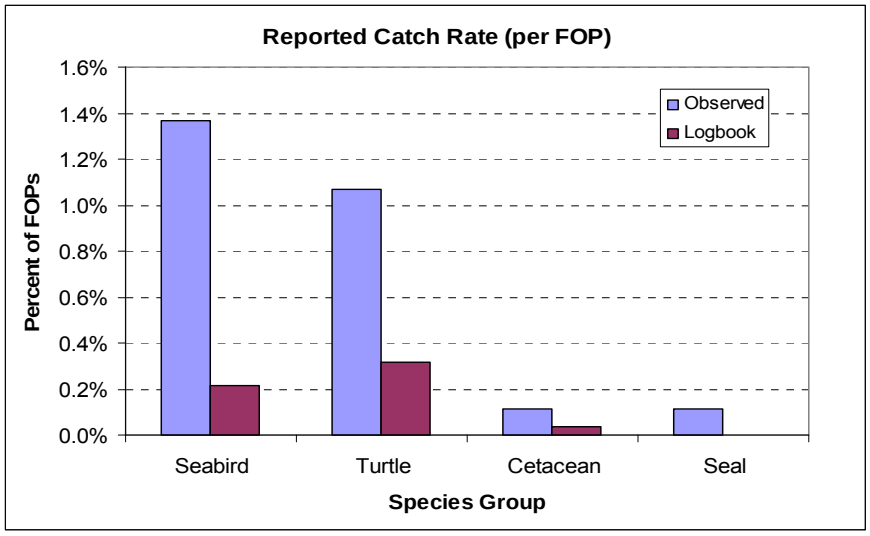


Figure 17.14 Comparison of the interaction rate for wildlife in the ETBF for the main species-groups based on both the logbook-recorded data and observer-recorded data

17.3.5 Comparison of Logbook and Observed Data

The total number of fish caught by all pelagic longline operations in the ETBF and reported on the AL05 and AL06 logbooks between 2000 and 2012 was 3,441,021, while of the sets observed during this same period a total of 207,806 fish were recorded by observers (c.f. Table 17.12). This equates to an overall observer coverage rate of 6.04% (although there is likely to be some under-reporting on logbooks) though this percentage varies between the five main species groups used in this report. These differences may be indicative of non-representative biases in the observer data due to spatial and temporal preferences in observer placement throughout the fishery.

Table 17.12 Summary of the number of fish reported in logbooks and by observers pertaining to pelagic longline operations reported in the AL05 and AL06 logbooks.

Data-Type	Tuna	Billfish	Byproduct	Sharks	Bycatch	Total
Logbook	1,948,491	386,899	679,331	123,797	302,503	3,441,021
Observer	127,864	17,801	32,645	9,256	20,240	207,806
%-observed	6.56%	4.60%	4.81%	7.48%	6.69%	6.04%

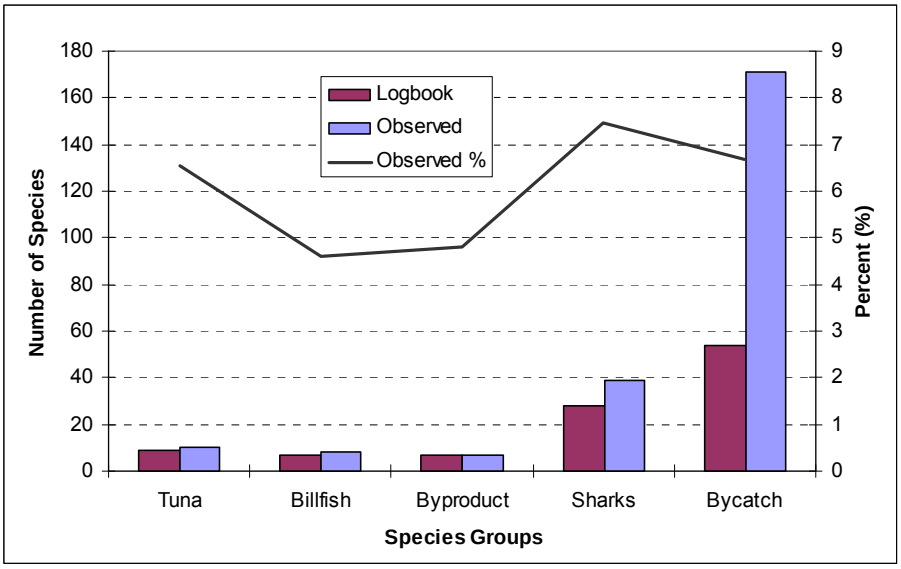


Figure 17.15 Number of species recorded on logbooks or by observers for each of the five species groups. The percentage of fish reported by observers relative to the number reported on logbooks is also shown for each species group.

The number of species recorded on logbooks or by observers for each of the five species groups is shown in Figure 17.15. For the main target (tuna and billfish) and byproduct groups the total number of species recorded by logbooks (23) and observers (25) is similar. However, 11 more shark species have been recorded by observers than on logbooks and at least 117 more bycatch species have been recorded by observers than on logbooks. This is most likely due to the fact that observers have a greater ability (and perhaps time) to correctly identify uncommon or infrequently caught species.

Reference to the catch-by-species tables provided in the Supplementary Tables indicates that there is a wide diversity in the numbers of each species caught. For example, over the 11+ year period to which the logbook data pertains, over 900,000 yellowfin tuna (*Thuunus albacares*) have been recorded in pelagic longline logbooks while only 1 southern eagle ray (*Myliobatis australis*) has been recorded. In order to gain some understanding of the likelihood of catching a given species, the total recorded logbook catch over this period for each species was placed into one of the following six categories:

Level 1:	Total catch ≥ 110,000 fish	(≥10,000 fish per year, on avg)
Level 2:	Total catch ≥ 11,000 fish	(10,000 to 1,000 fish per year)
Level 3:	Total catch ≥ 1,100 fish	(1,000 to 100 fish per year)
Level 4:	Total catch ≥ 110 fish	(100 to 10 fish per year)
Level 5:	Total catch ≥ 11 fish	(10 to 1 fish per year)
Level 6:	Total catch < 10 fish	(<1 fish per year)

Dividing by the 11 years between 2001 and 2011 over which most of the catch was reported gives the corresponding approximate mean annual catch levels as indicated. The number of species within each catch-level for each species group is shown in Table 17.3a and Figure 17.16.

Table 17.13 The number of species within each species group as recorded by (a) logbooks, and (b) observers against the catch-level categories (approximate number of fish caught per year) defined in the text.

(a) Logbook Catches

Catch per Year	Tuna	Billfish	Byproduct	Sharks	Bycatch	All Fish	%
≥10,000 fish	3	1	3	0	1	8	7.6%
10,000 to 1,000	2	1	3	3	0	9	8.6%
1,000 to 100	0	4	1	7	5	17	16.2%
100 to 10 fish	2	1	0	6	5	14	13.3%
10 to 1 fish	0	0	0	6	15	21	20.0%
<1 fish	2	0	0	6	28	36	34.3%
Total	9	7	7	28	54	105	100.0%

(b) Observed Catches

Catch per Year	Tuna	Billfish	Byproduct	Sharks	Bycatch	All Fish	%
≥10,000 fish	3	1	3	0	1	8	3.4%
10,000 to 1,000	2	2	3	2	4	13	5.5%
1,000 to 100	0	2	1	8	11	22	9.4%
100 to 10 fish	3	2	0	13	38	56	23.8%
10 to 1 fish	2	1	0	16	117	136	57.9%
<1 fish							
Total	10	8	7	39	171	235	100.0%

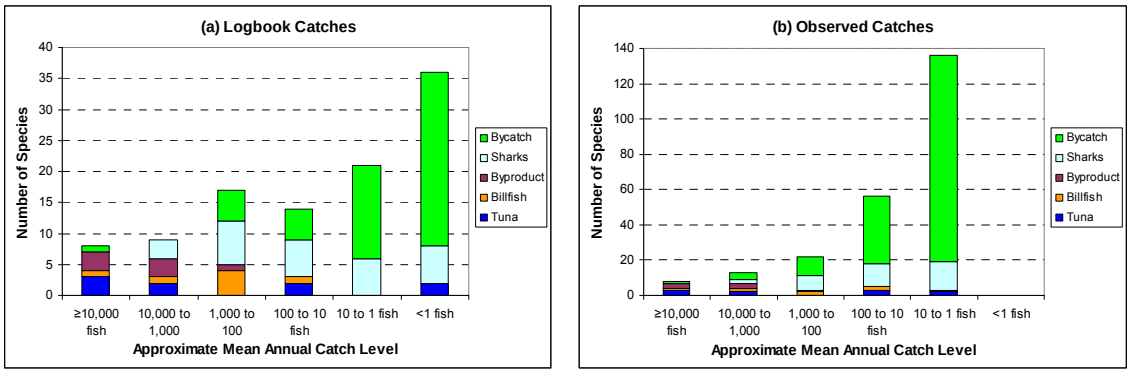


Figure 17.16 The number of (a) logbook recorded, and (b) observer recorded species for each species group within each catch-level defined in the text.

A similar exercise was also undertaken for each species recorded by observers, though the number of observed fish for each species was first re-scaled to reflect the estimated catch across the total fishery, i.e. they were multiplied by the ratio of the total catch recorded for all species recorded in logbooks and the total catch for all species recorded by observers (1/0.0604). Again, the number of species within each catch-level for each species group is shown in Table 17.3b and Figure 17.16. Note, due to the observed percentage being less than 10% it is not possible to use the observer data to estimate when a species will be caught, on average, less than once a year.

Of the 105 species recorded on logbooks only eight were categorised as level 1 (i.e. had a total catch of greater than 110,000 fish or an estimated mean catch greater than 10,000 fish per annum). Four of these were target species (yellowfin tuna, bigeye tuna, albacore tuna and broadbill swordfish), three were byproduct species (dolphin fish, rudderfish and Ray's bream) and one was a bycatch species (lancet fish). The eight same species were identified at level 1 with the observer data. On the other hand, 36 species (34% of the 105) recorded on logbooks had a total catch of less than 11 fish (i.e. on average, less than one fish per year). Furthermore, species

estimated to be caught, on average, less than 10 times a year represent 57 (54%) of the 105 species recorded on logbooks and 136 (58%) of the 235 species recorded by observers. This result indicates that while there are a large number of individual species caught in the ETBF, many (if not the majority) of these species are caught quite infrequently (less than 10 individuals a year). The number of species estimated to be caught, on average, more than 10 times a year is estimated to be between 48 and 99 (using the range between the logbook and observer data), while the number of species estimated to be caught, on average, more than 100 times a year is estimated to be between 34 and 43.

17.4 Bycatch Management Measures

Implementation of the Australian Government's Commonwealth Policy on Fisheries Bycatch within the ETBF is presently via the Bycatch and Discard Workplan for the Australian Tuna and Billfish Fisheries 2011-2013 (AFMA 2012a) which aims to minimise bycatch and discarding of high risk species that have been identified through the Ecological Risk Assessment (ERA) process (Webb *et al.,* 2007; AFMA 2009a).

The species identified as high risk following the Level 2 and Level 3 residual risk assessments for the ETBF are listed in Table 17.14. Under the Level 3 Sustainability Assessment for Fishing Effects (SAFE) assessment (carried out for chondrichthyan and teleost species only) two species of sunfish and four shark species were identified as being at high risk due to the effects of fishing in the ETBF (Zhou *et al.* 2007). The sunfish species were assessed as 'precautionary extremely high risk' mainly due to lack of biological data on the species productivity, though the results from more recent research, indicating that they have a high productivity, will be used to update this assessment in 2013.

The priorities of the Ecological Risk Management (ERM) plan for the ETBF (AFMA 2012b) are to reduce the effects of fishing on the species in the priority list shown in Table 17.14. Furthermore, while no individual species of seabird is considered to be at high risk, consistent with AFMA's ERM process all protected species (e.g. marine turtles, seabirds and whales) that come into contact with the fishery are managed to minimise interactions and fatalities.

The ERM report also lists specific actions for the priority groups—for example, all vessels in the ETBF are required to carry line cutters and de-hookers so that turtles and other threatened, endangered or protected species can be easily removed from fishing gear, should they become hooked or entangled.

The ERA will be reviewed in 2013 in line with recommendation 1 of the ETBF Wildlife Trade Operation Accreditation under the EPBC Act. The current list of high risk species will be amended according to the results of this review.

Bycatch mitigation measures for other species are also managed under various measures such as the Threat Abatement Plan (TAP) for seabirds, the ETBF Sea Turtle Mitigation Plan (AFMA 2009b) for sea turtles, and the 20 shark trip limit to decrease the capture and mortality of sharks under Australia's National Plan of Action for the management of sharks. Various international plans of action and recovery plans for Threatened, Endangered and Protected (TEP) species also apply.

Priority issues for managing the ecological effects of fishing in the ETBF are largely captured by the actions of the Australian Tuna and Billfish Longline Fisheries bycatch and discard workplan 2011-2013 (AFMA 2012a). Other documents aimed at managing the ecological effects of fishing in the ETBF include the Eastern Tuna and Billfish Fishery Management Plan 2010 (AFMA 2010), the Eastern Tuna and Billfish Fishery Harvest Strategy[10], and the Threat Abatement Plan for the incidental catch (or bycatch) of seabirds during oceanic longline operations (AAD 2006).

Table 17.14 List of high risk species for the ETBF after risk assessment (from AFMA 2012b).

Taxonomic Group	Scientific Name	Common Name	Role in Fishery	Highest Level of Assessment	Risk Score
Chondrichthyan	Isurus paucus	Longfin mako	Byproduct	Level 3	Precautionary High Risk
Chondrichthyan	Pseudocarchari as kamoharai	Crocodile shark	Byproduct	Level 3	Precautionary High Risk
Chondrichthyan	Alopias pelagicus	Pelagic Thresher	Byproduct	Level 3	Precautionary High Risk
Teleost	Mola mola	Ocean sunfish	Bycatch	Level 3	Precautionary High Risk
Teleost	Mola ramsayi	An Ocean Sunfish	Bycatch	Level 3	Precautionary High Risk
Chondrichthyan	Carcharhinus obscurus	Dusky Shark	Byproduct	Level 3	High
Cetacean	Globicephala macrorhynchos	Short-finned Pilot Whate	Bycatch	Level 2 Residual Risk Assessment	High
Marine Reptile	Dermochelys coriacea	Leatherback Turtle	Bycatch	Level 2 Residual Risk Assessment	High
Cetacean	Pseudorca crassidens	False Killer Whale	Bycatch	Level 2 Residual Risk Assessment	High

Australia is also obliged to abide by the Management Measures and Resolutions implemented by the Western and Central Pacific Fisheries Commission (WCPFC) to conserve the populations of sharks, turtles and seabirds in the Western and Central Pacific Ocean. Australia must also abide by measures adopted by the Commission for the Conservation of Southern Bluefin Tuna (CCSBT) which state that Members should implement national plans of action to reduce the interactions between the fishery and non-target species, namely seabirds, sharks and turtles.

17.4.1 Seabirds

Seabirds are attracted to fishing vessels by discarded offal and baits and on occasion ingest baited hooks during the setting or hauling of the longline. Many seabirds are long lived and late maturing with populations that are listed as vulnerable or have unknown status. As such, mortality as a result of longline fishing operations has the potential to lead to further declines in seabird populations.

The Commonwealth Government has listed the incidental capture of seabirds in oceanic longline operations as a key threatening process under the EPBC Act. In response the ETBF currently manages seabird bycatch through provisions under the Threat Abatement Plan (TAP) first introduced in 1998 and updated in 2006 (AAD

[10] http://www.afma.gov.au/managing-our-fisheries/harvest-strategies/eastern-tuna-and-billfish-harvest-strategy/

2006). The TAP requires the ETBF to significantly minimise the bycatch of seabirds in oceanic longline operations and maintain a bycatch rate of less than 0.05 birds per 1000 hooks set in all fishing areas (by five degree latitudinal bands) and all seasons (1 September – 30 April; 1 May – 31 August). If this trigger limit is reached, AFMA will enforce more stringent measures for management of the fishery including closures and night setting provisions. Seabird bycatch rates for the winter (1 May – 31 August) and summer (1 September – 30 April) TAP seasons between 2007 and 2011 from both logbook and observer data are shown in Table 17.15. Note, only one seabird has been recorded by an observer since the start of 2010 though 18 (all albatrosses) were recorded in the preceding three years The large differences between the logbook and observer bycatch rates should also be noted.

Table 17.15 Number and rate of seabird interactions for the summer and winter seasons in the ETBF between 2007 and 2011 based on data interactions recorded in logbooks and by observers. Note, the observer data are limited to those sets where the number of observed hooks is recorded in the database.

(a) Logbooks

Season	Recorded Interactions		Total Hooks		Interaction Rate (per 1000 hooks)	
	Summer	Winter	Summer	Winter	Summer	Winter
2007	7	2	5,326,165	3,188,434	0.0013	0.0006
2008	2	8	4,983,349	3,151,776	0.0004	0.0025
2009	15	0	5,449,277	3,474,452	0.0023	0
2010	2	2	4,912,552	2,974,516	0.0004	0.0007
2011	0	0	4,030,906	2,581,865	0	0

(b) Observers

Season	Recorded Interactions		Observed Hooks		Interaction Rate (per 1000 hooks)	
	Summer	Winter	Summer	Winter	Summer	Winter
2007	2	1	225,543	68,518	0.0089	0.0146
2008	1	2	104,422	35,604	0.0096	0.0562
2009	4	0	356,062	191,157	0.0112	0
2010	0	1	165,776	114,653	0	0.0087
2011	0	0	250,903	166,544	0	0

In the ETBF, AFMA has implemented a number of compulsory fishing permit conditions aimed at reducing seabird mortality which are consistent with the objectives and prescriptions of the TAP. For example:

- All longline operators fishing *south* of 25˚S must deploy a tori-line (of specific design requirements, see AFMA 2012c), use only non-frozen bait, and use a line weighting system with either a minimum of i) 60g swivels at a distance of no more than 3.5m from each hook, or ii) 98g swivels at a distance of no more than 4m from each hook, or iii) 40g weights at each hooks with dead non-frozen bait. The vessel must carry 1,000 weighted swivels each weighting at least 60g or 1,000 weights to be used at each hook weighting at least 40g. Offal discharge is also banned while setting and hauling (though an exemption whilst hauling for smaller boats can be given by AFMA).
- All longline operators fishing *north* of 25˚S in the ETBF must carry an assembled tori-line together with 1,000 weighted swivels each weighting at least 60g or 1,000 weights to be used at each hook weighting at least 40g. Offal discharge is also banned while setting and hauling (though an exemption whilst hauling for smaller boats can be given by AFMA).

In addition to these compulsory measures, operators in the ETBF have adopted voluntary measures from their respective fishery's *Industry Code of Practice* to minimise seabird bycatch. Such measures include:

- Using a tori line north of 25˚S in the ETBF;
- Puncturing the swim bladders of thawed baits to assist sinking;
- Using bait casting machines;
- Selecting gear that minimises the probability of seabird bycatch;
- Promoting safe handling and release of all seabirds caught alive on longlines; and
- Promoting night setting.

Observers have been recording the use of tori-poles on ETBF vessels and their compliance against AFMA's management measures since 2007. The number of observed sets, by year and 5-degree bands of latitude, for which this information has been collected is shown in Figure 17.17a while the percentage of observed sets where a tori-line was on the vessel is given in Figure 17.17b. This percentage has increased in recent years, especially in the 20-25^{o}S latitudinal band, and during 2012 all observed sets south of 20^{o}S there was a tori-line on the vessel. For sets where a tori-line was on-board, the percentage of sets for which the tori-line was either constructed and/or deployed in compliance with the AFMA regulations is shown in Figure 17.17c,d. Construction compliance had declined in recent years but for the small number of observed sets in 2012 it was 100%. Deployment compliance also appears to have declined in recent years. Finally, the mean percentage of time during each observed set that the tori-line was deployed (given there was one on the vessel) is shown in Figure 17.17e. South of 25^{o}S usage is generally high (above 90%).

As well as having undertaken extensive seabird bycatch education programs in 2009 (including commencing a new program in 2012) AFMA also encourage skippers and crew in the ETBF to use a new type of 40g weight on the hook. A recent study (Robertson *et al.,* 2012) has shown that these weights sink twice as fast as 60g swivels placed 3.5m from the hook, thereby reducing the probability of seabirds taking the bait.

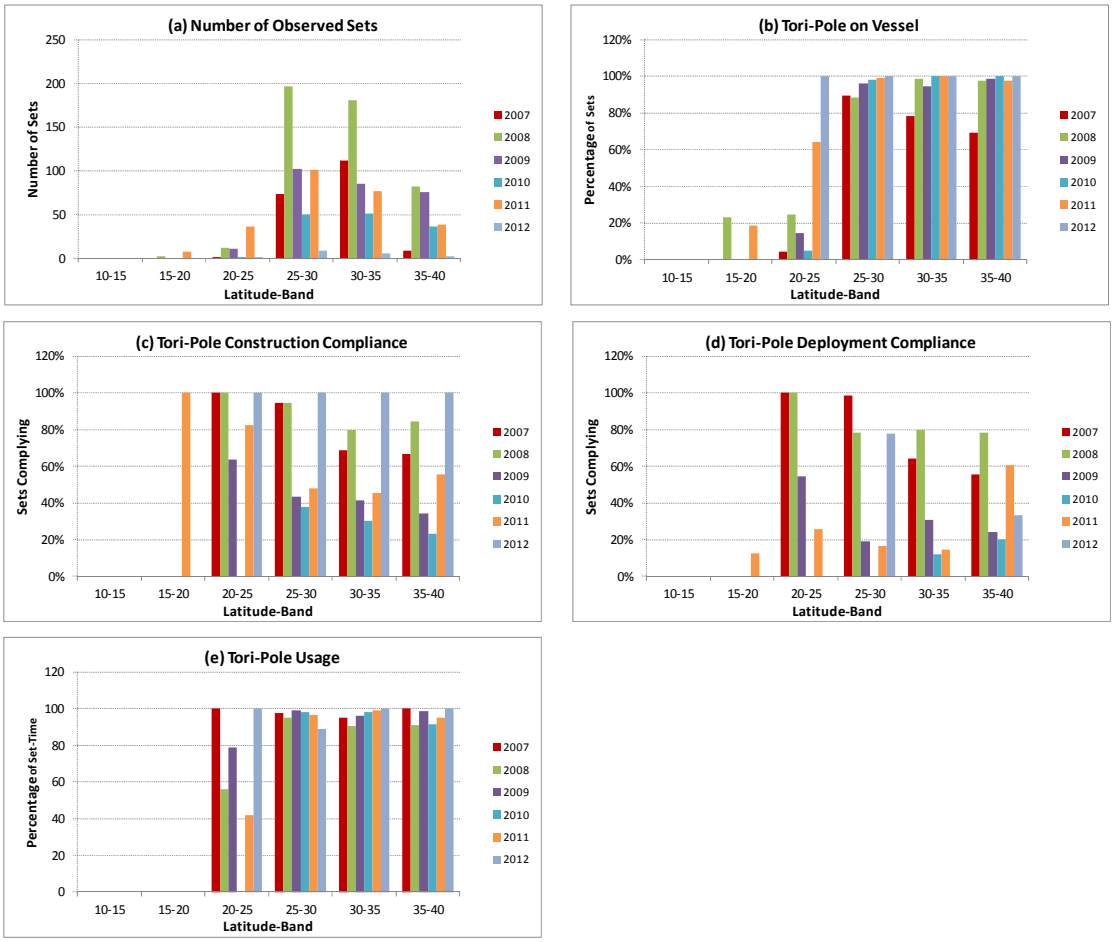


Figure 17.17 (a) The number of observed sets, by year and 5-degree bands of latitude, for which information of tori-pole use has been collected in the ETBF, and (b) the percentage of observed sets where a tori-line was on the vessel. For sets where a tori-line was on-board, the percentage of sets for which the tori-line was (c) constructed and (d) deployed in compliance with the AFMA regulations, while (e) shows the mean percentage of time during each observed set that the tori-line was deployed.

17.4.2 Marine Turtles

Six of the seven existing species of marine turtle are found in Australian waters, including the Loggerhead turtle, Green turtle, Hawksbill turtle, Olive Ridley turtle, Flatback turtle and Leatherback turtle.

Historically the majority of interactions that have occurred in the ETBF have been with green and leatherback turtles, accounting for 43% and 32% respectively of the 48 turtle interactions reported by observers (and 18% and 55% respectively of the 235 turtles reported on logbooks to the species level; Table 17.6). Of the 48 observed interactions, 47 have been reported as occurring during the haul, with 39 reported as released alive, 6 were released dead while the life status of the other 3 was not recorded. On the other hand, of the 326 turtles reported on logbooks, 93% are reported as released alive and 7% released dead. In 2009, industry members were provided a set of line cutters and de-hookers to assist in the healthy release of marine turtles and sharks without bringing them on board the boat, increasing their chances of post-release survival. A comparison of the interaction rates recorded in logbooks and by observers is shown in Table 17.6.

Table 17.16 Number and rate of turtle interactions by year in the ETBF from logbook and observer data. Note, the observer data are limited to those sets where the number of observed hooks is recorded in the database.

Season	Recorded Interactions		Total Hooks		Interaction Rate (per 1 million hooks)	
	Logbook	Observed	Logbook	Observed	Logbook	Observed
2007	17	8	8,514,686	294,061	2.00	27.2
2008	9	3	8,135,497	140,026	1.11	21.4
2009	6	7	8,923,777	547,219	0.67	12.8
2010	26	5	7,887,076	280,429	3.30	17.8
2011	8	13	6,612,717	417,487	1.21	31.1

Aggregated over the five years shown the observer based estimates of turtle interaction rates are more than an order-of-magnitude higher than those reported on logbooks (1.65 versus 21.45 per million hooks). This observed interaction rate is also similar to the rate of 24 turtles per million hooks estimated by Robins *et al* (2002) based on interviews with vessels skippers.

A turtle mitigation strategy has been developed in order to meet requirements under the Western Central Pacific Fisheries Commission (WCPFC) to minimise the bycatch of turtles in Australian longline fisheries. This strategy was agreed to at Eastern Tuna Management Advisory Committee 75 in April 2009 (AFMA 2009b).

The strategy utilises a trigger system that requires the fishery to maintain an observed marine turtle interaction rate at or below 4.8 per 1 million observed hooks set for green turtles and 4.0 per 1 million observed hooks set for all other species and implements management measures if the interaction rates are exceeded. These include establishing a Sea Turtle Mitigation Working Group, requiring vessels to use 'shallow set' pelagic longline fishing method to target Broadbill swordfish, requiring vessels to use whole finfish baits and large circle hooks and enforcing a trip limit of 20 swordfish. In addition, ETBF operators are required to ensure line cutters and de-hookers are carried on-board the boat at all times under their Boat Statutory Fishing Right conditions

17.4.3 Marine Mammals

The majority of interactions with marine mammals (whales, dolphins and seals) involve the mammals being hooked or entangled in the fishing gear while predating on tuna from longlines. The most common whales that have been reported interacting with longlines in the ETBF include Short Finned Pilot whales and Toothed whales, followed by Melon Headed, Humpback and Beaked whales. The majority of whales entangled are released alive.

Between 2007 and 2011 there were five observed interactions with whales (three Short Finned Pilot Whales, one Long Finned Pilot Whale and one Beaked Whale). Four were released alive without landing while the life-status of the fifth whale was not recorded. Five seals (four sea lions and one fur seal) were also recorded during this period with two released alive and the life-status of the others not recorded. A comparison of the interaction rates recorded in logbooks and by observers is shown in Table 17.17. Again, large differences between the logbook and observer interaction rates can be noted.

Table 17.17 Number and rate of marine mammal interactions by year in the ETBF from logbook and observer data. Note: the observer data are limited to those sets where the number of observed hooks is recorded in the database.

Season	Recorded Interactions		Total Hooks		Interaction Rate (per 1 million hooks)	
	Logbook	Observed	Logbook	Observed	Logbook	Observed
2007	2	0	8,514,686	294,061	0.23	0
2008	1	1	8,135,497	140,026	0.12	7.14
2009	2	2	8,923,777	547,219	0.22	3.65
2010	4	1	7,887,076	280,429	0.51	3.57
2011	2	0	6,612,717	417,487	0.30	0

It is compulsory for all operators in the ETBF to report interactions with marine mammals in their logbooks. AFMA have developed and sent out a protected species ID guide for all Commonwealth operators to help them identify protected species including marine mammals such as those rated as High Risk through the ERA. Line cutters and de-hookers have also been provided to ETBF operators to assist in the healthy release of marine mammals when they are brought up to the boat.

Operators in the ETBF are also encouraged to trial marine mammal bycatch mitigation devices such as tuna-guards that have been developed by the Australian Antarctic Division. These devices aim to prevent whale depredation of tuna caught on longlines, thereby preventing the whale being caught or entangled.

17.4.4 Sharks

The most commonly caught shark species observed in the ETBF are Blue Shark, Shortfin Mako, Bronze Whaler, Tiger Shark, Oceanic Whitetip Sharks and Crocodile Sharks. The nominal annual catch rate of sharks in the ETBF, based on observer records between 2007 and 2010 varies between 1.48 and 3.64 sharks per 1000 hooks There is a byproduct retention limit of 20 sharks per trip in the ETBF. Any excess sharks are classified as bycatch and must be discarded whether alive or dead.

AFMA banned the practice of shark finning at sea in 2000, prohibiting the possession or landing of fins separate from carcasses. To minimise the capture of all sharks, the use of wire leaders or traces has also been banned in the ETBF since 2005. Research has shown that the catch rates of sharks are much lower on nylon traces than on wire traces (Ward *et al.,* 2008). In 2009, ABARES and AFMA developed the Chondrichtyan guide for fisheries managers: A practical guide to mitigating chondrichtyan bycatch. This guide aims to provide fisheries managers with practical options to mitigate chondrichthyan, TEP and high risk species bycatch. Australia has also been involved in negotiating a National Plan of Action for managing shark bycatch.

The great white shark is listed as vulnerable under the EPBC Act 1999 and on 29 January 2010 porbeagle, shortfin mako and longfin mako sharks were listed as migratory species under this Act. The listing of these three species was a legislated requirement following their listing in Appendix II of the International Convention on Migratory Species. Under the EPBC Act, it is an offence to take, trade, keep or move a member of a listed migratory species. However, actions taken under accredited fisheries management plans or arrangements are exempt from these offence

provisions. The ETBF is an accredited fishery. The Australian Government Department of the Environment, Water, Heritage and the Arts (now the Department of Sustainability, Environment, Water, Populations and Communities) has advised that this exemption allows commercial fishers to retain and trade the three shark species if they are brought up already dead, but requires that live caught sharks must be returned to the sea unharmed. All catches of these sharks, whether retained or released, must be reported in the daily fishing logbooks. AFMA conducted educational port visits for ETBF operators in July 2011 to highlight this arrangement, and provided operators with line cutters and de-hookers to assist operators release these species in the water.

Of the two white sharks which have been observed caught in the ETBF both were released alive and vigorous. Of the other three listed shark species, 2028 have been observed caught of which 2005 also had the life-status recorded. Of these 49% were alive and vigorous, 22% were just alive or sluggish and 29% were dead. A comparison of the catch rates recorded in logbooks and by observers is shown in Table 17.18.

Table 17.18 Number and catch rate of listed shark (great white and porbeagle sharks, shortfin and longfin makos) caught by year in the ETBF from logbook and observer data. Note, the observer data are limited to those sets where the number of observed hooks is recorded in the database.

Season	Recorded Catch		Total Hooks		Catch Rate (per 1000 hooks)	
	Logbook	Observed	Logbook	Observed	Logbook	Observed
2007	1277	97	8,514,686	294,061	0.15	0.33
2008	1767	78	8,135,497	140,026	0.22	0.56
2009	3291	203	8,923,777	547,219	0.37	0.37
2010	2244	98	7,887,076	280,429	0.28	0.35
2011	1997	150	6,612,717	417,487	0.30	0.36

17.4.5 Sunfish

AFMA is developing a byproduct species policy that will implement arrangements to manage sunfish bycatch. Until this policy is in place a trigger limit of 750 sunfish caught in the ETBF per calendar year has been implemented in the fishery. This limit is based on the total recorded catch of sunfish in 2005 of 763 fish. At the effort levels in 2005, which was similar to 2007 when the ERA was published, it was determined that this limit would indicate any change in the sunfish stock to determine a decline in the stock. If the trigger limit is reached, AFMA will conduct a review of interactions within six months of reaching the limit. AFMA will also promote data collection in the ETBF to enable research into the biology and ecology of these species. Of the 1286 sunfish observed caught by observers in the ETBF with a recorded life-status upon release, 981 (76.5%) have been released alive and vigorous, 275 (21.4%) were released just alive or sluggish while 27 (2.1%) have been released dead. A comparison of the catch rates recorded in logbooks and by observers is shown in Table 17.19.

Table 17.19 Number and catch rate of sunfish caught by year in the ETBF from logbook and observer data. Note, the observer data are limited to those sets where the number of observed hooks is recorded in the database.

Season	Recorded Catch		Total Hooks		Catch Rate (per 1000 hooks)	
	Logbook	Observed	Logbook	Observed	Logbook	Observed
2007	252	65	8,514,686	294,061	0.030	0.22
2008	200	26	8,135,497	140,026	0.025	0.19
2009	209	87	8,923,777	547,219	0.023	0.16
2010	273	61	7,887,076	280,429	0.035	0.22
2011	396	118	6,612,717	417,487	0.060	0.28

17.4.6 Black marlin

In 1980 an area off Cairns (coincident with the Queensland Trough) was closed to Japanese longline fishing but remained open for handline fishing. The restriction was intended to reduce the interaction between Japanese longliners and the northern Queensland recreational and charter boat fisheries and to protect the spawning grounds of black marlin. In 1990 this area was extended to the south by closing the Townsville Tough region. The closed region become known as Area E but with the introduction of the management plan for the ETBF is now known as the Coral Sea Zone. Operations in this region are limited to a small number of permits (10) which are subject to restrictions limiting the amount of hooks which can be set (500 per shot) and carried (250 spare hooks). This is to ensure short hauling times so that any black marlin caught can be released alive.

Due to the ongoing concern expressed by recreational fishers that commercial catches of blue and black marlin were reducing population sizes and depressing recreational catch rates the retention of both blue and black marlin for commercial purposes was banned by Commonwealth legislation in 1997. Of the 562 black marlin observed caught by observers in the ETBF, 211 (38%) have been released alive and vigorous, 85 (15%) were released just alive or sluggish, while 266 (47%) were released dead, and of 376 blue marlin observed caught by observers, 182 (48%) have been released alive and vigorous, 74 (20%) were released just alive or sluggish, while 120 (32%) were released dead. A comparison of the catch rates of black and blue marlin recorded in logbooks and by observers is shown in Table 17.20.

Table 17.20 Number and catch rate of (a) black marlin and (b) blue marlin caught by year in the ETBF from logbook and observer data. Note: the observer data are limited to those sets where the number of observed hooks is recorded in the database.

(a) Black marlin

Season	Recorded Catch		Total Hooks		Catch Rate (per 1000 hooks)	
	Logbook	Observed	Logbook	Observed	Logbook	Observed
2007	341	23	8,514,686	294,061	0.040	0.078
2008	325	2	8,135,497	140,026	0.040	0.014
2009	227	21	8,923,777	547,219	0.025	0.038
2010	293	51	7,887,076	280,429	0.037	0.182
2011	266	38	6,612,717	417,487	0.040	0.091

(b) Blue marlin

	Logbook	Observed	Logbook	Observed	Logbook	Observed
2007	349	11	8,514,686	294,061	0.041	0.037
2008	377	3	8,135,497	140,026	0.046	0.021
2009	284	20	8,923,777	547,219	0.032	0.037
2010	254	44	7,887,076	280,429	0.032	0.157
2011	178	49	6,612,717	417,487	0.027	0.117

17.4.7 Southern Bluefin Tuna

The ETBF Management Plan does not allow fishing for Southern Bluefin Tuna (SBT) and any take of SBT must be done in accordance with the quota arrangements under the *Southern Bluefin Tuna Fishery Management Plan 1995*. Therefore, only operators who hold SBT quota SFRs are permitted to take SBT when fishing within the ETBF.

Each year AFMA restricts fishing operations to prevent the capture of SBT not covered by quota in the ETBF. This is achieved through the implementation of SBT Core and Buffer zones where operators must hold a suitable amount of quota before entering the zones. These are typically in place during the winter and spring months and reviewed fortnightly based on an SBT habitat preference model, sea surface temperatures, landings data, observer data, integrated computer vessel monitoring system data and industry advice. There are no SBT quota holding requirements for ETBF operators in the area outside the SBT zones.

17.4.8 Offshore Constitutional Settlement driven bycatch

The Commonwealth has negotiated Offshore Constitutional Settlement (OCS) agreements with the Australian States with which the ETBF interacts. The OCS agreements impose bycatch limits upon operators to ensure that species which are managed through State or other arrangements are not taken in commercial quantities by ETBF operators. The bycatch limits for fish species which may be taken by Commonwealth operators in the ETBF are specified in the management arrangements booklets for the respective fisheries.

17.5 Additional Analyses

The logbook and observer data collected from the ETBF represent the most important sources of information on the number and level of bycatch caught in the fishery. However, while the data summaries presented in this report provide a useful ‘broad picture’ of bycatch levels and discard practices in the fishery, further analyses are often required if more precise catch estimates are to be made from the observer

data or if a more detailed understanding is required of the reasons for changes in the bycatch levels of particular species. In this regard, the following documents provide useful examples of the types of analyses that can be undertaken:

Campbell, R 2007, Estimates of Total Catch based on Observer Data: the importance of Random Sampling and Appropriate Spatial Stratification. Information paper presented to ETBF Resource Assessment Group meeting, 13-14 November 2007, Canberra.

Campbell, R 2008, Catches of opah (*Lampris* spp.) in the ETBF – summary of AFMA logbook data. Information paper presented to ETBF Resource Assessment Group meeting, 29-30 July 2008, Hobart.

Campbell, R 2008, Non-Retention of Principal Target Species in the ETBF - update. Information paper presented to ETBF Resource Assessment Group meeting, 27-28 March 2008, Mooloolaba.

Campbell, R 2012, Analysis of logbook and observer data relating to the catch of mako sharks off eastern Australia. Information paper presented to Tropical Tuna Resource Assessment Group meeting, 5-6 June 2012, Brisbane.

17.5.1 Estimates of bycatch rates and population impacts for seabirds

By Geoff Tuck

As seabird bycatch is a concern for many longline fisheries, attempts have been made to estimate seabird bycatch rates for the ETBF (Lawrence *et al.*, 2006; 2009). Using statistical estimation methods that accounted for various factors that may influence bycatch rates (such as time of set, gear used, bait type, vessel characteristics), Lawrence *et al.* (2009) showed that seabird bycatch rates in the ETBF appear to have declined between 2002 and 2007 (Figure 17.18). However, they state that it is still likely that bycatch rates will have exceeded 0.05 birds per 1000 hooks in some areas and seasons (in particular, between 30˚S and 40˚S and in summer).

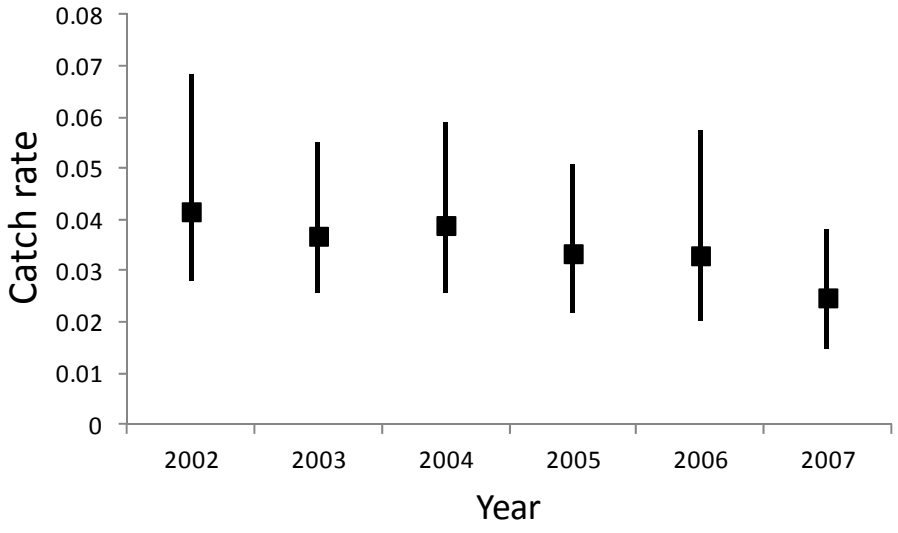


Figure 17.18 The estimated bycatch rate (birds per 1000 hooks) for seabirds and 95% confidence intervals between 20˚S and 40˚S based on a statistical model accounting for various influential factors (source: Lawrence *et al.*, 2009).

Flesh-footed shearwaters (*Puffinus carneipes*; FFS) off eastern Australia were a large component of the bycatch in the ETBF, particularly prior to 2005 (Table 17.25 and Table 17.28). In addition, observations of bycatch have been recorded in the Japanese longline fleet operating within the AFZ (which ceased operations in 1997) and the driftnet fisheries of the Northern Hemisphere (which ceased operations in the early 1990s; Tuck and Wilcox (2010)). The fishing distributions of the Pacific Ocean distant water longline fleets and the Japanese domestic coastal longline fishery also overlap to some extent with the foraging distributions of FFS. Additional threats to the population exist on their breeding colonies on Lord Howe Island. The nesting habitat of FFS is known to have been affected by residential and commercial development (Priddel *et al.*, 2006).

Bycatch rates, while enabling a comparison to management targets, do not provide an indication of the impact of fishing mortality at the population level (Tuck, 2011). In addition, scaling unstandardised bycatch rates up to fishery-wide estimates of total bycatch should only be done if observations of bycatch are representatively sampled across the fishery (Phillips *et al.*, 2010). In particular, at-sea trials to reduce seabird bycatch in this fishery were conducted in the early 2000s and led to atypical levels of observed seabird bycatch. Similarly, seabird bycatch rates are known to be influenced by the time of set, time of year (e.g. whether birds are incubating), and gear used (e.g. bait-type, species being targeted, tori line use) (Tuck, 2011).

Baker and Wise (2005) developed a population model of FFS that tested a number of scenarios of bycatch from the ETBF. They estimated that between 1794 and 4486 FFS per year were killed between years 1998 and 2002 and concluded that this level of continued bycatch was likely to be unsustainable. However, this model did not account for the spatial overlap between the birds and the fishery, the time of set, targeting behaviour or the various trial set types.

Tuck and Wilcox (2010) expanded the model of Baker and Wise (2005) by integrating information on FFS breeding biology, sea surface temperature (SST), colony size, foraging ranges, bycatch observations from the ETBF, shot type from the ETBF, fishing effort from multiple fisheries, and loss of nesting habitat. The model was able to consider the historical impacts of fishing and habitat loss, and predict population abundance under selected future fishing effort distributions and habitat changes. Results suggested a strong link between FFS position and SST, with birds generally found west of Lord Howe Island and in areas of SST between 20°C and 26°C. The likelihood of birds being killed on a shot increased during the day, was highest during the chute trials and was greater if vessels were targeting big-eye. The model predicted that bycatch from the ETBF fishery increased rapidly from 1997, reaching a peak of around 7000 birds in 2001/02. By contrast, estimated levels of bycatch from the ETBF between 2004 and 2006 (the final year of the model) are very small, with less than 20 FFS estimated killed per year over that period (Figure 17.19). Alternative models that assumed non-zero bycatch from distant-water longline fleets and the Japanese domestic longline fleets provided similarly reasonable fits to the input data but with a lower level of bycatch from the ETBF (peaking at 1500 FFS in 2001/02), as a larger magnitude of mortality was attributed to the other fleets. Note also that there have been no observations of FFS bycatch on ETBF vessels since 2006 (Table 17.28).

Tuck and Wilcox (2010) conclude that while FFS bycatch levels are currently either small or non-existent within the ETBF, continued monitoring of bycatch is needed to ensure that catches do not return to those predicted in the late 1990s and early 2000s. Critical information on FFS bycatch from Northern Hemisphere longline fisheries is lacking. The Japanese domestic coastal longline fishery is extensive and is well within the region inhabited by FFS during their Northern Hemisphere migration. No public information exists on this fleet's annual effort or bycatch.

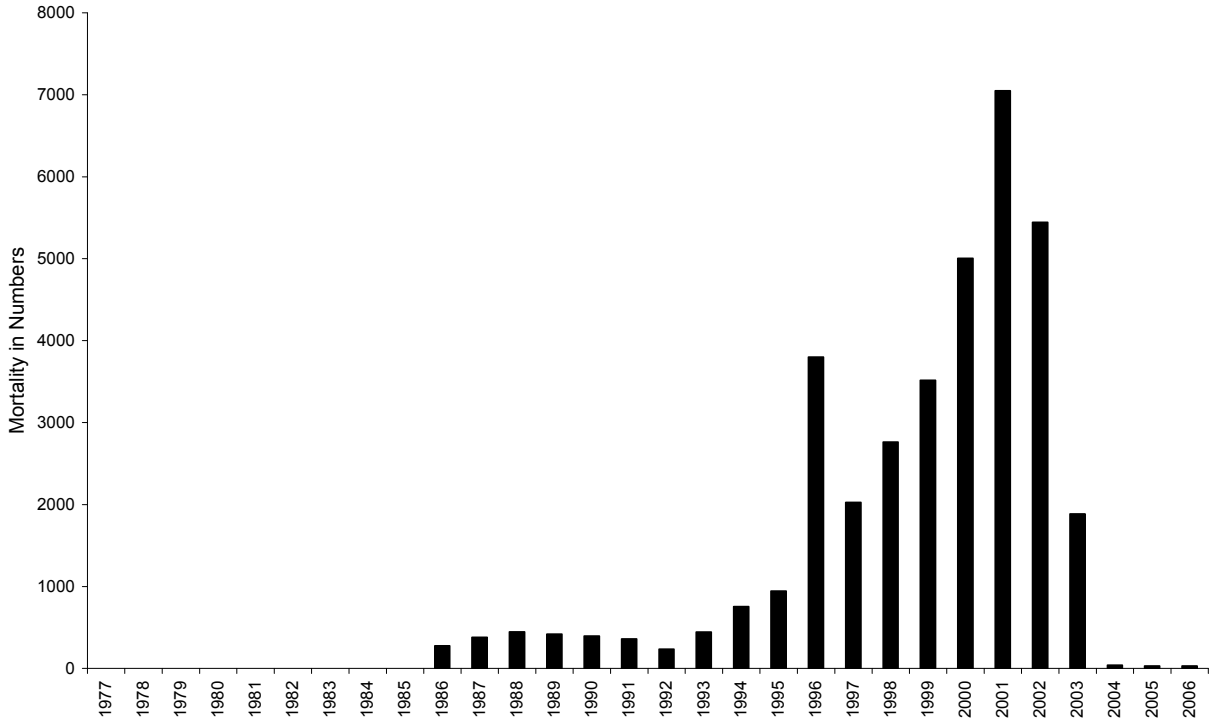


Figure 17.19 The estimated annual bycatch of flesh-footed shearwaters from the ETBF under the base-case scenario of Tuck and Wilcox (2010).

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Supplementary Tables

Table 17.21 Listing by species of the combined catch (both retained and discarded) for all FOPS recorded in the AL series of logbooks using the pelagic longline method. Species order by total catch.

Species Type	SPC_ID	Species Name	Common Name	FOPS with Catch	% FOPS with Catch	Number Retained	Number Discarded	% Discarded	Total Catch	% Total
Tuna	41	Thunnus alalunga	Albacore Tuna	61606	61.3%	889525	20934	2.3%	910459	26.5%
Tuna	38	Thunnus albacares	Yellowfin Tuna	82921	82.5%	700527	32858	4.5%	733385	21.3%
Tuna	42	Thunnus obesus	Bigeye Tuna	58183	57.9%	250486	15027	5.7%	265513	7.7%
Tuna	39	Katsuwonus pelamis	Skipjack Tuna	3591	3.57%	19312	1343	6.5%	20655	0.6%
Tuna	40	Thunnus maccoyii	Southern Bluefin Tuna	1803	1.79%	13254	4667	26.0%	17921	0.5%
Tuna	46	Thunnus thynnus	Northern Bluefin Tuna	377	0.375%	387	21	5.1%	408	0.0%
Tuna	44	Sarda australis	Australian Bonito	28	0.028%	129	3	2.3%	132	0.0%
Tuna	367	Scombridae spp (tribes Sardini & Thunnini)	tunas	3	0.003%	9	0	0.0%	9	0.0%
Tuna	87	Gymnosarda unicolor	Dogtooth Tuna	5	0.005%	9	0	0.0%	9	0.0%
	Total			94725	94.3%	1873638	74853	3.8%	1948491	56.6%
Billfish	48	Xiphias gladius	Broad Billed Swordfish	57573	57.3%	287192	7504	2.5%	294696	8.6%
Billfish	49	Tetrapturus audax	Striped Marlin	32325	32.2%	61672	2182	3.4%	63854	1.9%
Billfish	53	Tetrapturus angustirostris	Shortbilled Spearfish	6494	6.46%	9926	945	8.7%	10871	0.3%
Billfish	50	Makaira mazara	Blue Marlin	4369	4.35%	0	8107	100.0%	8107	0.2%
Billfish	52	Makaira indica	Black Marlin	3105	3.09%	0	6754	100.0%	6754	0.2%
Billfish	51	Istiophorus platypterus	Indo-Pacific Sailfish	1145	1.14%	913	1337	59.4%	2250	0.1%
Billfish	61	Istiophoridae	Marlin/Sailfish	113	0.11%	0	367	100.0%	367	0.0%
	Total			73025	72.7%	359703	27196	7.0%	386899	11.2%
Byproduct	29	Coryphaena hippurus	Dolphinfish	45808	45.6%	232464	8874	3.7%	241338	7.0%
Byproduct	55	Centrolophus niger	Rudderfish	33773	33.6%	202807	2201	1.1%	205008	6.0%
Byproduct	30	Brama brama	Ray's Bream	5848	5.8%	115559	399	0.3%	115958	3.4%
Byproduct	36	Lepidocybium flavobrunneum	Black Oilfish	11276	11.2%	77502	1768	2.2%	79270	2.3%
Byproduct	45	Acanthocybium solandri	Wahoo	9680	9.63%	17770	759	4.1%	18529	0.5%
Byproduct	23	Lampris guttatus	Moonfish	5549	5.52%	14391	165	1.1%	14556	0.4%
Byproduct	35	Ruvettus pretiosus	Oilfish	1379	1.37%	4123	549	11.8%	4672	0.1%
	Total			73898	73.5%	664616	14715	2.2%	679331	19.7%

Table 17.21 (cont'd) Listing by species of the combined catch (both retained and discarded) for all FOPS recorded in the AL series of logbooks using the pelagic longline method. Species order by total catch.

Species Type	SPC_ID	Species Name	Common Name	FOPS with Catch	% FOPS with Catch	Number Retained	Number Discarded	% Discarded	Total Catch	% Total
Shark	10	Prionace glauca	Blue Shark	16463	16.38%	5180	46811	90.0%	51991	1.5%
Shark	3	Isurus oxyrinchus	Shortfin Mako	18135	18.05%	24301	4165	14.6%	28466	0.8%
Shark	8	Carcharhinus brachyurus	Bronze Whaler	6110	6.080%	6481	8260	56.0%	14741	0.4%
Shark	13	Carcharhinus longimanus	Oceanic Whitetip Shark	5056	5.031%	3318	5023	60.2%	8341	0.2%
Shark	12	Galeocerdo cuvier	Tiger Shark	3047	3.032%	1725	2925	62.9%	4650	0.1%
Shark	9	Carcharhinus obscurus	Dusky Shark	1385	1.378%	1194	2414	66.9%	3608	0.1%
Shark	15	Sphyrna lewini	Scalloped Hammerhead	1419	1.412%	1807	1501	45.4%	3308	0.1%
Shark	14	Carcharhinus species	Blacktip sharks	954	0.949%	1425	1164	45.0%	2589	0.1%
Shark	6	Alopias vulpinus	Thresher Shark	1048	1.043%	300	1501	83.3%	1801	0.1%
Shark	360	Sphyrnidae - undifferentiated	hammerhead sharks	550	0.547%	881	319	26.6%	1200	0.0%
Shark	2	Pseudocarcharias kamoharai	Crocodile Shark	228	0.227%	12	1016	98.8%	1028	0.0%
Shark	5	Lamna nasus	Porbeagle	307	0.305%	340	303	47.1%	643	0.0%
Shark	11	Carcharhinus falciformis	Silky Shark	240	0.239%	220	304	58.0%	524	0.0%
Shark	184	Sphyrna zygaena	Smooth hammerhead shark	78	0.078%	86	179	67.5%	265	0.0%
Shark	182	Carcharhinus amblyrhynchos	Grey reef shark	2	0.002%	193	0	0.0%	193	0.0%
Shark	95	Caracharhinidae	whaler and weasel sharks	17	0.017%	142	5	3.4%	147	0.0%
Shark	178	Furgaleus macki	whiskery shark	8	0.008%	1	98	99.0%	99	0.0%
Shark	358	sharks - other	Sharks (other)	53	0.053%	57	37	39.4%	94	0.0%
Shark	63	Isurus paucus	Longfin Mako	33	0.033%	29	5	14.7%	34	0.0%
Shark	64	Carcharhinus plumbeus	Sandbar Shark	8	0.008%	11	4	26.7%	15	0.0%
Shark	65	Carcharhinus leucas	Bull Shark	7	0.007%	14	1	6.7%	15	0.0%
Shark	1	Carcharias taurus	Grey Nurse	12	0.012%	0	15	100.0%	15	0.0%
Shark	17	Isistius brasiliensis	Cookie-cutter Shark	8	0.008%	3	6	66.7%	9	0.0%
Shark	18	Centroscymnus and Deania.	Roughskin Shark	2	0.002%	8	0	0.0%	8	0.0%
Shark	70	Squatina australis	Australian Angel Shark	2	0.002%	4	0	0.0%	4	0.0%
Shark	4	Carcharodon carcharias	White Shark	4	0.004%	0	4	100.0%	4	0.0%
Shark	7	Galeorhinus galeus	School Shark	2	0.002%	3	0	0.0%	3	0.0%
Shark	170	Hexanchidae - undifferentiated	cow sharks	2	0.002%	1	1	50.0%	2	0.0%
	Total			38773	38.58%	47736	76061	61.4%	123797	3.6%

Table 17.21 (cont'd) Listing by species of the combined catch (both retained and discarded) for all FOPS recorded in the AL series of logbooks using the pelagic longline method. Species order by total catch.

Species Type	SPC_ID	Species Name	Common Name	FOPS with Catch	% FOPS with Catch	Number Retained	Number Discarded	% Discarded	Total Catch	% Total
Bycatch	22	Alepisauridae	Lancet fish	19952	19.85%	1545	279274	99.4%	280819	8.2%
Bycatch	47	Scomber scombrus	Mackerel	702	0.699%	49	6468	99.2%	6517	0.2%
Bycatch	56	Mola mola	Ocean Sunfish	2591	2.578%	29	6100	99.5%	6129	0.2%
Bycatch	362	Gempylus serpens	Snake Mackerel	225	0.224%	1	3099	100.0%	3100	0.1%
Bycatch	34	Thyrsites atun	Barracouta	443	0.441%	85	1842	95.6%	1927	0.1%
Bycatch	359	Skates & rays, unspecified	Skates & rays, unspecified	675	0.672%	0	1698	100.0%	1698	0.0%
Bycatch	59	Unknown/mixed Species	Other	115	0.114%	214	294	57.9%	508	0.0%
Bycatch	21	Dasyatididae "family"	Stingray	202	0.201%	0	429	100.0%	429	0.0%
Bycatch	91	Manta birostris	Manta Ray	226	0.225%	10	383	97.5%	393	0.0%
Bycatch	26	Rachycentron canadum	Black Kingfish	87	0.087%	197	5	2.5%	202	0.0%
Bycatch	353	Tetraodontidae - undifferentiated	puffer fish	75	0.075%	0	187	100.0%	187	0.0%
Bycatch	37	Lepidopus caudatus	Southern Frostfish	62	0.062%	16	67	80.7%	83	0.0%
Bycatch	31	Pagrus auratus	Snapper	7	0.007%	71	0	0.0%	71	0.0%
Bycatch	361	Mola ramsayi	Short Sunfish	25	0.025%	0	50	100.0%	50	0.0%
Bycatch	25	Regalecus glesne	Oarfish	30	0.030%	27	21	43.8%	48	0.0%
Bycatch	27	Seriola lalandi	Yellowtail Kingfish	26	0.026%	39	7	15.2%	46	0.0%
Bycatch	54	Hyperoglyphe antarctica	Blue Eye Trevalla	2	0.002%	44	1	2.2%	45	0.0%
Bycatch	24	Trachipterus jacksonensis	Dealfish	33	0.033%	0	38	100.0%	38	0.0%
Bycatch	28	Elegatis bipinnulata	Rainbow Runner	19	0.019%	23	3	11.5%	26	0.0%
Bycatch	114	Rexea solandri	Gemfish	11	0.011%	2	17	89.5%	19	0.0%
Bycatch	157	Cardinal Fish	Cardinal Fish	18	0.018%	12	6	33.3%	18	0.0%
Bycatch	317	Paristiopterus gallipavo	yellowspotted boarfish	7	0.007%	13	0	0.0%	13	0.0%
Bycatch	75	Trachurus declivis	Jack Mackerel	2	0.002%	12	1	7.7%	13	0.0%
Bycatch	79	Aphareus rutilans	Jobfish	2	0.002%	11	0	0.0%	11	0.0%
Bycatch	159	Pristipomoides filamentosus	Rosy Jobfish / King Snapper	2	0.002%	11	0	0.0%	11	0.0%
Bycatch	84	Scomberomorus Commerson	Spanish Mackerel	11	0.011%	11	0	0.0%	11	0.0%
Bycatch	227	Zeidae - undifferentiated	dories	1	0.001%	10	0	0.0%	10	0.0%
Bycatch	43	Gasterochisma melampus	Butterfly Mackerel	6	0.006%	8	0	0.0%	8	0.0%
Bycatch	115	Auxis thazard	Frigate mackerel	2	0.002%	8	0	0.0%	8	0.0%
Bycatch	83	Scomber australasicus	Blue Mackerel	4	0.004%	4	2	33.3%	6	0.0%

Table 17.21 (cont'd) Listing by species of the combined catch (both retained and discarded) for all FOPS recorded in the AL series of logbooks using the pelagic longline method. Species order by total catch.

Species Type	SPC_ID	Species Name	Common Name	FOPS with Catch	% FOPS with Catch	Number Retained	Number Discarded	% Discarded	Total Catch	% Total
Bycatch	354	Diodontidae - undifferentiated	porcupine fish	5	0.00%	0	6	100.0%	6	0.0%
Bycatch	103	Helicolenus percoides	Reef ocean perch	2	0.00%	6	0	0.0%	6	0.0%
Bycatch	264	Plectropomus and Variola spp.	coral trout	1	0.00%	4	0	0.0%	4	0.0%
Bycatch	32	Tilodon sexfasciatum	Moonlighter	1	0.00%	4	0	0.0%	4	0.0%
Bycatch	156	Argyrosomus japonicus	Jewfish/Mulloway	1	0.00%	0	4	100.0%	4	0.0%
Bycatch	155	Carangidae - undifferentiated	trevallies and jacks	2	0.00%	4	0	0.0%	4	0.0%
Bycatch	250	Lepidoperca pulchella	orange perch	1	0.00%	4	0	0.0%	4	0.0%
Bycatch	209	Gadus morhua	cod	1	0.00%	3	0	0.0%	3	0.0%
Bycatch	363	Bramidae - undifferentiated	pomfrets	3	0.00%	3	0	0.0%	3	0.0%
Bycatch	290	Aprion virescens	green jobfish	2	0.00%	3	0	0.0%	3	0.0%
Bycatch	368	Cynoglossidae & Soleidae spp	soles	1	0.00%	0	2	100.0%	2	0.0%
Bycatch	343	Trichiurus lepturus	large-headed hairtail	1	0.00%	2	0	0.0%	2	0.0%
Bycatch	88	Luvarus imperialis	Luvaru	2	0.00%	2	0	0.0%	2	0.0%
Bycatch	216	Hemiramphidae - undifferentiated	garfishes	1	0.00%	0	2	100.0%	2	0.0%
Bycatch	33	Pentacerotidae	Boarfish	1	0.00%	1	0	0.0%	1	0.0%
Bycatch	351	Balistidae Monacanthidae - undifferentiated	triggerfishes and leatherjackets	1	0.00%	1	0	0.0%	1	0.0%
Bycatch	310	Sparidae - undifferentiated	porgies	1	0.00%	1	0	0.0%	1	0.0%
Bycatch	280	Parastromateus niger	black pomfret	1	0.00%	1	0	0.0%	1	0.0%
Bycatch	277	Caranx sexfasciatus	bigeye trevally	1	0.00%	1	0	0.0%	1	0.0%
Bycatch	356	Order Teuthoidea	squid	1	0.00%	1	0	0.0%	1	0.0%
Bycatch	265	Epinephelus ergastularius & Epinephelus septemfa	bar rock cod	1	0.00%	0	1	100.0%	1	0.0%
Bycatch	158	Myliobatis australis	Southern Eagle Ray	1	0.00%	0	1	100.0%	1	0.0%
Bycatch	312	Rhabdosargus sarba	silver bream	1	0.00%	0	1	100.0%	1	0.0%
Bycatch	420	Whales	Whales	1	0.00%	0	1	100.0%	1	0.0%
	Total			21488	21.4%	2493	300010	99.2%	302503	8.8%
Grand	Total	All Species		100495	100.0%	2948186	492835	14.3%	3441021	100.0%

Table 17.22 Listing by species of the combined catch (both retained and discarded) for all FOPS recorded in the AL series of logbooks using a non-pelagic longline method (i.e. pole and line, rod and reel, trolling, handline). Species order by total catch.

Species Type	SPC_ID	Species Name	Common Name	FOPS with Catch	% FOPS with Catch	Number Retained	Number Discarded	% Discarded	Total Catch	% Total
Tuna	42	Thunnus obesus	Bigeye Tuna	78	16.4%	3143	464	12.9%	3607	61.8%
Tuna	38	Thunnus albacares	Yellowfin Tuna	118	24.7%	1055	199	15.9%	1254	21.5%
Tuna	39	Katsuwonus pelamis	Skipjack Tuna	40	8.4%	407	4	1.0%	411	7.0%
Tuna	41	Thunnus alalunga	Albacore Tuna	21	4.4%	255	1	0.4%	256	4.4%
Tuna	44	Sarda australis	Australian Bonito	2	0.4%	52	0	0.0%	52	0.9%
Tuna	40	Thunnus maccoyii	Southern Bluefin Tuna	2	0.4%	5	0	0.0%	5	0.1%
Billfish	49	Tetrapturus audax	Striped Marlin	7	1.5%	8	0	0.0%	8	0.1%
Billfish	50	Makaira mazara	Blue Marlin	4	0.8%	0	5	100.0%	5	0.1%
Billfish	52	Makaira indica	Black Marlin	3	0.6%	0	3	100.0%	3	0.1%
Billfish	53	Tetrapturus angustirostris	Shortbilled Spearfish	1	0.2%	1	0	0.0%	1	0.0%
Byproduct	29	Coryphaena hippurus	Dolphinfish	51	10.69%	122	3	2.4%	125	2.1%
Byproduct	55	Centrolophus niger	Rudderfish	3	0.63%	18	0	0.0%	18	0.3%
Byproduct	45	Acanthocybium solandri	Wahoo	7	1.47%	8	0	0.0%	8	0.1%
Shark	3	Isurus oxyrinchus	Shortfin Mako	4	0.84%	7	0	0.0%	7	0.1%
Shark	8	Carcharhinus brachyurus	Bronze Whaler	1	0.21%	6	0	0.0%	6	0.1%
Shark	11	Carcharhinus falciformis	Silky Shark	2	0.42%	2	1	33.3%	3	0.1%
Shark	10	Prionace glauca	Blue Shark	1	0.21%	0	2	100.0%	2	0.0%
Shark	13	Carcharhinus longimanus	Oceanic Whitetip Shark	1	0.21%	0	1	100.0%	1	0.0%
Bycatch	59	Unknown/mixed Species	OTHER	3	0.63%	46	0	0.0%	46	0.8%
Bycatch	34	Thyrsites atun	Barracouta	3	0.63%	1	5	83.3%	6	0.1%
Bycatch	47	Scomber scombrus	Mackerel	2	0.42%	2	1	33.3%	3	0.1%
Bycatch	27	Seriola lalandi	Yellowtail Kingfish	1	0.21%	2	0	0.0%	2	0.0%
Bycatch	56	Mola mola	Ocean Sunfish	1	0.21%	0	1	100.0%	1	0.0%
Bycatch	155	Carangidae - undifferentiated	trevallies and jacks	1	0.21%	2	0	0.0%	2	0.0%
	Total			477	100.00%	5142	690	11.8%	5832	100.0%

Table 17.23 Listing by species of the combined catch (both retained and discarded) for all FOPS recorded in the OT03 series of logbooks using minor line method (i.e. pole and line, rod and reel, trolling, handline). Species order by total catch.

Species Type	SPC_ID	Species Name	Common Name	FOPS with Catch	% FOPS with Catch	Number Retained	Number Discarded	% Discarded	Total Catch	% Total
Tuna	42	Thunnus obesus	Bigeye Tuna	55	21.8%	2144	365	14.5%	2509	22.1%
Tuna	41	Thunnus alalunga	Albacore Tuna	47	18.7%	1118	0	0.0%	1118	9.8%
Tuna	38	Thunnus albacares	Yellowfin Tuna	97	38.5%	889	111	11.1%	1000	8.8%
Tuna	39	Katsuwonus pelamis	Skipjack Tuna	46	18.3%	262	0	0.0%	262	2.3%
Billfish	49	Tetrapturus audax	Striped Marlin	1	0.4%	1	0	0.0%	1	0.0%
Byproduct	29	Coryphaena hippurus	Dolphinfish	4	1.6%	5	1	16.7%	6	0.1%
Shark	3	Isurus oxyrinchus	Shortfin Mako	11	4.4%	28	0	0.0%	28	0.2%
Shark	10	Prionace glauca	Blue Shark	7	2.8%	20	2	9.1%	22	0.2%
Shark	19	Pristiophorus	Saw Shark	1	0.4%	2	0	0.0%	2	0.0%
Bycatch	305	Lethrinus miniatus	redthroat emperor	39	15.5%	3689	0	0.0%	3689	32.4%
Bycatch	308	Gymnocranius spp.	sea peaches and snappers	26	10.3%	1136	0	0.0%	1136	10.0%
Bycatch	159	Pristipomoides filamentosus	Rosy Jobfish / King Snapper	31	12.3%	936	0	0.0%	936	8.2%
Bycatch	105	Polyprion oxygeneios	Temperate ocean bass	24	9.5%	595	0	0.0%	595	5.2%
Bycatch	265	Epinephelus ergastularius and Epine	bar rock cod	13	5.2%	42	0	0.0%	42	0.4%
Bycatch	290	Aprion virescens	green jobfish	5	2.0%	13	0	0.0%	13	0.1%
Bycatch	264	Plectropomus and Variola spp.	coral trout	2	0.8%	7	0	0.0%	7	0.1%
Bycatch	276	Seriola dumerili	Greater amberjack	3	1.2%	4	0	0.0%	4	0.0%
Bycatch	28	Elegatis bipinnulata	Rainbow Runner	1	0.4%	3	0	0.0%	3	0.0%
	Total			252	100.0%	10894	479	4.2%	11373	100.0%

Table 17.24 Listing by species of the combined catch (both retained and discarded) for all FOPS recorded in the NL01 and NL01A series of logbooks using a minor line method (i.e. pole and line, rod and reel, trolling, handline). Species order by total catch.

Species Type	SPC_ID	Species Name	Common Name	FOPS with Catch	% FOPS with Catch	Number Retained	Number Discarded	Total Catch	% Total
Tuna	42	Thunnus obesus	Bigeye Tuna	184	14.9%	8994	0	8994	20.76%
Tuna	39	Katsuwonus pelamis	Skipjack Tuna	77	6.2%	1943	0	1943	4.48%
Tuna	38	Thunnus albacares	Yellowfin Tuna	156	12.6%	1826	0	1826	4.21%
Tuna	41	Thunnus alalunga	Albacore Tuna	68	5.5%	1053	0	1053	2.43%
Tuna	44	Sarda australis	Australian Bonito	1	0.1%	1	0	1	0.00%
Billfish	48	Xiphias gladius	Broad Billed Swordfish	3	0.2%	2	0	2	0.00%
Byproduct	29	Coryphaena hippurus	Dolphinfish	11	0.9%	42	0	42	0.10%
Byproduct	30	Brama brama	Ray's Bream	43	3.5%	11	0	11	0.03%
Byproduct	55	Centrolophus niger	Rudderfish	5	0.4%	6	0	6	0.01%
Shark	177	Mustelus antarcticus	gummy shark	129	10.4%	3323	0	3323	7.67%
Shark	96	Deania calcea	platypus shark	86	7.0%	955	0	955	2.20%
Shark	358	sharks - other	Sharks (other)	47	3.8%	578	0	578	1.33%
Shark	7	Galeorhinus galeus	School Shark	83	6.7%	395	0	395	0.91%
Shark	16	Squalidae "family"	Dogfish	62	5.0%	389	0	389	0.90%
Shark	66	Centrophorus moluccensis	Endeavour Dogfish	40	3.2%	348	0	348	0.80%
Shark	69	Centroscymnus	Black Shark	79	6.4%	306	0	306	0.71%
Shark	9	Carcharhinus obscurus	Dusky Shark	15	1.2%	274	0	274	0.63%
Shark	174	Cephaloscyllium laticeps	Draughtboard shark	20	1.6%	234	0	234	0.54%
Shark	14	Carcharhinus species	Blacktip sharks	18	1.5%	185	0	185	0.43%
Shark	3	Isurus oxyrinchus	Shortfin Mako	67	5.4%	130	0	130	0.30%
Shark	62	Notorynchus cepedianus	Broadnose Sevengill Shark	40	3.2%	108	0	108	0.25%
Shark	8	Carcharhinus brachyurus	Bronze Whaler	12	1.0%	99	0	99	0.23%
Shark	175	Cephaloscyllium sp. A	swell sharks	2	0.2%	37	0	37	0.09%
Shark	193	Pristiophorus cirratus	Longnose sawshark	5	0.4%	32	0	32	0.07%
Shark	10	Prionace glauca	Blue Shark	16	1.3%	26	0	26	0.06%
Shark	192	Pristiophorus nudipinnis	Shortnose sawshark	6	0.5%	22	0	22	0.05%
Shark	375	Centrophorus harrissoni	Harrisson's Dogfish	3	0.2%	12	0	12	0.03%
Shark	95	Caracharhinidae	whaler and weasel sharks	1	0.1%	6	0	6	0.01%
Shark	376	Centrophorus zeehaani	Southern Dogfish	1	0.1%	2	0	2	0.00%
Shark	19	Pristiophorus	Saw Shark	1	0.1%	1	0	1	0.00%
Shark	379	Echinorhinus cookei	Prickly Shark	1	0.1%	1	0	1	0.00%
Shark	184	Sphyrna zygaena	Smooth hammerhead shark	1	0.1%	1	0	1	0.00%
Shark	189	Centroscymnus plunketi	Plunket shark	1	0.1%	0	0	0	0.00%
Shark	68	Squalus acanthias	White-Spotted Dogfish	1	0.1%	0	0	0	0.00%
Shark	186	Deania quadrispinosa	Longsnout dogfish	1	0.1%	0	0	0	0.00%
Shark	170	Hexanchidae - undifferentiated	cow sharks	6	0.5%	0	0	0	0.00%
Shark	5	Lamna nasus	Porbeagle	1	0.1%	0	0	0	0.00%

Table 17.24 (cont'd) Listing by species of the combined catch (both retained and discarded) for all FOPS recorded in the NL01 and NL01A series of logbooks using a minor line method (i.e. pole and line, rod and reel, trolling, handline). Species order by number of FOPS with catch.

Species Type	SPC_ID	Species Name	Common Name	FOPS with Catch	% FOPS with Catch	Number Retained	Number Discarded	Total Catch	% Total
Bycatch	54	Hyperoglyphe antarctica	Blue Eye Trevalla	666	53.9%	13804	0	13804	31.86%
Bycatch	112	Latris lineata	Striped trumpeter	27	2.2%	938	0	938	2.16%
Bycatch	188	Squalus mitsukurii	Shortspine spurdog	31	2.5%	935	0	935	2.16%
Bycatch	159	Pristipomoides filamentosus	Rosy Jobfish / King Snapper	39	3.2%	847	0	847	1.95%
Bycatch	294	Etelis coruscans	Flame snapper	121	9.8%	825	0	825	1.90%
Bycatch	197	Chimaeridae - undifferentiated	shortnose chimaeras	214	17.3%	689	0	689	1.59%
Bycatch	407	Gymnocranius euanus	Paddletail Seabream	20	1.6%	414	0	414	0.96%
Bycatch	265	Epinephelus ergastularius & Epine	bar rock cod	41	3.3%	397	0	397	0.92%
Bycatch	59	Unknown/mixed Species	OTHER	41	3.3%	364	0	364	0.84%
Bycatch	110	Etelis carbunculus	Sea perch/snapper	80	6.5%	348	0	348	0.80%
Bycatch	349	Schedophilus labyrinthica	Blue-eye trevalla	41	3.3%	300	0	300	0.69%
Bycatch	27	Seriola lalandi	Yellowtail Kingfish	17	1.4%	265	0	265	0.61%
Bycatch	380	Rhinidae, Rhynchobatidae - undiffer	wedgefishes	21	1.7%	250	0	250	0.58%
Bycatch	74	Polyprion spp	Hapuku and Bass Groper-NSW	159	12.9%	177	0	177	0.41%
Bycatch	103	Helicolenus percoides	Reef ocean perch	488	39.5%	137	0	137	0.32%
Bycatch	295	Pristipomoides flavipinnis	Golden eye jobfish	12	1.0%	126	0	126	0.29%
Bycatch	397	Pristipomoides argyrogrammicus	Ornate Snapper	42	3.4%	117	0	117	0.27%
Bycatch	292	Lipocheilus carnolabrum	Tangs snapper	23	1.9%	98	0	98	0.23%
Bycatch	399	Paracaesio kusakarii	Saddleback Snapper	12	1.0%	97	0	97	0.22%
Bycatch	213	Macrouridae - undifferentiated	whiptails	21	1.7%	92	0	92	0.21%
Bycatch	137	Percichthyidae, Serranidae	freshwater perches, tempe	9	0.7%	70	0	70	0.16%
Bycatch	387	Epinephelus fasciatus	Blacktip Rockcod	13	1.1%	68	0	68	0.16%
Bycatch	111	Nemadactylus macropterus	jackass morwong	154	12.5%	62	0	62	0.14%
Bycatch	298	Etelis spp.	ruby snappers	9	0.7%	62	0	62	0.14%
Bycatch	105	Polyprion oxygeneios	Temperate ocean bass	269	21.8%	60	0	60	0.14%
Bycatch	205	Mora moro	Common mora	372	30.1%	60	0	60	0.14%
Bycatch	276	Seriola dumerili	Greater amberjack	27	2.2%	58	0	58	0.13%
Bycatch	305	Lethrinus miniatus	redthroat emperor	11	0.9%	41	0	41	0.09%
Bycatch	330	Nemadactylus sp.	king morwong	7	0.6%	38	0	38	0.09%
Bycatch	290	Aprion virescens	green jobfish	12	1.0%	28	0	28	0.06%
Bycatch	261	Epinephelus morrhua	Cornet grouper	15	1.2%	27	0	27	0.06%
Bycatch	262	Variola louti	Yellowedge coronation trout	8	0.6%	25	0	25	0.06%
Bycatch	79	Aphareus rutilans	Jobfish	4	0.3%	16	0	16	0.04%
Bycatch	394	Lutjanus bohar	Red Bass	3	0.2%	13	0	13	0.03%
Bycatch	187	Squalus megalops	piked spurdog	46	3.7%	12	0	12	0.03%
Bycatch	114	Rexea solandri	Gemfish	360	29.1%	12	0	12	0.03%
Bycatch	223	Centroberyx gerrardi	bight redfish	2	0.2%	12	0	12	0.03%

Table 17.24 (cont'd) Listing by species of the combined catch (both retained and discarded) for all FOPS recorded in the NL01 and NL01A series of logbooks using a minor line method (i.e. pole and line, rod and reel, trolling, handline). Species order by number of FOPS with catch.

Species Type	SPC_ID	Species Name	Common Name	FOPS with Catch	% FOPS with Catch	Number Retained	Number Discarded	Total Catch	% Total
Bycatch	398	Pristipomoides zonatus	Oblique-banded Snapper	5	0.4%	8	0	8	0.02%
Bycatch	326	Nemadactylus valenciennesi	blue morwong	114	9.2%	7	0	7	0.02%
Bycatch	371	Brachyura - undifferentiated	crabs	4	0.3%	7	0	7	0.02%
Bycatch	139	Congridae spp	Congor eel	51	4.1%	7	0	7	0.02%
Bycatch	307	Wattsia mossambica	Mozambique seabream	4	0.3%	6	0	6	0.01%
Bycatch	100	Genypterus blacodes	Pink ling	486	39.4%	6	0	6	0.01%
Bycatch	333	Bodianus vulpinus	Western pigfish	5	0.4%	6	0	6	0.01%
Bycatch	221	Beryx decadactylus	imperador	108	8.7%	6	0	6	0.01%
Bycatch	263	Aethaloperca Anyperodon and Epinep	rock cod	4	0.3%	6	0	6	0.01%
Bycatch	33	Pentacerotidae	Boarfish	25	2.0%	6	0	6	0.01%
Bycatch	405	Lethrinus rubrioperculatus	Spotcheek Emperor	3	0.2%	5	0	5	0.01%
Bycatch	254	Epinephelus radiatus	Oblique-banded rockcod	3	0.2%	4	0	4	0.01%
Bycatch	284	Plagiogeneion spp.	rubyfish	1	0.1%	4	0	4	0.01%
Bycatch	169	Pseudocarcinus gigas	giant crab	3	0.2%	3	0	3	0.01%
Bycatch	209	Gadus morhua	cod	3	0.2%	3	0	3	0.01%
Bycatch	31	Pagrus auratus	Snapper	5	0.4%	3	0	3	0.01%
Bycatch	362	Gempylus serpens	Snake Mackerel	1	0.1%	2	0	2	0.00%
Bycatch	416	Hapalogenys kishinouyei	Lined javelinfish	2	0.2%	2	0	2	0.00%
Bycatch	226	Sargocentron rubrum	Red soldier fish	2	0.2%	2	0	2	0.00%
Bycatch	179	Hypogaleus hyugaensis	Blactip tope	1	0.1%	2	0	2	0.00%
Bycatch	299	Plectorhinchus spp.	sea bream	1	0.1%	2	0	2	0.00%
Bycatch	227	Zeidae - undifferentiated	dories	1	0.1%	1	0	1	0.00%
Bycatch	257	Plectropomus leopardus	Coral trout	1	0.1%	1	0	1	0.00%
Bycatch	409	Parupeneus ciliatus	Diamondscale Goatfish	1	0.1%	1	0	1	0.00%
Bycatch	391	Epinephelus cyanopodus	Purple Rockcod	1	0.1%	1	0	1	0.00%
Bycatch	287	Lutjanus malabaricus	saddletail seaperch	1	0.1%	1	0	1	0.00%
Bycatch	323	Oplegnathus woodwardi	conway	1	0.1%	0	0	0	0.00%
Bycatch	89	Seriolella punctata	Spotted Warehou	2	0.2%	0	0	0	0.00%
Bycatch	73	Macruronus novaezelandiae	Blue Grenadier	156	12.6%	0	0	0	0.00%
Bycatch	155	Carangidae - undifferentiated	trevallies and jacks	2	0.2%	0	0	0	0.00%
Bycatch	47	Scomber scombrus	Mackerel	4	0.3%	0	0	0	0.00%
Bycatch	329	Cheilodactylus fuscus	red morwong	1	0.1%	0	0	0	0.00%
Bycatch	338	Achoerodus viridis	eastern blue groper	2	0.2%	0	0	0	0.00%
Bycatch	341	Uranoscopidae - undifferentiated	stargazers	1	0.1%	0	0	0	0.00%
Bycatch	34	Thyrsites atun	Barracouta	1	0.1%	0	0	0	0.00%
Bycatch	77	Pseudocaranx dentex	Silver Trevally	1	0.1%	0	0	0	0.00%
Bycatch	393	Lutjanus gibbus	Paddletail	2	0.2%	0	0	0	0.00%

Table 17.24 (cont'd) Listing by species of the combined catch (both retained and discarded) for all FOPS recorded in the NL01 and NL01A series of logbooks using a minor line method (i.e. pole and line, rod and reel, trolling, handline). Species order by number of FOPS with catch.

Species Type	SPC_ID	Species Name	Common Name	FOPS with Catch	% FOPS with Catch	Number Retained	Number Discarded	Total Catch	% Total
Bycatch	141	Centroberyx affinis	Redfish	5	0.4%	0	0	0	0.00%
Bycatch	348	Seriolella caerulea	white warehou	2	0.2%	0	0	0	0.00%
Bycatch	244	Pterygotrigla polyommata	latchet	1	0.1%	0	0	0	0.00%
Bycatch	243	Chelidonichthys kumu	red gurnard	3	0.2%	0	0	0	0.00%
Bycatch	241	Scorpaena papillosa	Southern red scorpiofish	1	0.1%	0	0	0	0.00%
Bycatch	233	Neocyttus rhomboidalis	spiky oreo	3	0.2%	0	0	0	0.00%
Bycatch	222	Beryx splendens	alfonsino	129	10.4%	0	0	0	0.00%
Bycatch	198	Callorhinchus milii	elephant fish	5	0.4%	0	0	0	0.00%
Bycatch	230	Zenopsis nebulosus	mirror dory	1	0.1%	0	0	0	0.00%
				1235	Total	43328	0	43328	100.00%

Table 17.25 Listing of recorded catch of Listed Marine and Threatened Species associated with AL05, AL06 and LN01 logbooks.

Associated Logbook	SPECIES GROUP	SPECIES	FOPS with Catch	% FOPS with Catch	Catch while Setting	Catch while Hauling	Total Catch	Released Alive	Released Dead	Total Released
AL05 and AL06	CETACEAN	BEAKED WHALE	1	0.001%	0	1	1	1	0	1
		BOTTLE NOSE WHALE	1	0.001%	0	1	1	1	0	1
		BROWN WHALE	1	0.001%	0	0	0	1	0	1
		CETACEAN	1	0.001%	0	1	1	1	0	1
		DOLPHIN	6	0.006%	1	4	5	6	0	6
		HUMPBACK WHALE	1	0.001%	1	0	1	1	0	1
		MELON HEADED WHALE	3	0.003%	0	2	2	2	2	4
		PILOT WHALE	16	0.016%	0	15	15	16	1	17
		PYGMY KILLER WHALE (JUVENILE)	1	0.001%	0	0	0	1	0	1
		TOOTHED WHALE	5	0.005%	3	1	4	5	0	5
		WHALE	3	0.003%	0	2	2	1	2	3
	FISH - OTHER	SOUTHERN BLUEFIN TUNA	1	0.001%	0	0	0	1	0	1
		SUNFISH	1	0.001%	0	0	0	8	0	8
	FISH - RAYS	BLACK STINGRAY	2	0.002%	1	0	1	4	0	4
		DEVIL RAY	2	0.002%	1	1	2	2	0	2
		MANTA RAY	11	0.011%	0	8	8	12	0	12
	SEABIRD - ALBATROSS	ALBATROSS	26	0.026%	29	7	36	17	22	39
		BLACK BROWED ALBATROSS	8	0.008%	6	2	8	4	9	13
		SHY ALBATROSS	2	0.002%	0	2	2	0	2	2
		WANDERING ALBATROSS	9	0.009%	2	7	9	8	4	12
		YELLOW-NOSED ALBATROSS	6	0.006%	6	2	8	4	8	12
	SEABIRD - JAEGER	JAEGER	1	0.001%	1	0	1	0	1	1
	SEABIRD - PETREL	GIANT PETREL	1	0.001%	0	1	1	1	0	1
		GREAT WINDED PETREL	4	0.004%	3	0	3	0	4	4
		NORTHERN PETREL	1	0.001%	1	0	1	0	1	1
		PETREL SEABIRD	1	0.001%	1	0	1	1	0	1
	SEABIRD - SHEARWATER	FLESH-FOOTED SHEARWATER	19	0.019%	30	2	32	2	39	41
		SEABIRD (SHEARWATER)	1	0.001%	1	0	1	1	0	1
		SHEARWATER	62	0.062%	70	12	82	10	102	112
		SHORT-TAILED SHEARWATER	66	0.066%	52	21	73	16	155	171
		SOOTY SHEARWATER	2	0.002%	3	0	3	0	3	3
		WEDGE-TAILED SHEARWATER	6	0.006%	2	1	3	1	5	6
	SEABIRD - UNKNNOWN	SEABIRD (UNKNOWN)	8	0.008%	6	3	9	3	6	9
	TURTLE	GREEN TURTLE	44	0.044%	1	36	37	36	7	43
		HAWKSBILL TURTLE	16	0.016%	1	13	14	15	1	16
		LEATHERBACK TURTLE	124	0.123%	7	92	99	123	6	129
		LOGGERHEAD TURTLE	38	0.038%	3	21	24	37	2	39
		OLIVE RIDLEY TURTLE	8	0.008%	0	7	7	6	2	8
		TURTLE	88	0.088%	7	56	63	86	5	91
	UNKNOWN	UNIDENTIFIED SUBMERGED OBJECT	1	0.001%	0	0	0	0	0	0
		NOT RECORDED	3	0.003%	0	0	0	0	1	1
	TOTAL		575	0.5722%	239	321	560	434	390	824
		Total Number of AL05 & AL06 FOPs	100495							
LN01	SEAL	SEAL	2	0.16%	0	2	2	4	0	4
		Total Number of LN01 FOPs	1235							

Table 17.26 Listing by year of the recorded catch of Listed Marine and Threatened Species associated with AL05, AL06 and LN01 logbooks.

SPECIES GROUP	SPECIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	TOTAL
CETACEAN	BEAKED WHALE	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	BOTTLE NOSE WHALE	0	1	0	0	0	0	0	0	0	0	0	0	0	1
	BROWN WHALE	1	0	0	0	0	0	0	0	0	1	0	0	0	1
	CETACEAN	1	0	0	0	0	0	0	0	0	1	0	0	0	1
	DOLPHIN	0	1	0	3	1	0	1	0	0	0	0	0	0	6
	HUMPBACK WHALE	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	MELON HEADED WHALE	0	2	0	0	0	0	0	0	1	0	1	0	0	4
	PILOT WHALE	0	1	2	1	1	2	1	1	0	0	2	2	0	17
	PYGMY KILLER WHALE (JUVENILE)	0	1	0	0	0	0	0	0	0	0	0	0	0	1
	TOOTHED WHALE	0	0	0	0	2	0	1	1	0	0	0	0	0	5
	WHALE	0	0	0	1	1	0	0	0	0	0	1	0	0	3
FISH - OTHER	SOUTHERN BLUEFIN TUNA	0	0	0	1	0	0	0	0	0	0	0	0	0	1
	SUNFISH	0	0	0	0	8	0	0	0	0	0	0	0	0	8
FISH - RAYS	BLACK STINGRAY	0	3	0	0	1	0	0	0	0	0	0	0	0	4
	DEVIL RAY	0	0	0	1	0	1	0	0	0	0	0	0	0	2
	MANTA RAY	5	5	0	0	2	0	0	0	0	5	0	0	0	12
SEABIRD - ALBATROSS	ALBATROSS	10	2	4	1	8	2	1	5	6	10	0	0	0	39
	BLACK BROWED ALBATROSS	0	0	6	1	0	0	0	1	1	0	0	0	0	13
	SHY ALBATROSS	0	0	0	0	0	0	0	0	2	0	0	0	0	2
	WANDERING ALBATROSS	0	0	2	3	1	4	1	2	0	0	0	0	0	13
	YELLOW-NOSED ALBATROSS	0	0	4	0	0	0	6	0	0	0	2	0	0	12
SEABIRD - JAEGER	JAEGER	0	0	1	0	0	0	0	0	0	0	0	0	0	1
SEABIRD - PETREL	GIANT PETREL	1	0	0	0	0	0	0	0	0	1	0	0	0	1
	GREAT WINDED PETREL	0	0	2	1	1	0	0	0	0	0	0	0	0	4
	NORTHERN PETREL	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	PETREL SEABIRD	1	0	0	0	0	0	0	0	0	1	0	0	0	1
SEABIRD - SHEARWATER	FLESH-FOOTED SHEARWATER	0	0	23	11	6	1	0	0	0	0	0	0	0	41
	SEABIRD (SHEARWATER)	1	0	0	0	0	0	0	0	0	1	0	0	0	1
	SHEARWATER	0	21	44	27	19	3	0	0	0	0	0	0	0	114
	SHORT-TAILED SHEARWATER	0	89	47	10	18	1	6	0	1	0	0	0	0	172
	SOOTY SHEARWATER	0	1	0	0	0	0	0	0	0	0	2	0	0	3
	WEDGE-TAILED SHEARWATER	0	0	2	3	1	0	0	0	0	0	0	0	0	6
SEABIRD - UNKNNOWN	SEABIRD (UNKNOWN)	2	0	2	1	0	2	2	1	0	2	0	0	0	10
SEAL	SEAL	0	0	0	0	0	0	0	0	4	0	0	0	0	4
TURTLE	GREEN TURTLE	0	4	2	4	4	6	3	6	1	0	7	5	2	45
	HAWKSBILL TURTLE	0	4	4	1	2	1	0	2	0	0	1	0	0	16
	LEATHERBACK TURTLE	1	13	23	12	30	14	9	5	3	1	12	2	0	129
	LOGGERHEAD TURTLE	1	6	3	1	6	5	1	2	3	1	4	0	0	39
	OLIVE RIDLEY TURTLE	0	0	0	1	2	3	0	0	2	0	0	0	0	8
	TURTLE	4	17	20	22	5	7	8	2	0	4	2	1	0	91
UNKNOWN	UNIDENTIFIED SUBMERGED OBJECT	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	UNKNOWN	0	1	0	0	0	0	0	0	0	0	0	0	0	1
		28	172	191	106	119	52	40	28	24	28	34	10	2	835

Table 17.27 Listing by species and species group of the combined catch (both retained and discarded) for all FOPS recorded in the Observer logbook using the pelagic longline method. Species order by total catch.

Species Type	SPC_ID	Species Name	Common Name	FOPS with Catch	% FOPS with Catch	Number Retained	Number Discarded	% Discarded	Fate Unknown	Total Catch	% Total
Tuna	501	Thunnus albacares	Yellowfin Tuna	3754	87.0%	57787	2858	4.7%	186	60831	29.27%
Tuna	504	Thunnus alalunga	Albacore	3189	73.9%	45205	2399	5.0%	103	47707	22.96%
Tuna	507	Thunnus obesus	Bigeye tuna	2412	55.9%	9306	1168	11.2%	13	10487	5.05%
Tuna	503	Thunnus maccoyii	Southern Bluefin Tuna	396	9.2%	2449	3144	56.2%	8	5601	2.70%
Tuna	502	Katsuwonus pelamis	Skipjack Tuna	982	22.8%	2695	459	14.6%	11	3165	1.52%
Tuna	3978	Thunnus orientalis	Northern Bluefin Tuna	22	0.5%	19	12	38.7%	0	31	0.01%
Tuna	514	Sarda australis	Australian Bonito	20	0.5%	10	13	56.5%	0	23	0.01%
Tuna	506	Euthynnus affinis	Mackerel Tuna	8	0.2%	6	5	45.5%	0	11	0.01%
Tuna	517	Gymnosarda unicolor	Dogtooth Tuna	2	0.0%	1	3	75.0%	0	4	0.00%
Tuna	163	Cybiosarda elegans	Leaping bonito	4	0.1%	4	0	0.0%	0	4	0.00%
	Total			4179	96.9%	117482	10061	7.9%	321	127864	61.53%
Billfish	521	Xiphias gladius	Swordfish	2537	58.8%	11977	1110	8.5%	110	13197	6.35%
Billfish	523	Tetrapturus audax	Striped Marlin	1392	32.3%	2576	214	7.7%	27	2817	1.36%
Billfish	527	Tetrapturus angustirostris	Shortbill Spearfish	464	10.8%	532	231	30.3%	7	770	0.37%
Billfish	526	Makaira indica	Black Marlin	312	7.2%	7	555	98.8%	0	562	0.27%
Billfish	524	Makaira nigricans	Blue Marlin	292	6.8%	9	376	97.7%	1	386	0.19%
Billfish	525	Istiophorus platypterus	Sailfish	48	1.1%	35	18	34.0%	1	54	0.03%
Billfish	1303	Istiophoridae - undifferentiated	Marlins spearfishes sailfishes	11	0.3%	0	13	100.0%	0	13	0.01%
Billfish	2858	Tetrapturus pfluegeri	Longbill spearfish	2	0.0%	2	0	0.0%	0	2	0.00%
	Total			3310	76.7%	15138	2517	14.3%	146	17801	8.57%
Byproduct	496	Lepidocybium flavobrunneum	Escolar	2003	46.4%	12150	1075	8.1%	56	13281	6.39%
Byproduct	810	Coryphaena hippurus	Mahi Mahi	1919	44.5%	9012	372	4.0%	16	9400	4.52%
Byproduct	812	Brama brama	Ray's Bream	634	14.7%	6739	40	0.6%	10	6789	3.27%
Byproduct	377	Centrolophus niger	Rudderfish	219	5.1%	867	49	5.3%	3	919	0.44%
Byproduct	515	Acanthocybium solandri	Wahoo	451	10.5%	780	74	8.7%	7	861	0.41%
Byproduct	3976	Ruvettus pretiosus	Oilfish	395	9.2%	557	270	32.6%	7	834	0.40%
Byproduct	159	Lampris guttatus	Opah	248	5.7%	535	24	4.3%	2	561	0.27%
	Total			3338	77.4%	30640	1904	5.9%	101	32645	15.71%

Table 17.27 (cont'd). Listing by species and species group of the combined catch (both retained and discarded) for all FOPS recorded in the Observer logbook using the pelagic longline method. Species order by total catch.

Species Type	SPC_ID	Species Name	Common Name	FOPS with Catch	% FOPS with Catch	Number Retained	Number Discarded	% Discarded	Fate Unknown	Total Catch	% Total
Shark	616	Prionace glauca	Blue Shark	1590	36.9%	355	4215	92.2%	11	4581	2.204%
Shark	600	Isurus oxyrinchus	Shortfin Mako	1287	29.8%	1481	491	24.9%	13	1985	0.955%
Shark	615	Carcharhinus brachyurus	Bronze Whaler	268	6.2%	121	412	77.3%	3	536	0.258%
Shark	620	Galeocerdo cuvier	Tiger Shark	347	8.0%	141	322	69.5%	0	463	0.223%
Shark	623	Carcharhinus longimanus	Oceanic Whitetip Shark	260	6.03%	97	216	69.0%	1	314	0.151%
Shark	599	Pseudocarcharias kamoharai	Crocodile Shark	117	2.71%	1	289	99.7%	0	290	0.140%
Shark	626	Sphyrnidae - undifferentiated	Hammerhead sharks	138	3.20%	119	136	53.3%	1	256	0.123%
Shark	618	Carcharhinus falciformis	Silky Shark	139	3.22%	55	194	77.9%	0	249	0.120%
Shark	604	Alopias vulpinus	Thresher Shark	114	2.64%	11	120	91.6%	0	131	0.063%
Shark	614	Carcharhinidae, Hemigaleidae - undifferentiated	Whaler and weasel sharks	61	1.41%	31	62	66.7%	1	94	0.045%
Shark	5915	Sphyrna zygaena	Smooth Hammerhead	24	0.56%	5	53	91.4%	2	60	0.029%
Shark	625	Carcharhinus, Loxodon & Rhizoprionodon spp	Blacktip shark (mixed)	10	0.23%	3	35	92.1%	0	38	0.018%
Shark	389	sharks - other	Sharks (mixed)	12	0.28%	3	29	90.6%	0	32	0.015%
Shark	48	Cetorhinus maximus	Basking shark	3	0.07%	21	6	22.2%	0	27	0.013%
Shark	1206	Sphyrna mokarran	Great hammerhead	15	0.35%	2	25	92.6%	0	27	0.013%
Shark	601	Isurus paucus	Longfin Mako	23	0.53%	15	9	37.5%	0	24	0.012%
Shark	62	Carcharhinus limbatus	Blacktip shark	11	0.25%	14	6	30.0%	0	20	0.010%
Shark	65	Carcharhinus tilstoni	Australian blacktip shark	12	0.28%	7	12	63.2%	0	19	0.009%
Shark	603	Lamna nasus	Porbeagle	15	0.35%	3	15	83.3%	1	19	0.009%
Shark	636	Isistius brasiliensis	Smalltooth Cookiecutter Shark	17	0.39%	7	10	58.8%	0	17	0.008%
Shark	1504	Alopiidae - undifferentiated	Thresher sharks	13	0.30%	1	16	94.1%	0	17	0.008%
Shark	627	Sphyrna lewini	Scalloped Hammerhead	8	0.19%	2	10	83.3%	0	12	0.006%
Shark	617	Carcharhinus plumbeus	Sandbar Shark	10	0.23%	0	10	100.0%	0	10	0.005%
Shark	621	Carcharhinus albimarginatus	Silvertip Shark	3	0.07%	3	1	25.0%	0	4	0.002%
Shark	624	Triaenodon obesus	Whitetip Reef Shark	3	0.07%	1	2	66.7%	0	3	0.001%
Shark	1435	Lamnidae - undifferentiated	Mackerel Sharks	2	0.05%	0	3	100.0%	0	3	0.001%
Shark	613	Galeorhinus galeus	School Shark	2	0.05%	2	1	33.3%	0	3	0.001%
Shark	622	Carcharhinus amblyrhynchos	Grey Reef Shark	3	0.07%	1	2	66.7%	0	3	0.001%
Shark	628	Centrophoridae, Dalatiidae, Squalidae, Somniosidae &	Dogfishes	2	0.05%	2	1	33.3%	0	3	0.001%
Shark	898	Centroscymnus owstonii	Roughskin dogfish	1	0.02%	2	0	0.0%	0	2	0.001%
Shark	43	Carcharhinus melanopterus	Blacktip reef shark	2	0.05%	0	2	100.0%	0	2	0.001%
Shark	56	Carcharhinus altimus	Bignose shark	2	0.05%	1	1	50.0%	0	2	0.001%
Shark	602	Carcharodon carcharias	White Shark	2	0.05%	0	2	100.0%	0	2	0.001%
Shark	57	Carcharhinus brevipinna	Spinner shark	1	0.02%	1	1	50.0%	0	2	0.001%
Shark	1075	Remora remora	Shark sucker	2	0.05%	0	2	100.0%	0	2	0.001%
Shark	647	Squatina australis	Australian Angelshark	1	0.02%	0	1	100.0%	0	1	0.000%
Shark	629	Centrophorus moluccensis	Endeavour Dogfish	1	0.02%	1	0	0.0%	0	1	0.000%
Shark	328	Figaro boardmani	Australian sawtail catshark	1	0.02%	0	1	100.0%	0	1	0.000%
Shark	619	Carcharhinus leucas	Bull Shark	1	0.02%	0	1	100.0%	0	1	0.000%
	Total			2854	66.16%	2509	6714	72.8%	33	9256	4.45%

Table 17.27 (cont'd). Listing by species and species group of the combined catch (both retained and discarded) for all FOPS recorded in the Observer logbook using the pelagic longline method. Species order by total catch.

Species Type	SPC_ID	Species Name	Common Name	FOPS with Catch	% FOPS with Catch	Number Retained	Number Discarded	% Discarded	Fate Unknown	Total Catch	% Total
Bycatch	144	Alepisaurus ferox	Long snouted lancetfish	2128	49.33%	42	11116	99.6%	18	11176	5.378%
Bycatch	497	Gemphylus serpens	Snake Mackerel	609	14.12%	10	1784	99.4%	3	1797	0.865%
Bycatch	1632	Molidae - undifferentiated	Ocean sunfishes	798	18.50%	6	1262	99.5%	2	1270	0.611%
Bycatch	143	Alepisaurus brevirostris	Short snouted lancetfish	379	8.79%	12	1162	99.0%	3	1177	0.566%
Bycatch	1455	Identity unknown or bad data	Unknown or other	447	10.36%	34	931	96.5%	139	1104	0.531%
Bycatch	1043	Dasyatis spp	Pelagic stingrays	436	10.11%	2	601	99.7%	3	606	0.292%
Bycatch	5913	Carcharhinus obscurus	Dusky Whaler	180	4.17%	32	278	89.7%	1	311	0.150%
Bycatch	5854	Puffinus carneipes	Flesh Footed Shearwater	102	2.36%	2	233	99.1%	44	279	0.134%
Bycatch	657	Manta birostris	Manta Ray	186	4.31%	0	224	100.0%	5	229	0.110%
Bycatch	329	Sphyraena barracuda	Great barracuda	132	3.06%	5	214	97.7%	0	219	0.105%
Bycatch	50	Alopias superciliosus	Bigeye thresher	153	3.55%	12	182	93.8%	2	196	0.094%
Bycatch	1052	Alopias pelagicus	Pelagic thresher	137	3.18%	4	181	97.8%	2	187	0.090%
Bycatch	495	Rexea solandri	Gemfish	24	0.56%	9	80	89.9%	0	89	0.043%
Bycatch	385	Tetraodontidae - undifferentiated	Toadfishes unspecified	71	1.65%	2	87	97.8%	0	89	0.043%
Bycatch	27	Sphyraena spp	Barracudas	54	1.25%	2	75	97.4%	0	77	0.037%
Bycatch	811	Bramidae - undifferentiated	Pomfret	49	1.14%	55	8	12.7%	3	66	0.032%
Bycatch	494	Thyrsites atun	Barracouta	51	1.18%	1	62	98.4%	1	64	0.031%
Bycatch	5890	Trachipterus spp	Dealfishes	57	1.32%	3	57	95.0%	0	60	0.029%
Bycatch	388	Mola mola	Ocean Sunfish	40	0.93%	0	58	100.0%	0	58	0.028%
Bycatch	25	Sphyraena jello	Pickhandle barracuda	35	0.81%	2	41	95.3%	0	43	0.021%
Bycatch	399	Dermochelys coriacea	Leatherback Turtle	40	0.93%	0	40	100.0%	1	41	0.020%
Bycatch	171	Lagocephalus lagocephalus	Oceanic puffer	25	0.58%	3	36	92.3%	2	41	0.020%
Bycatch	206	Epinephelus malabaricus	Malabar grouper	24	0.56%	3	29	90.6%	0	32	0.015%
Bycatch	1469	Pteroplatytrygon violacea	Pelagic stingray	21	0.49%	0	32	100.0%	0	32	0.015%
Bycatch	683	Alepisauridae - undifferentiated	Lancetfishes	15	0.35%	0	29	100.0%	0	29	0.014%
Bycatch	395	Chelonia mydas	Green turtle	25	0.58%	4	21	84.0%	1	26	0.013%
Bycatch	729	Trachipteridae - undifferentiated	Ribbonfishes	19	0.44%	1	22	95.7%	1	24	0.012%
Bycatch	797	Seriola lalandi	Yellowtail Kingfish	20	0.46%	18	5	21.7%	0	23	0.011%
Bycatch	759	Polyprion oxygeneios	Hapuku	12	0.28%	23	0	0.0%	0	23	0.011%
Bycatch	814	Taractichthys longipinnis	Bigscale Pomfret	18	0.42%	13	8	38.1%	2	23	0.011%
Bycatch	407	Thalassarche melanophrys	Black Browed Albatross	16	0.37%	5	10	66.7%	6	21	0.010%
Bycatch	84	Mene maculata	Moonfish	16	0.37%	20	1	4.8%	0	21	0.010%
Bycatch	3739	Taractichthys steindachneri	Sickle Pomfret	14	0.32%	18	2	10.0%	0	20	0.010%
Bycatch	787	Apogonidae, Dinolestidae - undifferentiated	Cardinalfishes	14	0.32%	0	18	100.0%	0	18	0.009%
Bycatch	1112	Ratabulus diversidens	Orange-freckled flathead	5	0.12%	15	2	11.8%	0	17	0.008%
Bycatch	406	Diomedea exulans	Wandering Albatross	11	0.25%	5	9	64.3%	2	16	0.008%
Bycatch	3154	Masturus lanceolatus	Sharptail Sunfish	13	0.30%	0	15	100.0%	0	15	0.007%
Bycatch	793	Rachycentron canadum	Cobia	9	0.21%	15	0	0.0%	0	15	0.007%
Bycatch	1449	Class Holothuroidea - undifferentiated	Holothurians	12	0.28%	6	9	60.0%	0	15	0.007%
Bycatch	33	Benthodesmus spp	Frostfishes	13	0.30%	1	13	92.9%	0	14	0.007%

Table 17.27 (cont'd). Listing by species and species group of the combined catch (both retained and discarded) for all FOPS recorded in the Observer logbook using the pelagic longline method. Species order by total catch.

Species Type	SPC_ID	Species Name	Common Name	FOPS with Catch	% FOPS with Catch	Number Retained	Number Discarded	% Discarded	Fate Unknown	Total Catch	% Total
Bycatch	394	Caretta caretta	Loggerhead turtle	14	0.32%	0	14	100.0%	0	14	0.007%
Bycatch	421	Pterodroma macroptera	Great Winged Petrel	12	0.28%	5	1	16.7%	6	12	0.006%
Bycatch	863	Gymnocranius spp.	Sea Bream Snapper	10	0.23%	10	2	16.7%	0	12	0.006%
Bycatch	815	Brama australis	Southern Ray's Bream	7	0.16%	11	0	0.0%	0	11	0.005%
Bycatch	803	Elagatis bipinnulata	Rainbow Runner	8	0.19%	10	1	9.1%	0	11	0.005%
Bycatch	145	Diomedeidae - undifferentiated	Albatrosses	8	0.19%	0	10	100.0%	0	10	0.005%
Bycatch	425	Puffinus tenuirostris	Short Tailed Shearwater	9	0.21%	7	1	12.5%	1	9	0.004%
Bycatch	5855	Puffinus pacificus	Wedge Tailed Shearwater	7	0.16%	6	2	25.0%	1	9	0.004%
Bycatch	500	Scomber australasicus	Blue Mackerel	6	0.14%	2	6	75.0%	0	8	0.004%
Bycatch	403	Thalassarche cauta	Shy Albatross	7	0.16%	3	3	50.0%	2	8	0.004%
Bycatch	832	Pristipomoides filamentosus	Rosy Snapper	1	0.02%	8	0	0.0%	0	8	0.004%
Bycatch	1196	Sillago ciliata	Sand Whiting	6	0.14%	3	4	57.1%	0	7	0.003%
Bycatch	397	Lepidochelys olivacea	Pacific (Olive) Ridely turtle	7	0.16%	1	6	85.7%	0	7	0.003%
Bycatch	3990	Pterygotrigla polyommata	Latchet	5	0.12%	0	6	100.0%	0	6	0.003%
Bycatch	1289	Tasmacetus shepherdi	Sherpherd's beaked whale	4	0.09%	0	5	100.0%	0	5	0.002%
Bycatch	414	Daption capense	Cape Petrel	5	0.12%	4	1	20.0%	0	5	0.002%
Bycatch	1747	Trochidae - undifferentiated	Trochidae	3	0.07%	0	5	100.0%	0	5	0.002%
Bycatch	378	Seriolella brama	Blue Warehou	3	0.07%	5	0	0.0%	0	5	0.002%
Bycatch	1219	Taractes asper	Rough pomfret	5	0.12%	3	2	40.0%	0	5	0.002%
Bycatch	161	Lampanyctodes hectoris	Hector's lanternfish	2	0.05%	0	5	100.0%	0	5	0.002%
Bycatch	1633	Globicephala macrorhynchus	Short-finned pilot whale	5	0.12%	0	5	100.0%	0	5	0.002%
Bycatch	391	Skates & rays unspecified	Skates and rays	1	0.02%	0	5	100.0%	0	5	0.002%
Bycatch	894	Nomeidae - undifferentiated	Driftfishes	4	0.09%	3	2	40.0%	0	5	0.002%
Bycatch	418	Procellaria westlandica	Westland Petrel	5	0.12%	3	0	0.0%	2	5	0.002%
Bycatch	808	Parastromateus niger	Black Pomfret	3	0.07%	4	0	0.0%	0	4	0.002%
Bycatch	1572	Regalecidae - undifferentiated	Oarfishes	3	0.07%	0	4	100.0%	0	4	0.002%
Bycatch	429	Catharacta skua	Great Skua	3	0.07%	1	3	75.0%	0	4	0.002%
Bycatch	2834	Nesiarchus nasutus	Black Gemfish	4	0.09%	0	4	100.0%	0	4	0.002%
Bycatch	141	Theragra chalcogramma	Alaska pollock	2	0.05%	0	4	100.0%	0	4	0.002%
Bycatch	396	Eretmochelys imbricata	Hawksbill turtle	4	0.09%	0	4	100.0%	0	4	0.002%
Bycatch	654	Rajidae - undifferentiated	Skates	2	0.05%	2	1	33.3%	0	3	0.001%
Bycatch	402	Thalassarche bulleri	Buller's Albatross	3	0.07%	3	0	0.0%	0	3	0.001%
Bycatch	868	Acanthopagrus butcheri	Black Bream	3	0.07%	3	0	0.0%	0	3	0.001%
Bycatch	5891	Epigonus spp	Deepsea Cardinalfish	1	0.02%	0	3	100.0%	0	3	0.001%
Bycatch	1185	Arctocephalus pusillus doriferus	Australian fur seal	3	0.07%	0	3	100.0%	0	3	0.001%
Bycatch	121	Kaupichthys hyoproroides	False moray	3	0.07%	0	3	100.0%	0	3	0.001%
Bycatch	32	Belonepterygion fasciolatum	Barred spiny basslet	3	0.07%	2	1	33.3%	0	3	0.001%
Bycatch	1045	Micromesistius australis	Southern blue whiting	1	0.02%	3	0	0.0%	0	3	0.001%
Bycatch	541	Order Teuthoidea - undifferentiated	Squids	3	0.07%	0	2	100.0%	1	3	0.001%
Bycatch	120	Alabes parvulus	Pygmy shore-eel	3	0.07%	2	1	33.3%	0	3	0.001%

Table 17.27 (cont'd). Listing by species and species group of the combined catch (both retained and discarded) for all FOPS recorded in the Observer logbook using the pelagic longline method. Species order by total catch.

Species Type	SPC_ID	Species Name	Common Name	FOPS with Catch	% FOPS with Catch	Number Retained	Number Discarded	% Discarded	Fate Unknown	Total Catch	% Total
Bycatch	4101	Gerres oblongus	Slender Silverbiddy	2	0.05%	1	2	66.7%	0	3	0.001%
Bycatch	101	Naucrates ductor	Pilotfish	3	0.07%	1	2	66.7%	0	3	0.001%
Bycatch	3050	Aluterus scriptus	Scrawled Leatherjacket	3	0.07%	2	1	33.3%	0	3	0.001%
Bycatch	5285	Labracinus cyclophthalmus	Firetail Dottyback	3	0.07%	3	0	0.0%	0	3	0.001%
Bycatch	5847	Trichiuridae - undifferentiated	Ribbonfishes & cutlassfishes	2	0.05%	0	2	100.0%	0	2	0.001%
Bycatch	530	Phylum Mollusca - undifferentiated	Molluscs	1	0.02%	0	2	100.0%	0	2	0.001%
Bycatch	1205	Siganus spp	Spinefeet(=Rabbitfishes) nei	2	0.05%	0	2	100.0%	0	2	0.001%
Bycatch	4009	Thalassarche chrysostoma	Grey Headed Albatross	2	0.05%	1	1	50.0%	0	2	0.001%
Bycatch	928	Echinophryne crassispina	Prickly anglerfish	2	0.05%	2	0	0.0%	0	2	0.001%
Bycatch	158	Geotria australis	Pouched lamprey	2	0.05%	2	0	0.0%	0	2	0.001%
Bycatch	1192	Raja spp.	Skate (mixed)	2	0.05%	2	0	0.0%	0	2	0.001%
Bycatch	505	Scomberomorus commerson	Spanish Mackerel	2	0.05%	2	0	0.0%	0	2	0.001%
Bycatch	80	Acanthopagrus berda	Goldsilk seabream	2	0.05%	0	1	100.0%	1	2	0.001%
Bycatch	12	Neophoca cinerea	Australian sea lion	2	0.05%	0	2	100.0%	0	2	0.001%
Bycatch	3644	Batrachoididae - undifferentiated	frogfishes	2	0.05%	0	2	100.0%	0	2	0.001%
Bycatch	1174	Sardinella gibbosa	Goldstripe sardinella	2	0.05%	2	0	0.0%	0	2	0.001%
Bycatch	2515	Eumecichthys fiski	Unicorn Crestfish	2	0.05%	2	0	0.0%	0	2	0.001%
Bycatch	731	Regalecus glesne	Oarfish	2	0.05%	0	2	100.0%	0	2	0.001%
Bycatch	3183	Aipysurus laevis	golden seasnake	2	0.05%	1	1	50.0%	0	2	0.001%
Bycatch	379	Seriolella punctata	Silver warehou	2	0.05%	1	1	50.0%	0	2	0.001%
Bycatch	34	Brachynectes fasciatus	Southern barred triplefin	2	0.05%	1	1	50.0%	0	2	0.001%
Bycatch	183	Lophotus lacepede	Crested oarfish	2	0.05%	0	2	100.0%	0	2	0.001%
Bycatch	404	Thalassarche chlororhynchos	Yellow Nosed Albatross	2	0.05%	2	0	0.0%	0	2	0.001%
Bycatch	333	Gerres filamentosus	Whipfin silver-biddy	2	0.05%	0	2	100.0%	0	2	0.001%
Bycatch	903	Delphinus delphis	Common dolphin	2	0.05%	0	2	100.0%	0	2	0.001%
Bycatch	1215	Otariidae - undifferentiated	Eared seals	1	0.02%	0	2	100.0%	0	2	0.001%
Bycatch	423	Puffinus griseus	Sooty Shearwater	2	0.05%	2	0	0.0%	0	2	0.001%
Bycatch	5936	Procellaria spp.	Petrels	2	0.05%	1	0	0.0%	1	2	0.001%
Bycatch	1244	Xiphocheilus typus	Bluetooth Tuskfish	1	0.02%	2	0	0.0%	0	2	0.001%
Bycatch	655	Dasyatidae - undifferentiated	Stingrays	2	0.05%	0	2	100.0%	0	2	0.001%
Bycatch	386	Diodontidae - undifferentiated	Porcupine Fish	1	0.02%	0	1	100.0%	0	1	0.000%
Bycatch	1191	Symphorus nematophorus	Chinamanfish	1	0.02%	0	1	100.0%	0	1	0.000%
Bycatch	258	Megaptera novaeangliae	Humpback whale	1	0.02%	0	1	100.0%	0	1	0.000%
Bycatch	777	Epinephelus morrhua	Comet Grouper	1	0.02%	1	0	0.0%	0	1	0.000%
Bycatch	1034	Globicephala melas	Long-finned pilot whale	1	0.02%	0	1	100.0%	0	1	0.000%
Bycatch	1876	Albulidae - undifferentiated	bonefishes	1	0.02%	0	1	100.0%	0	1	0.000%
Bycatch	4020	Australophocoena dioptrica	Spectacled porpoise	1	0.02%	1	0	0.0%	0	1	0.000%
Bycatch	2078	Salmonidae - undifferentiated	salmons	1	0.02%	0	1	100.0%	0	1	0.000%
Bycatch	164	Bothidae, Achiropsettidae, Paralichthyidae - undifferenti	Lefteye flounders	1	0.02%	1	0	0.0%	0	1	0.000%
Bycatch	71	Elops hawaiensis	Hawaiian ladyfish	1	0.02%	1	0	0.0%	0	1	0.000%

Table 17.27 (cont'd). Listing by species and species group of the combined catch (both retained and discarded) for all FOPS recorded in the Observer logbook using the pelagic longline method. Species order by total catch.

Species Type	SPC_ID	Species Name	Common Name	FOPS with Catch	% FOPS with Catch	Number Retained	Number Discarded	% Discarded	Fate Unknown	Total Catch	% Total
Bycatch	4018	Delphinidae - undifferentiated	Dolphins	1	0.02%	1	0	0.0%	0	1	0.000%
Bycatch	1136	Oncorhynchus mykiss	Rainbow trout	1	0.02%	0	1	100.0%	0	1	0.000%
Bycatch	1446	Class Polychaeta - undifferentiated	Polychaeta	1	0.02%	1	0	0.0%	0	1	0.000%
Bycatch	459	Paristiopterus labiosus	Giant Boarfish	1	0.02%	0	1	100.0%	0	1	0.000%
Bycatch	3878	Brachypterois serrulata	Sawcheek Scorpionfish	1	0.02%	1	0	0.0%	0	1	0.000%
Bycatch	31	Benthodesmus elongatus	Elongate frostfish	1	0.02%	0	1	100.0%	0	1	0.000%
Bycatch	1408	Alepocephalidae - undifferentiated	Slickheads	1	0.02%	0	1	100.0%	0	1	0.000%
Bycatch	160	Mordacia mordax	Australian lamprey	1	0.02%	1	0	0.0%	0	1	0.000%
Bycatch	430	Sterna bergii	Crested Tern	1	0.02%	1	0	0.0%	0	1	0.000%
Bycatch	4022	Lobodon carcinophagus	Crabeater seal	1	0.02%	0	1	100.0%	0	1	0.000%
Bycatch	1025	Pellona ditchela	Indian pellona	1	0.02%	1	0	0.0%	0	1	0.000%
Bycatch	55	Choeroichthys brachysoma	Short-bodied pipefish	1	0.02%	1	0	0.0%	0	1	0.000%
Bycatch	1290	Arctocephalus tropicalis	Subantarctic fur seal	1	0.02%	1	0	0.0%	0	1	0.000%
Bycatch	4007	order Testudines (except fam. Testunididae) - undiffere	Turtles	1	0.02%	0	1	100.0%	0	1	0.000%
Bycatch	202	Platax orbicularis	Orbicular batfish	1	0.02%	0	1	100.0%	0	1	0.000%
Bycatch	802	Seriola dumerili	Amberjack	1	0.02%	0	1	100.0%	0	1	0.000%
Bycatch	3146	Arothron caeruleopunctatus	Bluespotted Puffer	1	0.02%	0	1	100.0%	0	1	0.000%
Bycatch	633	Squalus megalops	Piked Spurdog	1	0.02%	0	1	100.0%	0	1	0.000%
Bycatch	3209	Pelamis platurus	Yellow-Bellied Seasnake	1	0.02%	0	1	100.0%	0	1	0.000%
Bycatch	842	Lutjanus spp	Sea Perch	1	0.02%	1	0	0.0%	0	1	0.000%
Bycatch	436	Physeter catodon	Sperm Whale	1	0.02%	0	1	100.0%	0	1	0.000%
Bycatch	383	Nelusetta ayraudi	Ocean Jacket	1	0.02%	1	0	0.0%	0	1	0.000%
Bycatch	167	Lophodiodon calori	Four-bar porcupinefish	1	0.02%	1	0	0.0%	0	1	0.000%
Bycatch	2867	Cubiceps baxteri	Black Cubehead	1	0.02%	0	1	100.0%	0	1	0.000%
Bycatch	466	Nemadactylus macropterus	Jackass Morwong	1	0.02%	1	0	0.0%	0	1	0.000%
Bycatch	687	Halieutaea brevicauda	Shortfin Seabat	1	0.02%	1	0	0.0%	0	1	0.000%
Bycatch	405	Diomedea epomophora	Southern Royal Albatross	1	0.02%	0	1	100.0%	0	1	0.000%
Bycatch	29	Barbourisia rufa	Velvet whalefish	1	0.02%	1	0	0.0%	0	1	0.000%
Bycatch	5877	Hippocampus spp	Seahorses - Hippocampid	1	0.02%	0	1	100.0%	0	1	0.000%
Bycatch	688	Mora moro	Ribaldo	1	0.02%	0	1	100.0%	0	1	0.000%
Bycatch	1246	Bryaninops amplus	Large whip goby	1	0.02%	1	0	0.0%	0	1	0.000%
Bycatch	3228	Thalassarche salvini	Salvin's albatross	1	0.02%	1	0	0.0%	0	1	0.000%
Bycatch	441	Epigonus denticulatus	Pencil cardinal	1	0.02%	0	1	100.0%	0	1	0.000%
Bycatch	1125	Urolophus viridis	Greenback stingaree	1	0.02%	0	0		1	1	0.000%
Bycatch	824	Etelis carbunculus	Ruby Snapper	1	0.02%	0	1	100.0%	0	1	0.000%
Bycatch	384	Abalistes stellatus	Starry Triggerfish	1	0.02%	1	0	0.0%	0	1	0.000%
Bycatch	1195	Syncomistes kimberleyensis	Kimberley Grunter	1	0.02%	1	0	0.0%	0	1	0.000%
Bycatch	1264	Balaenoptera edeni	Bryde's whale	1	0.02%	1	0	0.0%	0	1	0.000%
Bycatch	1739	Loligo opalescens	opalescent inshore squid	1	0.02%	1	0	0.0%	0	1	0.000%
Bycatch	82	Malacocephalus laevis	Softhead grenadier	1	0.02%	1	0	0.0%	0	1	0.000%

Table 17.27 (cont'd). Listing by species and species group of the combined catch (both retained and discarded) for all FOPS recorded in the Observer logbook using the pelagic longline method. Species order by total catch.

Species Type	SPC_ID	Species Name	Common Name	FOPS with Catch	% FOPS with Catch	Number Retained	Number Discarded	% Discarded	Fate Unknown	Total Catch	% Total
Bycatch	434	Peponocephala electra	Melon-headed whale	1	0.02%	0	0		1	1	0.000%
Bycatch	5935	Gerres spp.	Silverbiddies (mixed)	1	0.02%	0	1	100.0%	0	1	0.000%
Bycatch	123	Lumiconger arafura	Luminous Conger	1	0.02%	1	0	0.0%	0	1	0.000%
Bycatch	1138	Sorosichthys ananassa	Little pineapple fish	1	0.02%	0	1	100.0%	0	1	0.000%
Bycatch	173	Nuchequula glenysae	Twoblotch ponyfish	1	0.02%	1	0	0.0%	0	1	0.000%
Bycatch	139	Allenichthys glauerti	Glauert's anglerfish	1	0.02%	1	0	0.0%	0	1	0.000%
Bycatch	697	Genypterus blacodes	Pink Ling	1	0.02%	0	1	100.0%	0	1	0.000%
Bycatch	1193	Scobinichthys granulatus	Rough leatherjackets	1	0.02%	1	0	0.0%	0	1	0.000%
Bycatch	1294	Mirounga leonina	Southern elephant seal	1	0.02%	0	1	100.0%	0	1	0.000%
Bycatch	3207	Lapemis hardwickii	Spine-bellied seasnake	1	0.02%	1	0	0.0%	0	1	0.000%
Bycatch	UNK	Unknown SPC code	Unknown SPC code	151	3.50%	178	137	43.5%	2	317	0.153%
	Total			3467	80.37%	727	19253	96.4%	260	20240	9.74%
Grand	Total	All Species		4314	100.0%	166496	40449	19.5%	861	207806	100.00%

Table 17.28 Listing of recorded catch of Listed Marine and Threatened Species recorded by observers.

SPECIES GROUP	SPECIES	FOPS with Catch	% FOPS with Catch	Catch while Setting	Catch while Hauling	Catch Unknown Time	Released Dead	Released Alive	Unknown Status	Total
FISH	Guppy	1	0.02%	2	0	0	0	0	2	2
FISH	Atlantic Lanternfish	1	0.02%	0	0	1	0	0	1	1
SEABIRD - ALBATROSS	Black Browed Albatross	10	0.23%	1	9	1	4	2	5	11
SEABIRD - ALBATROSS	Wandering Albatross	4	0.09%	0	4	0	4	0	0	4
SEABIRD - ALBATROSS	Yellow Nosed Albatross	4	0.09%	2	2	0	2	1	1	4
SEABIRD - ALBATROSS	Shy Albatross	3	0.07%	0	3	0	1	0	2	3
SEABIRD - ALBATROSS	Albatrosses	2	0.05%	0	2	0	0	0	2	2
SEABIRD - ALBATROSS	Buller's Albatross	1	0.02%	0	1	0	0	0	1	1
SEABIRD - ALBATROSS	Grey Headed Albatross	1	0.02%	0	1	0	1	0	0	1
SEABIRD - PETREL	Great Winged Petrel	2	0.05%	2	0	0	0	0	2	2
SEABIRD - SHEARWATER	Flesh Footed Shearwater	31	0.72%	77	10	6	0	2	91	93
SEABIRD - SHEARWATER	Short Tailed Shearwater	4	0.09%	1	3	0	0	0	4	4
SEAL	Australian sea lion	3	0.07%	0	4	0	0	2	2	4
SEAL	Australian fur seal	2	0.05%	0	3	0	0	0	3	3
SHARK	Shortfin Mako	108	2.50%	2	186	0	81	101	6	188
SHARK	Longfin Mako	2	0.05%	0	2	0	0	2	0	2
SHARK	White Shark	1	0.02%	0	1	0	0	1	0	1
SHARK	Porbeagle	1	0.02%	0	1	0	1	0	0	1
SNAKE	Yellow-Bellied Seasnake	1	0.02%	0	1	0	0	1	0	1
TURTLE	Green turtle	19	0.44%	0	20	0	4	15	1	20
TURTLE	Leatherback Turtle	15	0.35%	0	15	0	0	14	1	15
TURTLE	Loggerhead turtle	7	0.16%	0	7	0	1	6	0	7
TURTLE	Hawksbill turtle	3	0.07%	0	3	0	1	1	1	3
TURTLE	Pacific (Olive) Ridely turtle	3	0.07%	1	2	0	0	3	0	3
UNKNOWN	Unknown or other	2	0.05%	0	2	0	0	1	1	2
WHALE	Short-finned pilot whale	3	0.07%	0	3	0	0	3	0	3
WHALE	Long-finned pilot whale	1	0.02%	0	1	0	0	1	0	1
WHALE	Beaked whales - Mesoplodid	1	0.02%	0	1	0	0	0	1	1
TOTAL		226	5.24%	88	287	8	100	156	127	383
Number of Observed FOPS		4314								

Table 17.29 Listing, by year, of the recorded catch of Listed Marine and Threatened Species recorded by observers.

SPECIES GROUP	SPECIES	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	TOTAL
FISH	Guppy	0	2	0	0	0	0	0	0	0	0	0	0	2
FISH	Atlantic Lanternfish	0	1	0	0	0	0	0	0	0	0	0	0	1
SEABIRD - ALBATROSS	Black Browed Albatross	0	0	1	0	0	2	2	3	3	0	0	0	11
SEABIRD - ALBATROSS	Wandering Albatross	0	0	0	0	0	1	1	2	0	0	0	0	4
SEABIRD - ALBATROSS	Yellow Nosed Albatross	0	1	0	0	0	0	1	1	0	1	0	0	4
SEABIRD - ALBATROSS	Shy Albatross	0	0	0	0	0	1	0	1	1	0	0	0	3
SEABIRD - ALBATROSS	Albatrosses	0	0	0	0	0	0	0	2	0	0	0	0	2
SEABIRD - ALBATROSS	Grey Headed Albatross	0	0	0	0	0	1	0	0	0	0	0	0	1
SEABIRD - ALBATROSS	Buller's Albatross	0	0	0	0	0	0	0	1	0	0	0	0	1
SEABIRD - PETREL	Great Winged Petrel	0	2	0	0	0	0	0	0	0	0	0	0	2
SEABIRD - SHEARWATER	Flesh Footed Shearwater	22	69	0	0	0	2	0	0	0	0	0	0	93
SEABIRD - SHEARWATER	Short Tailed Shearwater	0	1	0	3	0	0	0	0	0	0	0	0	4
SEAL	Australian sea lion	0	0	0	0	0	0	0	4	0	0	0	0	4
SEAL	Australian fur seal	0	0	0	0	0	2	0	1	0	0	0	0	3
SHARK	Shortfin Mako	0	0	0	0	0	0	0	0	0	62	115	11	188
SHARK	Longfin Mako	0	0	0	0	0	0	0	0	0	0	1	1	2
SHARK	Porbeagle	0	0	0	0	0	0	0	0	0	0	1	0	1
SHARK	White Shark	0	0	0	0	0	0	0	0	1	0	0	0	1
SNAKE	Yellow-Bellied Seasnake	0	0	0	0	0	0	0	0	0	1	0	0	1
TURTLE	Green turtle	0	0	1	0	0	0	5	2	1	1	10	0	20
TURTLE	Leatherback Turtle	0	0	0	0	0	1	3	3	4	2	2	0	15
TURTLE	Loggerhead turtle	0	0	0	0	0	0	2	2	2	1	0	0	7
TURTLE	Pacific (Olive) Ridely turtle	0	0	0	0	1	0	0	1	0	0	1	0	3
TURTLE	Hawksbill turtle	0	0	0	1	0	0	1	0	0	1	0	0	3
UNKNOWN	Unknown or other	0	0	0	0	0	2	0	0	0	0	0	0	2
WHALE	Short-finned pilot whale	0	0	0	0	0	0	1	0	0	2	0	0	3
WHALE	Long-finned pilot whale	0	0	0	0	0	0	0	0	0	0	1	0	1
WHALE	Beaked whales - Mesoplodid	0	0	0	0	0	0	0	0	1	0	0	0	1
	TOTAL	22	76	2	4	1	12	16	23	13	71	131	12	383

18 APPENDIX 7: NORTHERN PRAWN FISHERY

Gary Fry and Margaret Miller

CSIRO Wealth from Oceans Flagship and Marine and Atmospheric Research

18.1 Summary

The Northern Prawn Fishery (NPF) is a multispecies trawl fishery targeting a number of prawn species along with byproduct including squid, cuttlefish, bugs, scallops, scampi and fish. The bycatch of the fishery can comprise up to 56 elasmobranch, 450 teleost and 230 invertebrate species. In addition, the NPF interacts with a number of EPBC listed 'Threatened, Endangered or Protected' species (TEPs); at least 5 marine turtle species, 15 sea snake species, 5 sawfish species and a number of Syngnathidae species. Since the first NPF Bycatch Action Plan was implemented in 1998, it is estimated that total bycatch volume for the NPF has been reduced by around 50% due a combination of voluntary licence buy-backs, compulsory gear unit reduction schemes and the introduction of bycatch reduction devices. In addition, the mandatory implementation of Turtle Excluder Devices in 2000 has led to significant reductions in catches of marine turtles and other large bycatch species across the NPF. However the reduction in total bycatch from the introduction of Bycatch Reduction Devices in 2001 has been minimal and variable. Due to significant spatial differences in catch rates of total bycatch, the diversity of TED and BRD types used throughout the fishery and the lack of comprehensive data on bycatch recorded by the commercial fleet, it is difficult to estimate total bycatch volume caught across the fishery with acceptable accuracy.

18.2 Fishery Description

The Northern Prawn Fishery (NPF) is located off Australia's northern coast covering 771,000 km^2. The region extends from Cape York (142° 10.00' E) in Queensland and Cape Londonderry (126° 58.00' E) in Western Australia and out to the edge of the Australian Fishing Zone (AFZ). It is a multispecies fishery targeting a number of prawn species, including the Grooved Tiger (*Penaeus semisulcatus*), Brown Tiger (*P. esculentus*), White Banana (*Fennerpenaeus merguiensis*), Red-legged Banana (*F. indicus*), Red Endeavour (*Metapenaeus ensis*), Blue Endeavour (*M. endeavouri*), Western King (*Melicertus latisulcatus*) and Red-spot King (*M. longistylus*). A range of byproduct species can also be retained by the NPF, including squid, cuttlefish, scallops, bugs, scampi and some fish.

The NPF began in the late 1960's and has developed into one of Australia's most valuable fisheries (BRS 2011). By 1970, there were more than 200 vessels operating in the fishery. As a result of the rapidly expanding effort in the fishery, the first management plan was introduced in 1977 with entry limited to 302 vessels (BRS 2011). Currently there are 52 boats in the fleet and it is now run under a number of input management controls – limited entry, seasonal, spatial and temporal closures, ITE based on gear length and operational controls. Trawling in the NPF is undertaken over two seasons – the Banana Season from April to June, and the Tiger Season from August to December. The short banana prawn season operates during the day and night while the tiger prawn season only operates at night. The number of vessels and total effort (boat days) for the tiger and banana prawn seasons has

fluctuated from 1970 to 2011, peaking in the mid 1980's at around 30000 and 7000 boat days, respectively (Figure 18.1).

18.3 Bycatch Management Measures

The Australian Fisheries Management Authority (AFMA), responsible for managing the NPF, have developed and implemented a number of management arrangements to ensure the ecological sustainability of this resource (see http://www.afma.gov.au/managing-our-fisheries/fisheries-a-to-z-index/northern-prawn-fishery). The Northern Prawn Fishery Management Plan was implemented in 1995 and establishes strict mechanisms for managing effort levels by restricting the number of trawlers that may operate and the amount of gear used in the fishery. Further measures such as byproduct limits, turtle excluder device (TED) and bycatch reduction device (BRD) requirements are implemented via direction underneath the Management Plan.

In 1998, the first NPF Bycatch Action Plan (BAP) was developed by the Northern Prawn Fishery Management Advisory Committee (NORMAC) and AFMA in response to the implementation of the Commonwealth Policy on Fisheries Bycatch for all Australian fisheries (AFMA 2011). The core objectives of the NPF BAP were to reduce overall bycatch, improve the protection of vulnerable species and determine acceptable levels of ecological impacts on bycatch. This is achieved by the NPF through data collection on bycatch and developing, monitoring and reviewing mitigation and management measures to incorporate further bycatch reduction strategies (DAFF, 2000).

The Northern Prawn Fishery Harvest Strategy (Jarrett and Dichmont, 2007) was developed by AFMA in conjunction with CSIRO to set out management actions necessary to achieve sustainable and profitable utilisation of the fishery resource by maintaining key commercial stocks at ecologically sustainable levels and maximising the economic returns to the Australian community. The NPF Harvest Strategy also contains a process for monitoring and conducting assessments on the status of the fishery, including both target and some bycatch species (Dichmont and Jarrett, 2012).

AFMA also developed the Northern Prawn Fishery Bycatch and Discarding Workplan January 2012 – January 2014 (AFMA, 2011) to provide guidelines and regulations for (a) responding to high ecological risks assessed through AFMA's Ecological Risk Assessment for the Effect of Fishing (ERAEF) and other assessment processes; (b) avoiding interactions with species listed under the *Environment Protection and Biodiversity Conservation (EPBC) Act 1999* (EPBC Act); (c) reducing discarding of target species to as close to zero as practically possible; and (d) minimising overall bycatch in the fishery over the long-term.

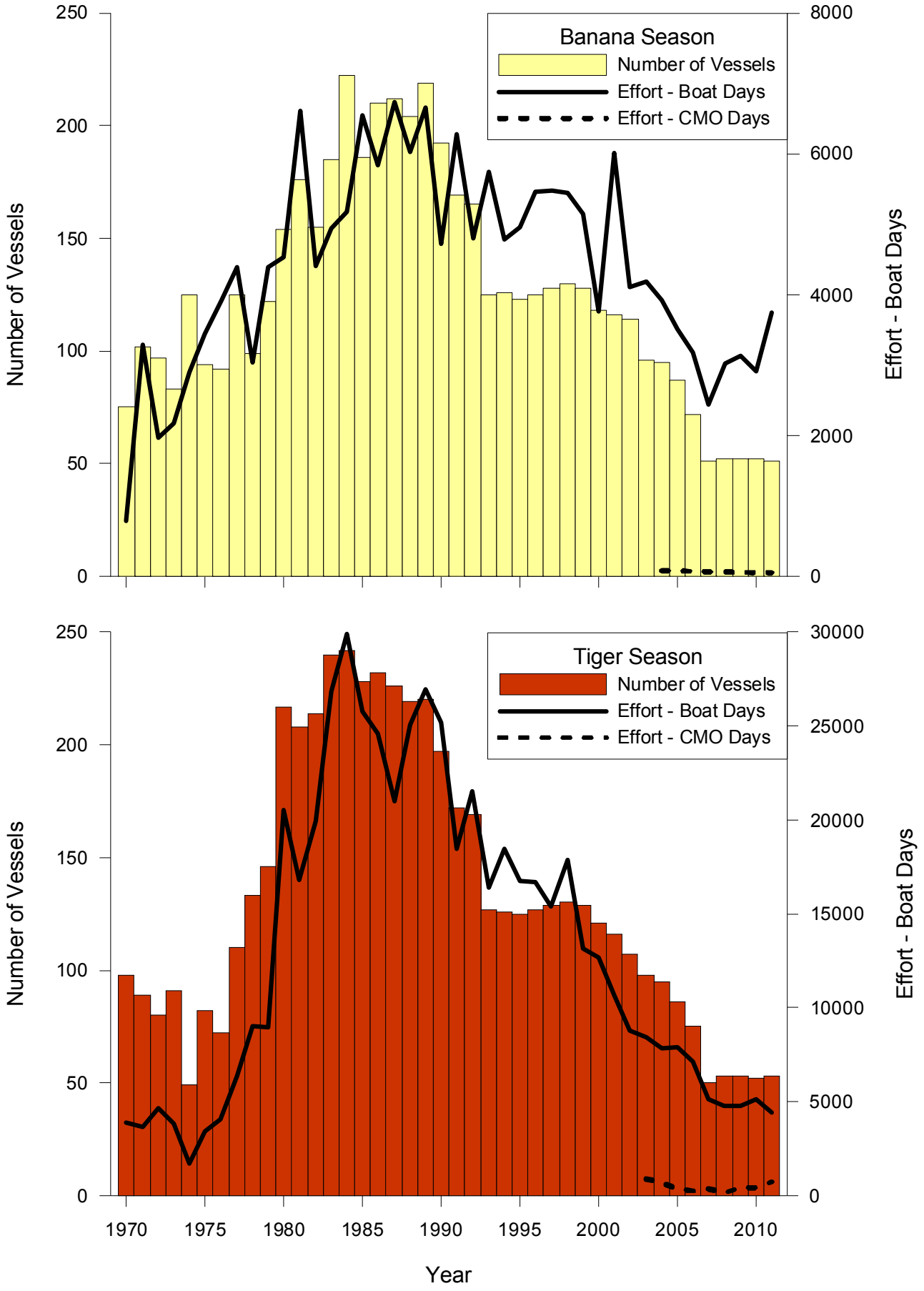

Figure 18.1 The number of vessels and total boat days for the banana and tiger prawn seasons between 1970 and 2011. The number of boat days where Crew Member Observers (CMO) were collecting bycatch data on-board are also included.

The Ecological Risk Assessment (ERA) process first undertaken by AFMA was developed to identify specific species (target, byproduct, bycatch, and threatened, endangered and protected (TEP)), habitats and communities potentially at risk to the impacts of trawling. It also helped in prioritising research, data collection, monitoring needs and management actions for fisheries to ensure they are managed both sustainably and efficiently (Griffiths *et al.,* 2007). Initially the Level 1 analysis (SICA – Scale Intensity Consequence Analysis) assessed 9 target species, 135 byproduct species, 516 chondrichthyan and teleost bycatch species, 128 TEP species, 157 habitats and 3 communities. Following this, a Level 2 analysis (PSA – Productivity Susceptibility Analysis) was undertaken on 272 marine reptile, elasmobranch, teleost and invertebrate species occurring in the NPF and resulted in a total of 28 species being assessed as 'at high risk' (25 in the Tiger Prawn fishery and 27 in the Banana Prawn fishery) (Griffiths *et al.,* 2007). Due to management measures currently implemented in the NPF, a Level 2 Residual Risk Assessment was undertaken on these 28 'at high risk' species, further reducing the list to 26 species – 14 bycatch or byproduct, five sawfish and seven seasnake species (AFMA, 2011). These species, if not already being recorded, were included within the monitoring programs of the NPF.

CSIRO then undertook a number of higher level ERA's – Level 2.5 ERA and Sustainability Assessment for Fishing Effects (SAFE) – on all bycatch species occurring in the NPF (Brewer *et al.,* 2007; Griffiths *et al.,* 2006; Griffiths *et al.,* 2007; Milton *et al.,* 2008; Zhou and Griffiths, 2008; Zhou *et al.,* 2009; Zhou, 2011). These assessments removed all but three invertebrate, two teleost and one elasmobranch species from the 'at high risk' category. These species are currently regarded as priority species for the NPF and requiring management attention (AFMA 2011). Regardless of the ERA outcomes for any EPBC listed TEP species, NPF vessel operators are also required to record all interactions with TEP species in logbooks during trawling activities.

18.4 Bycatch Reduction Measures

Over the last two decades, industry and research organisations have invested a considerable amount of effort and funds into bycatch reduction within the NPF. This included establishing a bycatch subcommittee to provide specialist advice on the development of strategies to reduce bycatch in the NPF. The NPF industry has also been proactive in working closely with Government and researchers to design and trial fishing gears and undertake monitoring programs to improve bycatch reduction and monitor catch rates of bycatch to meet their legislative requirements and to ensure an environmentally sustainable fishery (Burke *et al.,* 2012).

Since the mid-1980's, there have been a number of voluntary licence buy-backs (1985 and 1990) and compulsory gear unit reduction (1993, 1999, 2002, 2005 and 2006) schemes which have resulted in a significant decrease in overall fishing effort and spatial distribution of fishing effort (AFMA, 2011) (Figure 18.2, Figure 18.3, Figure 18.4). This has led to a reduction in the total annual catch of bycatch by the NPF. However a number of more direct operational changes have occurred in the fishery since 2000 that have had a significant impact on bycatch reduction. It was estimated that to date there has been at least a 50% reduction in total bycatch volume caught by the NPF since the implementation of the first Bycatch Action Plan in 1998 due a combination of voluntary licence buy-backs, compulsory gear unit reduction schemes and the introduction of bycatch reduction devices (AFMA 2011).

Turtle Excluder Devices became mandatory in the NPF in 2000 and have led to significant reductions in catch of turtles and other large bycatch species (Figure 18.5 - Figure 18.7). Catches of turtles have been reduced by more than 97% since the introduction of TEDs (Brewer *et al.,* 2006). During the period prior to TEDs, catches were reported to be around 5000 - 6000 turtles per year with mortality rates of up to 39% (Poiner *et al.,* 1990; Poiner and Harris, 1996). In 2010, only 27 interactions were reported with no reported fatalities (Barwick 2011). Catches of other large animals such as sharks and rays and large sponges have also been reduced by up to 86%, 94% and 85% respectively (Brewer *et al.,* 2004). In one study, a reduction of up to 73% in catches of the most common sawfish species encountered in the NPF, the narrow sawfish (*Anoxypristis cuspidata*), was also reported due to the introduction of TEDs (Brewer *et al.,* 2004). However, the reduction in sawfish catches overall (Figure 18.6) and total small bycatch through the introduction of TEDs has been minimal, up to 8% (Brewer *et al.,* 2004).

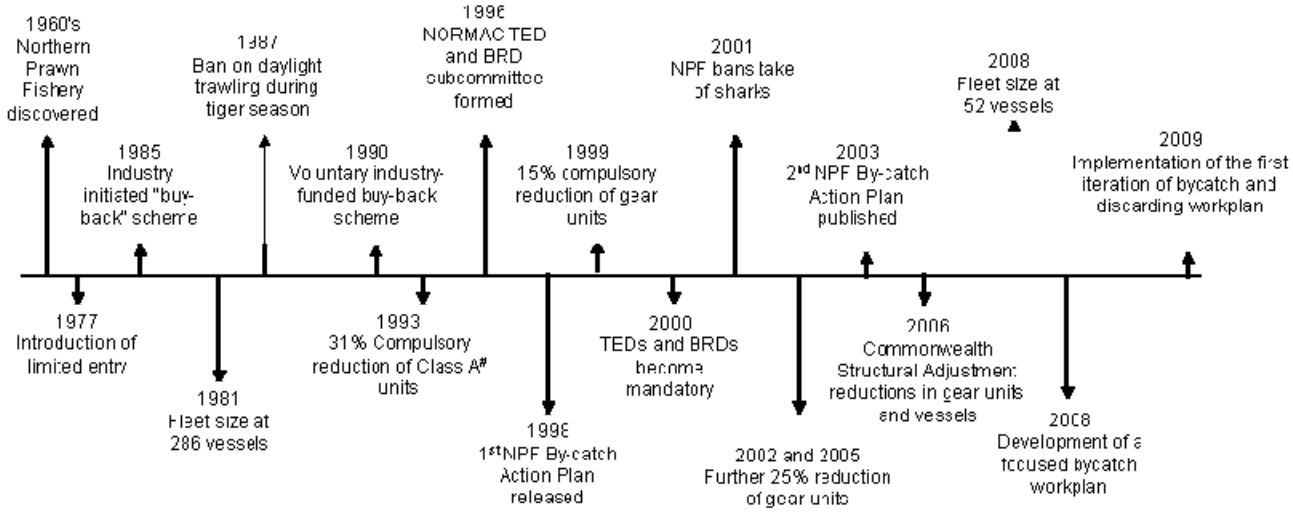

Figure 18.2 Time series of key management actions that have reduced bycatch in the NPF. Source: AFMA 2011. Bycatch and Discard Workplan 2011.

Bycatch Reduction Devices (BRDs) became compulsory in 2001 to reduce the catches of small teleost and invertebrate bycatch. Since its introduction in the fishery, a number of designs have been tested and met the minimum requirements for approval for current use in the NPF - the Square Mesh Codend, Square Mesh Panel, Radial Escape Section, Fisheye, Yarrow Fisheye, Popeye Fishbox, and modified Turtle Excluder Device (Burke *et al.,* 2012). Currently most operators in the NPF are using either the Square Mesh Panel (90% of operators) or the Fisheye (10% of operators) (Burke *et al.,* 2012). However, the reduction in total small bycatch by BRDs has been minimal and variable, dependent on both the type of BRD used and its position within the net (Brewer *et al.,* 2006; Burke *et al.,* 2012). Despite reported reduction rates of up to 40% in small bycatch in scientific trials using the Square Mesh Panel (Brewer *et al.,* 1998), this BRD has been shown to reduce bycatch by only 8% under commercial at-sea trials in the NPF (Brewer *et al.,* 2004). Brewer *et al.* (1998) also reported a reduction of up to 50% in seasnake catches in 1995 trials with

the Square Mesh Panel BRD. However, further trials conducted in 2001 reported only a reduction of about 5% due to the Square Mesh Panel being positioned closer to the TED (Brewer *et al.,* 2006; Milton *et al.,* 2008).

18.5 Bycatch Data Collection

The bycatch of the NPF can be composed of at least 5 marine turtle species, 15 sea snake species, 56 elasmobranch species, 450 teleost species and 230 invertebrate species (Stobutzki *et al.,* 2000; Fry *et al.,* 2009). Prior to and during the implementation of TEDs and BRDs into the NPF, CSIRO Marine and Atmospheric Research has undertaken a number of fishery-independent scientific surveys to collect detailed data on bycatch across a broad area within the NPF. These datasets include species compositions and length frequencies for all reptile, elasmobranch, teleost and invertebrate bycatch caught. However, since the mid-2000's, there has been no further detailed catch composition data collected for bycatch in the NPF.

As part of its obligation under the Harvest Strategy and Bycatch and Discard Workplan, AFMA and the NPF industry have developed a number of monitoring programs within the fishery to record interactions with target, byproduct, TEP and bycatch (Table 18.1). These include NPF logbook records, the Crew Member Observer program, the Scientific Observer program and CSIRO Scientific Surveys. Each vessel operating in the NPF is required to fill out daily logbooks that record catch and effort data for all commercial prawns and byproduct retained and all interactions with TEP species. However, these data do not assign individual species to most of the TEP and bycatch groups (Table 18.2).

Since 2002, NPF Industry, AFMA and CSIRO have been involved in a co-operative pre-season monitoring program aimed at obtaining long-term catch data for the NPF. The main focus of this fishery-independent program was on obtaining recruit and broodstock indices for the target prawn species but also included recording all TEP and 'at high risk' bycatch species (Kenyon *et al.,* 2011). In the following year, the Bycatch Monitoring Program (BMP) was initiated to develop a cost-effective and scientifically acceptable method to assess the sustainability of the diverse and abundant bycatch of the NPF (Brewer *et al.,* 2007).

The outcome of this project recommended the implementation of a long-term bycatch monitoring program for the NPF with involvement of Crew Member Observers, AFMA Scientific Observers and the pre-season fishery-independent monitoring program. This work also provided management with recommendations on minimum levels of monitoring needed by each monitoring program to detect changes in the bycatch (Brewer *et al*., 2007). The Crew Member Observer (CMO) program recruits a number of NPF crew to attend annual workshops where they are trained in the identification of TEP and 'at risk' bycatch species and in the collection of trawl shot and catch data. Each of the CMO's would record and photograph all TEP and 'at high risk' bycatch species in each shot during the season and record bycatch volume estimates for each shot during two nights a week throughout the season (Fry *et al.,* 2009). The data would then be sent to NPF Industry where it is collated and handed to CSIRO for verification of species. In addition, AFMA-employed scientific observers have been collecting some bycatch data since 2005 including interactions with TEP species, bycatch volume estimates and bycatch species compositions from a number

of shots over the fishing season. The AFMA observer data are used as an additional data source as well as a means of verifying the accuracy of the CMO collected data.

These monitoring programs have provided valuable and scientifically robust catch and effort data for marine turtles, sea snakes, sawfish, syngnathids and the current bycatch priority listed species assessed as 'at high risk' (Table 18.2). The data collected by these monitoring programs are also validated by CSIRO scientific staff for reliability in recording and accuracy in species identifications (Fry *et al*., 2009). These data are being used to undertake catch trend analysis on each of the TEP and 'at high risk' bycatch species in the NPF to determine their sustainability in the NPF. A bycatch sustainability assessment report is produced on a triennial cycle for AFMA and the NPF Industry (See Fry *et al.* (2009)).

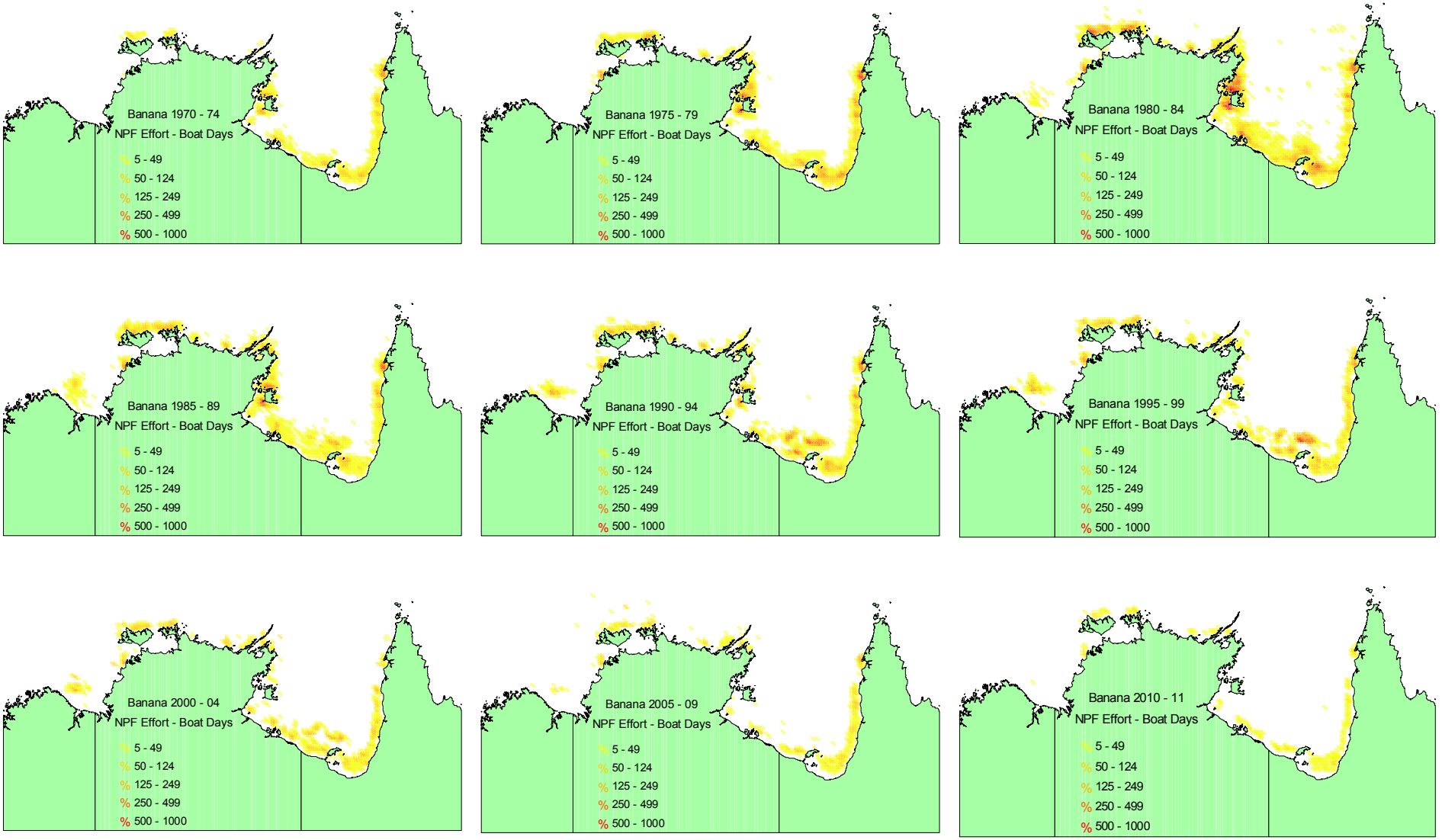

Figure 18.3 Spatial distribution of NPF trawl effort (boat days fished within a 6 nautical mile grid) for the banana season from 1970 to 2011. Data grouped to 5-year increments, except for the 2010-11 plot.

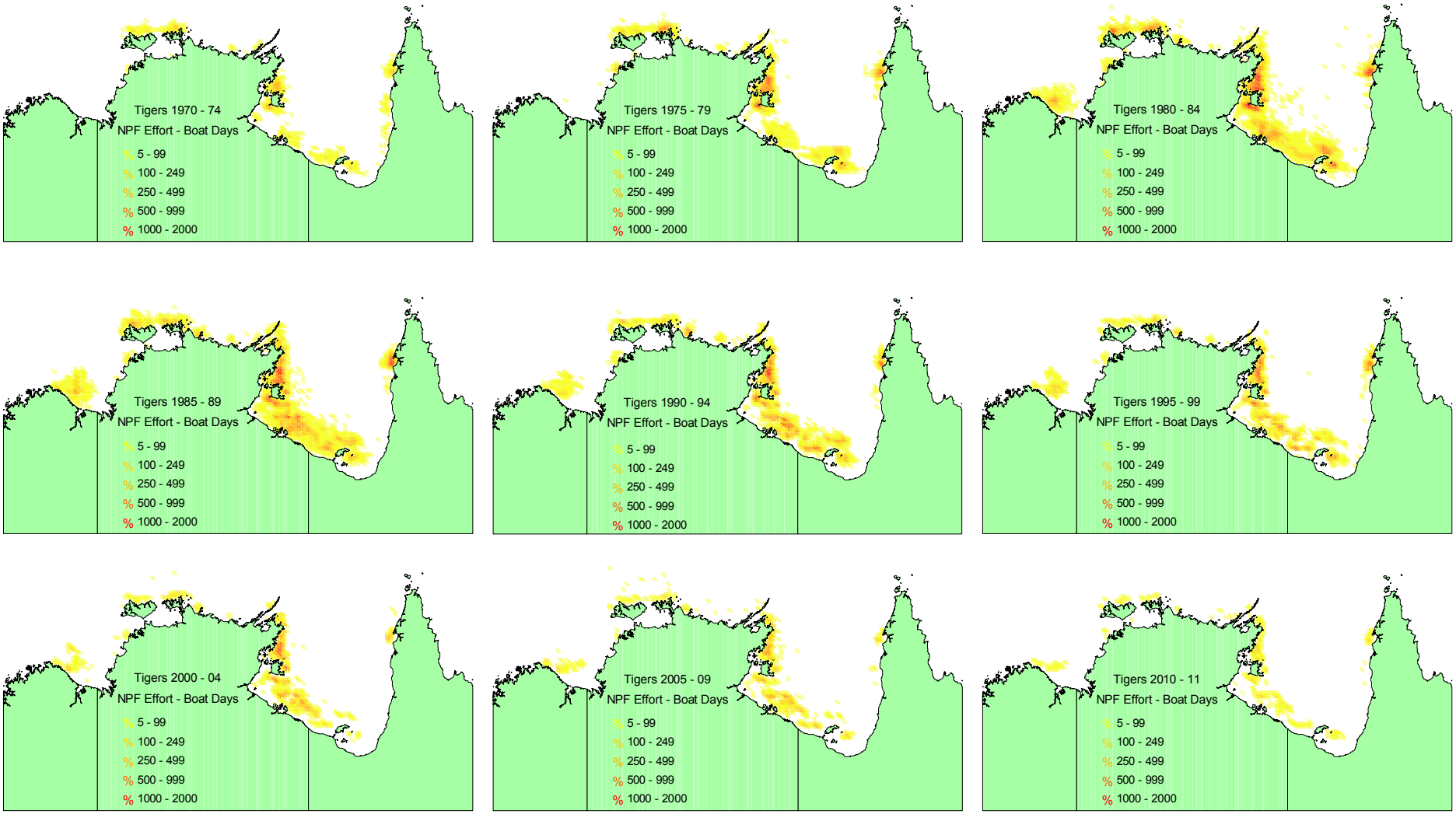

Figure 18.4 Spatial distribution of NPF trawl effort (boat days fished within a 6 nautical mile grid) for the tiger season from 1970 to 2011. Data grouped to 5-year increments, except for the 2010-11 plot.

Table 18.1 Monitoring programs working within the NPF and the year monitoring commenced.

Bycatch Group	NPF Vessel Logbook	Crew Member Observer	AFMA Scientific Observer	CSIRO Scientific Survey
Marine Turtles	1998	2003	2005/07/08	2002
Sea Snakes	2003*	2003	2005/07/08	2002
Syngnathids	2003*	2006	2005/07/08	2002
Sawfish	2007*	2003	2005/07/08	2002
Other TEPs (Birds, Dolphins)	1998	2003	2005/07/08	2002
ERA 'at high risk' species	No	2007	2005/07/08	2007
Bycatch Estimates	No	2003	2005/07/08	2002
Bycatch Composition	No	No	2005/07/08	No

* Count only, no species data available Source: AFMA 2011. Bycatch and Discard Workplan 2011

Table 18.2 Number of trawls and catch in numbers of TEP and 'at high risk' bycatch species recorded from NPF commercial logbooks and current NPF Monitoring Programs (CMO – Crew Member Observer; AFMA SO – AFMA Scientific Observer; NPF Monitoring – CSIRO Pre-season Prawn Monitoring Surveys). The CMO and AFMA Monitoring Programs are a sub-set of the NPF Logbook Program. The NPF Pre-season Prawn Monitoring Survey Program is independent of the NPF Logbook Program. '-' denotes where data was not available. Some monitoring programs only recorded to Group level (see Table 18.1).

DATASET	Group	Species	Common Name	1998	1999	2000	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
NPF Logbook		Number of Trawls		*17868*	*13159*	*12654*	*8764*	*8439*	*7863*	*7910*	*7125*	*5140*	*4752*	*4749*	*5103*	*4393*	-
NPF Logbook	Sawfish	Pristidae	Sawfish	-	-	-	-	-	-	-	-	153	314	311	286	302	-
NPF Logbook	Sawfish	Pristis zijsron	Green Sawfish	-	-	-	-	-	-	-	-	21	10	82	46	69	-
NPF Logbook	Sawfish	Anoxypristis cuspidata	Narrow Sawfish	-	-	-	-	-	-	-	-	135	134	16	42	100	-
NPF Logbook	Sawfish	Pristis microdon	Freshwater Sawfish	-	-	-	-	-	-	-	-	2	0	0	5	0	-
NPF Logbook	Sawfish	Pristis clavata	Dwarf Sawfish	-	-	-	-	-	-	-	-	1	0	0	2	0	-
NPF Logbook	Syngnathids	Syngnathidae	Pipefishes	-	-	-	-	26	-	-	42	1747	38	8	18	6	-
NPF Logbook	Sailfish	Istiophorus platypterus	Sailfish	0	0	0	-	0	-	0	0	1	0	0	0	0	-
NPF Logbook	Marine Turtle	Testudines	Turtle	113	110	8	-	5	-	0	10	31	12	36	4	7	-
NPF Logbook	Marine Turtle	Caretta caretta	Loggerhead Turtle	54	58	6	-	0	-	2	2	1	2	0	0	7	-
NPF Logbook	Marine Turtle	Chelonia mydas	Green Turtle	168	150	17	-	10	-	18	10	7	0	7	11	27	-
NPF Logbook	Marine Turtle	Eretmochelys imbricata	Hawksbill Turtle	41	25	2	-	0	-	1	6	0	2	1	0	0	-
NPF Logbook	Marine Turtle	Lepidochelys olivacea	Pacific Ridley Turtle	315	262	23	-	3	-	3	5	6	3	1	6	8	-
NPF Logbook	Marine Turtle	Natator depressus	Flatback Turtle	350	275	11	-	9	-	5	12	10	8	2	6	4	-
NPF Logbook	Marine Turtle	Dermochelyidae	Turtle	0	0	0	-	0	-	0	0	0	6	0	0	0	-
NPF Logbook	Marine Turtle	Dermochelys coriacea	Leathery Turtle	19	3	1	-	0	-	0	0	0	0	0	0	0	-
NPF Logbook	Sea Snake	Hydrophiidae	Sea Snake	-	-	-	-	7775	-	-	9589	7581	5978	7348	7490	5363	-
NPF Logbook	Marine Bird	Diomedeidae	Albatrosses	0	0	0	-	0	-	0	10	0	0	0	0	0	-
NPF Logbook	Marine Bird	Sterna nilotica	Gull-billed Tern	0	0	0	-	0	-	0	5	0	0	0	0	0	-
NPF Logbook	Marine Bird	Sterna spp.	Terns	0	0	0	-	0	-	0	0	0	1	0	0	0	-
NPF Logbook	Dolphin	Delphinidae	Dolphins	0	0	0	-	0	-	0	1	1	0	1	0	0	-
NPF Logbook	Marine Seal	Arctocephalus gazella	Antarctic Fur-seal	0	0	0	-	0	-	0	0	0	0	0	0	1	-
CMO		Number of Trawls		-	-	-	-	*3478*	*2921*	*1329*	*911*	*1307*	*456*	*1351*	*1331*	*2402*	-
CMO	Sawfish	Pristidae	Sawfish	-	-	-	-	41	10	0	13	15	9	-	-	-	-
CMO	Sawfish	Pristis zijsron	Green Sawfish	-	-	-	-	1	1	0	0	0	0	-	-	-	-
CMO	Sawfish	Anoxypristis cuspidata	Narrow Sawfish	-	-	-	-	63	60	2	28	6	6	-	-	-	-
CMO	Sawfish	Pristis microdon	Freshwater Sawfish	-	-	-	-	0	1	0	0	0	0	-	-	-	-
CMO	Sawfish	Pristis clavata	Dwarf Sawfish	-	-	-	-	1	0	0	0	0	0	-	-	-	-
CMO	Syngnathids	Syngnathidae	Pipefishes	-	-	-	-	-	-	-	7	15	11	-	-	-	-
CMO	Syngnathids	Trachyrhamphus longirostris	Pipefishes	-	-	-	-	-	-	-	0	13	4	-	-	-	-
CMO	Marine Turtle	Cheloniidae	Turtle	-	-	-	-	6	0	0	5	9	1	-	-	-	-
CMO	Marine Turtle	Caretta caretta	Loggerhead Turtle	-	-	-	-	1	1	0	0	1	0	-	-	-	-

CMO	Marine Turtle	Chelonia mydas	Green Turtle	-	-	-	-	0	1	0	0	1	0	-	-	-	-
CMO	Marine Turtle	Eretmochelys imbricata	Hawksbill Turtle	-	-	-	-	1	0	0	0	1	1	-	-	-	-
CMO	Marine Turtle	Lepidochelys olivacea	Pacific Ridley Turtle	-	-	-	-	1	2	0	0	1	1	-	-	-	-
CMO	Marine Turtle	Natator depressus	Flatback Turtle	-	-	-	-	1	4	0	2	2	2	-	-	-	-
CMO	Sea Snake	Hydrophiidae	Sea Snake	-	-	-	-	812	400	136	87	219	65	-	-	-	-
CMO	Sea Snake	Acalyptophis peronii	Sea Snake	-	-	-	-	40	12	3	5	11	0	-	-	-	-
CMO	Sea Snake	Aipysurus duboisii	Sea Snake	-	-	-	-	0	0	5	2	15	0	-	-	-	-
CMO	Sea Snake	Aipysurus eydouxii	Sea Snake	-	-	-	-	71	70	36	7	17	2	-	-	-	-
CMO	Sea Snake	Aipysurus laevis	Sea Snake	-	-	-	-	126	53	40	35	25	1	-	-	-	-
CMO	Sea Snake	Astrotia stokesii	Sea Snake	-	-	-	-	141	89	73	23	34	0	-	-	-	-
CMO	Sea Snake	Disteira kingii	Sea Snake	-	-	-	-	7	2	2	0	0	0	-	-	-	-
CMO	Sea Snake	Disteira major	Sea Snake	-	-	-	-	326	152	98	36	38	2	-	-	-	-
CMO	Sea Snake	Hydrophis elegans	Sea Snake	-	-	-	-	334	345	175	133	93	14	-	-	-	-
CMO	Sea Snake	Hydrophis mcdowelli	Sea Snake	-	-	-	-	2	4	3	0	0	0	-	-	-	-
CMO	Sea Snake	Hydrophis ornatus	Sea Snake	-	-	-	-	67	38	29	13	14	3	-	-	-	-
CMO	Sea Snake	Hydrophis pacificus	Sea Snake	-	-	-	-	52	41	18	5	4	0	-	-	-	-
CMO	Sea Snake	Lapemis hardwickii	Sea Snake	-	-	-	-	205	154	32	32	18	6	-	-	-	-
CMO	Sea Snake	Pelamis platurus	Sea Snake	-	-	-	-	0	0	1	0	0	0	-	-	-	-
AFMA SO		Number of Trawls		-	-	-	-	-	-	*140*	-	*501*	*160*	-	-	-	-
AFMA SO	Sawfish	Pristidae	Sawfish	-	-	-	-	-	-	1	-	2	0	-	-	-	-
AFMA SO	Sawfish	Anoxypristis cuspidata	Narrow Sawfish	-	-	-	-	-	-	6	-	5	32	-	-	-	-
AFMA SO	Syngnathids	Syngnathidae	Pipefishes	-	-	-	-	-	-	0	-	3	1	-	-	-	-
AFMA SO	Syngnathids	Filicampus tigris	Pipefishes	-	-	-	-	-	-	0	-	2	0	-	-	-	-
AFMA SO	Marine Turtle	Chelonia mydas	Green Turtle	-	-	-	-	-	-	0	-	1	0	-	-	-	-
AFMA SO	Marine Turtle	Natator depressus	Flatback Turtle	-	-	-	-	-	-	1	-	1	3	-	-	-	-
AFMA SO	Sea Snake	Hydrophiidae	Sea Snake	-	-	-	-	-	-	0	-	12	0	-	-	-	-
AFMA SO	Sea Snake	Acalyptophis peronii	Sea Snake	-	-	-	-	-	-	4	-	11	0	-	-	-	-
AFMA SO	Sea Snake	Aipysurus duboisii	Sea Snake	-	-	-	-	-	-	0	-	1	0	-	-	-	-
AFMA SO	Sea Snake	Aipysurus eydouxii	Sea Snake	-	-	-	-	-	-	1	-	2	0	-	-	-	-
AFMA SO	Sea Snake	Aipysurus laevis	Sea Snake	-	-	-	-	-	-	13	-	6	0	-	-	-	-
AFMA SO	Sea Snake	Astrotia stokesii	Sea Snake	-	-	-	-	-	-	11	-	5	0	-	-	-	-
AFMA SO	Sea Snake	Disteira kingii	Sea Snake	-	-	-	-	-	-	0	-	1	0	-	-	-	-
AFMA SO	Sea Snake	Disteira major	Sea Snake	-	-	-	-	-	-	18	-	3	0	-	-	-	-
AFMA SO	Sea Snake	Hydrophis elegans	Sea Snake	-	-	-	-	-	-	34	-	107	13	-	-	-	-
AFMA SO	Sea Snake	Hydrophis ornatus	Sea Snake	-	-	-	-	-	-	2	-	8	0	-	-	-	-
AFMA SO	Sea Snake	Hydrophis pacificus	Sea Snake	-	-	-	-	-	-	3	-	1	0	-	-	-	-
AFMA SO	Sea Snake	Lapemis hardwickii	Sea Snake	-	-	-	-	-	-	31	-	19	25	-	-	-	-

NPF Monitoring		Number of Trawls		-	-	-	*169*	*843*	*815*	*516*	*511*	*517*	*509*	*514*	*303*	*516*	*501*
NPF Monitoring	Stomatopod	Dictyosquilla tuberculata	Squillidae	-	-	-	-	-	-	-	-	-	-	-	-	-	46
NPF Monitoring	Stomatopod	Harpiosquilla stephensoni	Squillidae	-	-	-	-	-	-	-	-	-	-	-	-	-	26
NPF Monitoring	Coral Prawn	Solenocera australiana	Solenoceridae	-	-	-	-	27	-	-	-	-	-	-	-	185	72
NPF Monitoring	Sawfish	Pristis zijsron	Green Sawfish	-	-	-	0	0	0	0	0	0	0	0	1	0	0
NPF Monitoring	Sawfish	Anoxypristis cuspidata	Narrow Sawfish	-	-	-	3	20	6	3	3	2	7	9	2	10	8
NPF Monitoring	Sawfish	Pristis microdon	Freshwater Sawfish	-	-	-	0	0	1	0	0	0	1	0	0	0	0
NPF Monitoring	Sawfish	Pristis clavata	Dwarf Sawfish	-	-	-	0	0	0	1	0	0	0	0	0	0	0
NPF Monitoring	Syngnathids	Syngnathidae	Pipefishes	-	-	-	1	0	2	0	0	3	11	3	6	2	4
NPF Monitoring	Syngnathids	Filicampus tigris	Pipefishes	-	-	-	0	1	0	0	0	0	0	0	0	0	0
NPF Monitoring	Syngnathids	Trachyrhamphus longirostris	Pipefishes	-	-	-	0	0	0	0	0	1	6	9	12	2	16
NPF Monitoring	Syngnathids	Hippocampus queenslandicus	Pipefishes	-	-	-	0	1	0	0	0	0	0	0	0	0	0
NPF Monitoring	Marine Turtle	Cheloniidae	Turtle	-	-	-	0	0	1	0	0	2	3	0	0	1	1
NPF Monitoring	Marine Turtle	Caretta caretta	Loggerhead Turtle	-	-	-	0	0	0	0	0	0	0	0	0	1	0
NPF Monitoring	Marine Turtle	Chelonia mydas	Green Turtle	-	-	-	0	0	0	0	0	0	0	0	0	0	1
NPF Monitoring	Marine Turtle	Eretmochelys imbricata	Hawksbill Turtle	-	-	-	0	0	0	0	0	0	0	1	0	0	0
NPF Monitoring	Marine Turtle	Lepidochelys olivacea	Olive Ridley	-	-	-	0	0	0	0	0	1	0	0	0	0	0
NPF Monitoring	Marine Turtle	Natator depressus	Flatback Turtle	-	-	-	0	0	1	0	0	1	0	1	0	1	0
NPF Monitoring	Sea Snake	Hydrophiidae sp	Sea Snake	-	-	-	6	1	9	2	3	0	0	4	1	2	1
NPF Monitoring	Sea Snake	Acalyptophis peronii	Sea Snake	-	-	-	0	7	7	7	3	3	1	2	0	2	0
NPF Monitoring	Sea Snake	Aipysurus duboisii	Sea Snake	-	-	-	0	1	0	0	0	0	0	1	0	2	0
NPF Monitoring	Sea Snake	Aipysurus eydouxii	Sea Snake	-	-	-	2	5	3	2	4	2	2	4	3	2	1
NPF Monitoring	Sea Snake	Aipysurus laevis	Sea Snake	-	-	-	2	8	6	6	2	1	3	10	3	4	7
NPF Monitoring	Sea Snake	Astrotia stokesii	Sea Snake	-	-	-	0	9	8	1	1	3	5	3	5	5	2
NPF Monitoring	Sea Snake	Disteira kingii	Sea Snake	-	-	-	0	3	3	0	1	3	0	2	1	0	3
NPF Monitoring	Sea Snake	Disteira major	Sea Snake	-	-	-	4	16	12	4	4	4	9	12	3	4	7
NPF Monitoring	Sea Snake	Enhydrina schistosa	Sea Snake	-	-	-	0	1	0	0	0	0	1	2	0	0	0
NPF Monitoring	Sea Snake	Hydrophis caerulescens	Sea Snake	-	-	-	0	1	0	0	0	0	0	0	0	0	0
NPF Monitoring	Sea Snake	Hydrophis elegans	Sea Snake	-	-	-	12	63	36	30	26	39	30	47	36	31	30
NPF Monitoring	Sea Snake	Hydrophis mcdowelli	Sea Snake	-	-	-	0	0	0	0	0	0	0	0	0	0	1
NPF Monitoring	Sea Snake	Hydrophis ornatus	Sea Snake	-	-	-	1	4	5	2	2	2	2	4	0	5	1
NPF Monitoring	Sea Snake	Hydrophis pacificus	Sea Snake	-	-	-	0	3	6	4	2	5	6	7	2	9	11
NPF Monitoring	Sea Snake	Lapemis hardwickii	Sea Snake	-	-	-	1	91	60	51	50	57	54	64	72	46	45
NPF Monitoring	Sea Snake	Pelamis platurus	Sea Snake	-	-	-	0	1	0	0	0	1	2	0	0	0	0

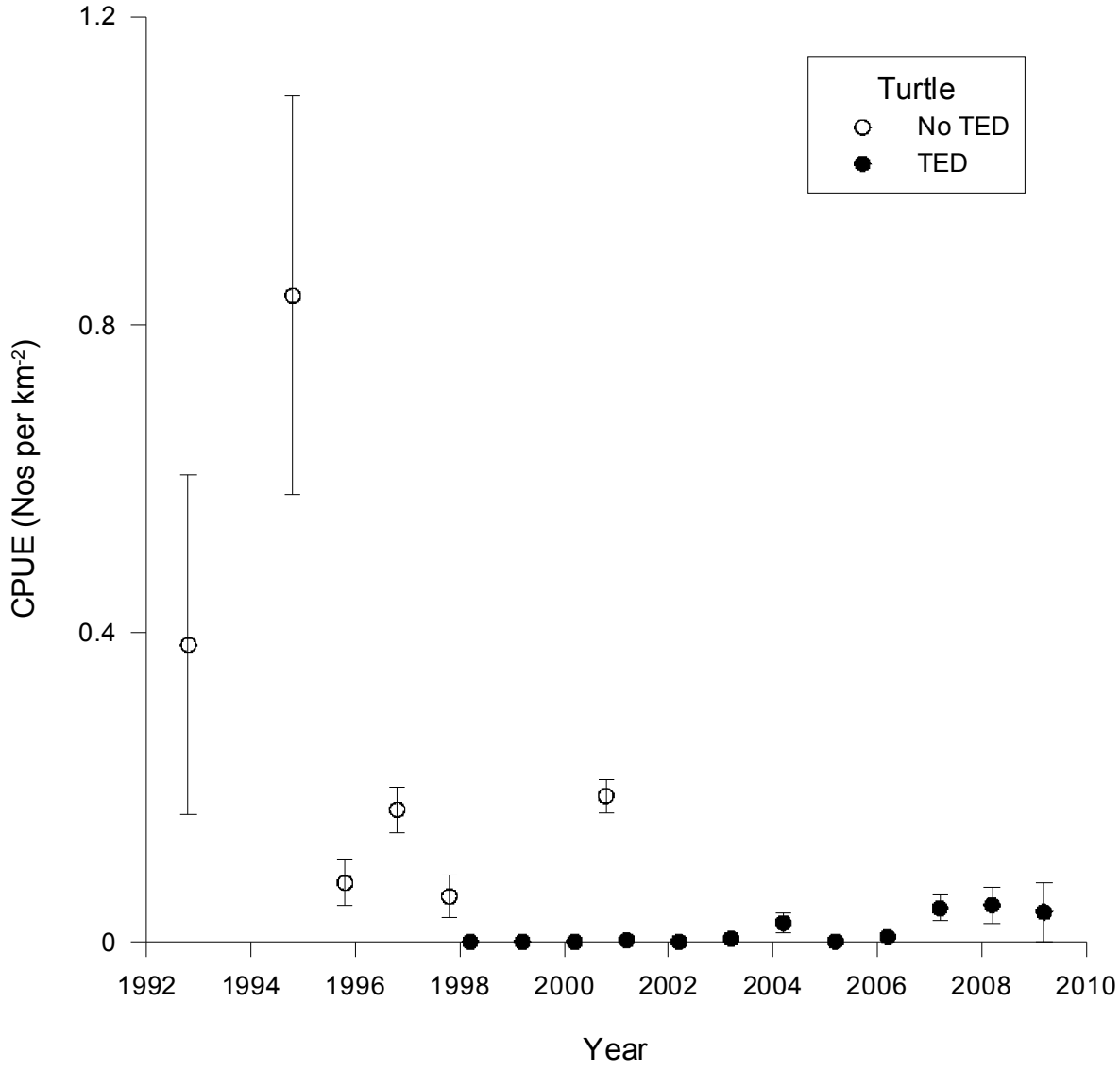

Figure 18.5 Plots of CPUE (numbers per km^{-2} trawled) for marine turtles in the NPF using NPF Logbook, Crew Member Observer, AFMA Scientific Observer, NPF Pre-season Prawn Monitoring and CSIRO Scientific Survey data. Catch data was standardised to Florida Flyer nets with and without TEDs for comparisons.

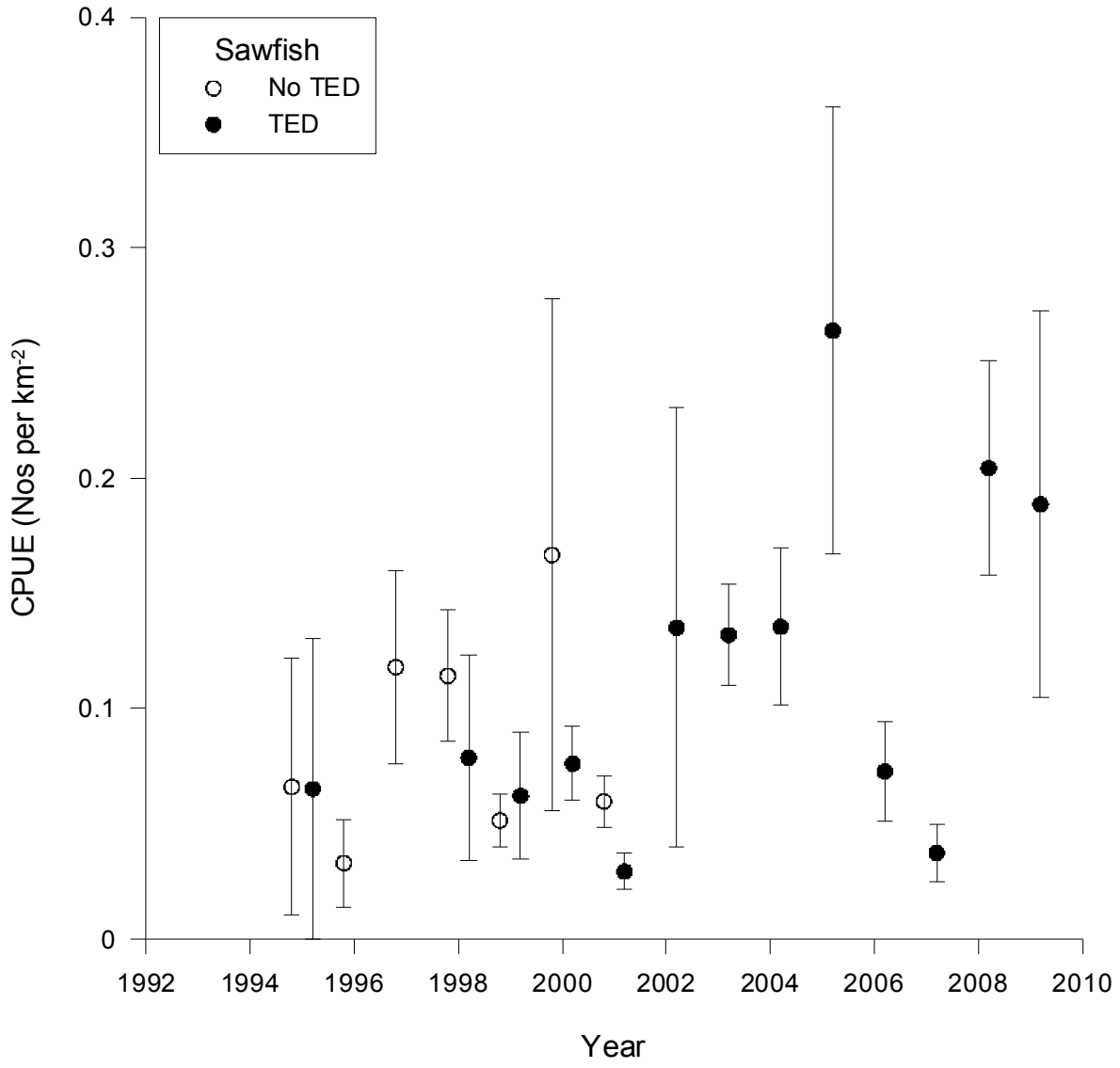

Figure 18.6 Plots of CPUE (numbers per km^{-2} trawled) for sawfish in the NPF using NPF Logbook, Crew Member Observer, AFMA Scientific Observer, NPF Pre-season Prawn Monitoring and CSIRO Scientific Survey data. Catch data was standardised to Florida Flyer nets with and without TEDs.

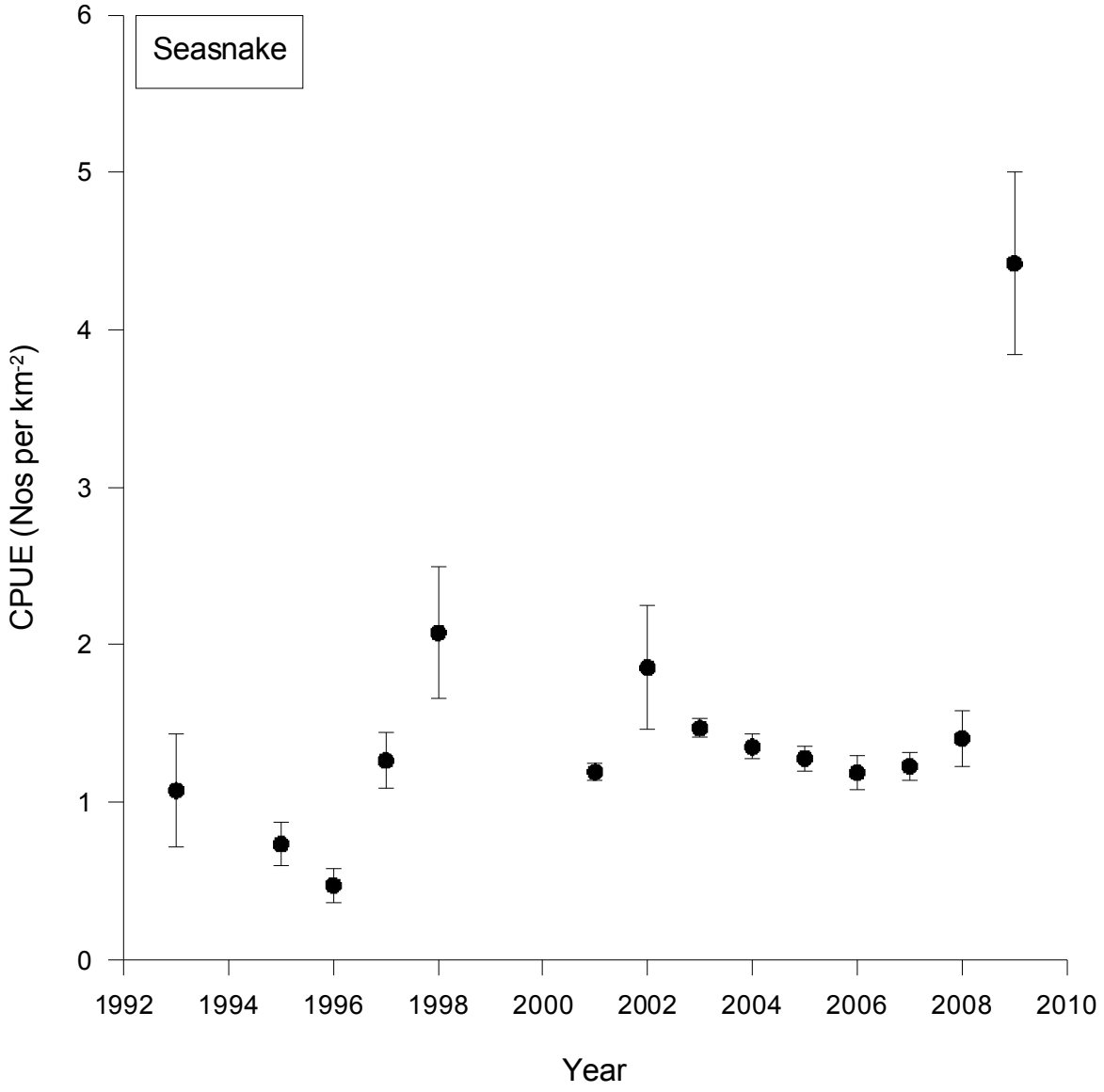

Figure 18.7 Plots of CPUE (numbers per km^{-2} trawled) for sea snakes in the NPF using NPF Logbook, Crew Member Observer, AFMA Scientific Observer, NPF Pre-season Prawn Monitoring and CSIRO Scientific Survey data. Catch data was standardised to Florida Flyer nets. Catches in nets with and without TEDs were not compared as TEDs have no significant effect on sea snake escapement. The high catch rate in 2009 was an effect of only one data source; the NPF Pre-season Prawn Monitoring dataset, being available for inclusion in this plot.

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19 APPENDIX 8: SMALL PELAGIC FISHERY

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19.1 Summary

The main species groups reported as SPF-associated bycatch comprise cephalopods, fishes, seabirds and marine mammals, particularly seals and dolphins. Very few bycatch fish species were discarded during observer trips between 2007-2010. Similarly, almost all reported bycatch fish species were retained during 2002-2011 based on Commonwealth logbook data.

A total of 37 interactions between seabirds and mid-water trawl gear and one using purse-seine gear were reported by on-board observers in 2002 and 2006 and during Commercial fishing operations in 2006. Commonwealth logbooks show no seabird interactions in the Jack Mackerel Fishery (JMF) in 2001-2002 or the SPF before 2006 and 2007-2011.

Of the 184 seal interactions with mid-water trawl gear reported during 2001-2010, 175 were incidentally caught during scientific projects aimed to determine the type and frequency of interactions and to assess the performance of various excluder devices as a means to mitigate seal and dolphin interactions. Most of the seals were believed to be Australian fur seals, with 145 reported as surviving the interaction. There have been no reported incidental interactions between fur seal and mid-water trawls since 2007. Also, no interactions between fur seal and purse-seines have been recorded in observer or Commonwealth logbook databases. These reports are based on observer coverage of <13% mid-water trawl shots (per annum) since 2007, and <15% purse-seine shots (per annum) since 2001.

A total of 25 dolphin mortalities (with mid-water trawls) were reported during 2001-2005. There have been no reported incidental interactions with dolphins since June 2005 following the introduction of bycatch management measures.

No interactions between TEP species and SPF mid-water trawl or purse-seine operations have been reported since the inception of the 2009 Management Plan. The lack of reported interactions coincides with a reduction in effort in the fishery, a decline in observer coverage as well as no mid-water trawl fishery catches in 2011, and the absence of observers in the purse-seine fishery except in 2010. However, management measures currently in place have been designed to minimise bycatch in mid-water trawl and purse-seine operations in the SPF.

19.2 Fishery Description

The Commonwealth managed Small Pelagic Fishery (SPF) covers waters between three and 200 nm extending from south-east Queensland around southern Australia and to latitude 31°S in Western Australia. The four target species are redbait (*Emmelichthys nitidus*), blue mackerel (*Scomber australasicus*), jack mackerels (*Trachurus novaezelandiae*, *T. declivis*, *T. symmetricus murphyi*) and Australian sardine (*Sardinops sagax*). The two species *T. murphyi* and *T. symmetricus* have

been described as one sub-species known as *T. symmetricus murphyi* since the 1990s (Taylor 1999). Prior to July 2008, the SPF was managed by four zones (A-D; Figure 19.1) before adopting a two-zone management approach (east and west of 146°30'00"; Figure 19.2). This was based on scientific advice that suggested the fishery be managed using two major stocks, reflecting natural delineations of most target species (Bulman *et al*. 2008).

This SPF was initially managed as the Jack Mackerel Fishery (JMF), with jack mackerel the primary target and harvested species. However, with the introduction of mid-water trawling in November 2002, the primary target species changed to redbait. Purse seining and mid-water trawling are the two fishing methods permitted to target SPF species to date.

The bycatch associated with the SPF comprises a small amount of non-target fish species, and any catch of a species that is subject to quotas in other Commonwealth fisheries (e.g. silver warehou) is required to be covered by quota from that fishery. Beside fish, there have also been a small number of reported interactions with threatened, endangered and protected species (TEPs) such as seals and dolphins during fishing operations.

AFMA set separate Total Allowable Catches (TACs) for each target species in the two zones (except Australian sardine which only applies to eastern zone). Since May 2012, the SPF has moved to a quota management system and SPF operators must cover any catches of the target species with quota.

19.2.1 Target and bycatch species catches in the SPF

Target species

The total number of shots recorded in Commonwealth logbooks for mid-water trawling and purse seining between 2002 and 2011 reached similar peaks in 2006 (191-298 shots) and decreased to 91 shots for purse seining and zero for mid-water trawling operations in 2011 (Figure 19.3). The drop in total catch and effort in the SPF for mid-water trawling and purse seining in 2010 and 2011 (Figure 19.3 and Figure 19.4) was likely caused by numerous factors. These include the loss of processing facilities in Eden (NSW) in late 2010, difficulty in finding fish aggregations off Triabunna (Tas.) and operators waiting for Statutory Fishing Rights to take effect from 1 May 2012 (AFMA, 2012).

Overall, 36,199 t of redbait and 9,964 t of jack mackerel were retained by commercial mid-water trawling operations during 2002-2010. Retained redbait catches peaked at 8,224 t in 2006 but decreased steadily thereafter reaching <76 t in 2010 (Figure 19.4). Catches of jack mackerel over the same period followed a similar pattern to that of redbait, peaking at 3,578 t in 2005 and gradually declining to <56 t in 2010. By comparison, retained catches of blue mackerel and Australian sardine over the same period were very small. Blue mackerel catches totalled 556 t and peaked in 2003, and sardines only 9 t.

In contrast to mid-water trawling, 9,003 t of blue mackerel and 8,083 t of Australian sardine were retained by commercial purse-seine operations during 2002-2010 (Figure 19.5). Retained catches of jack mackerel and redbait, on the other hand,

were low compared to those retained by mid-water trawling, i.e. 649 t and 88.7 t, respectively.

All catches of target species during 2002-2010 were retained by mid-water trawling operations. By contrast, very small catches of jack mackerel (111 t), blue mackerel (94 t) and Australian sardine (60 t) were discarded from purse-seine operations, accounting for 15%, 1% and <0.001% of the overall catch, respectively.

Bycatch species

A total of 780 t of non-target species were retained during 2002-2011 by mid-water trawl commercial operations, with no reported bycatch species discarded during the same period except for 0.2 t of tiger flathead (Figure 19.6). By contrast, bycatch species discarded during purse seining operations during 2002-2010 consisted of 30 t of redfish (2006), accounting for 12.1% of the overall catch during that period (Figure 19.7). No discards of bycatch species were reported from 2007.

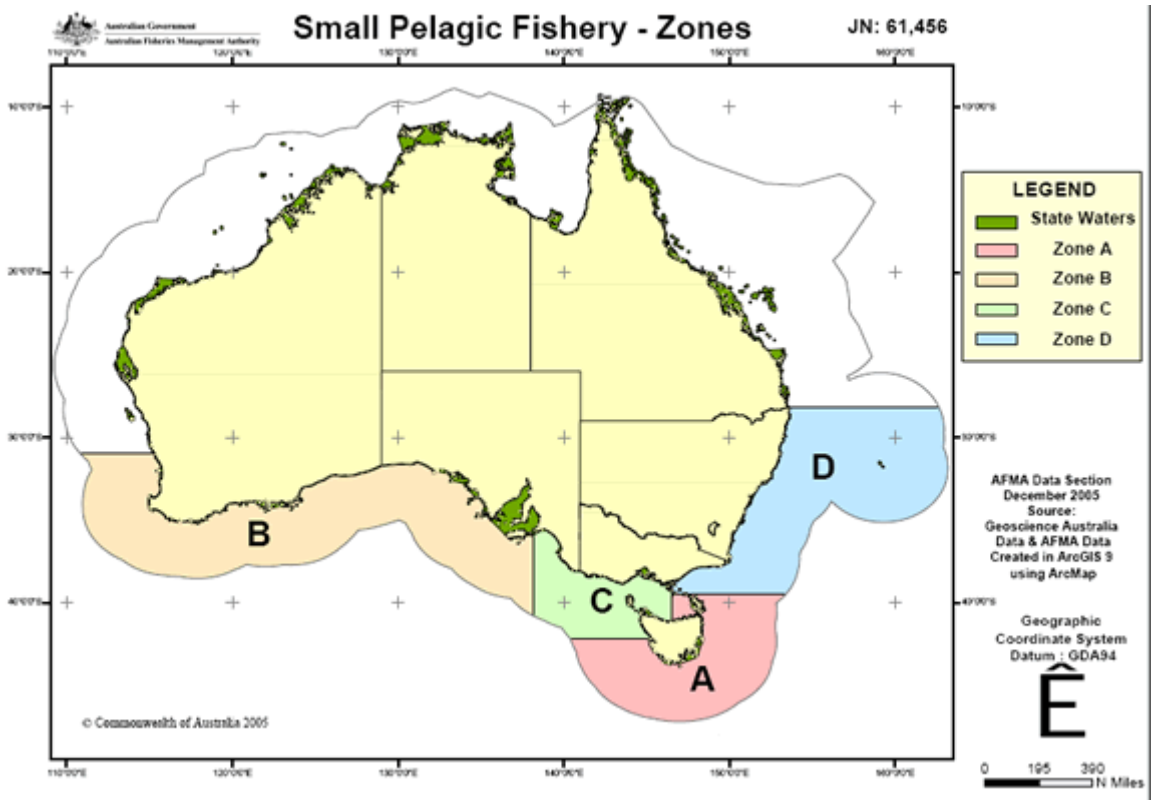

Figure 19.1 Management zones within the SPF during 2000-2008.

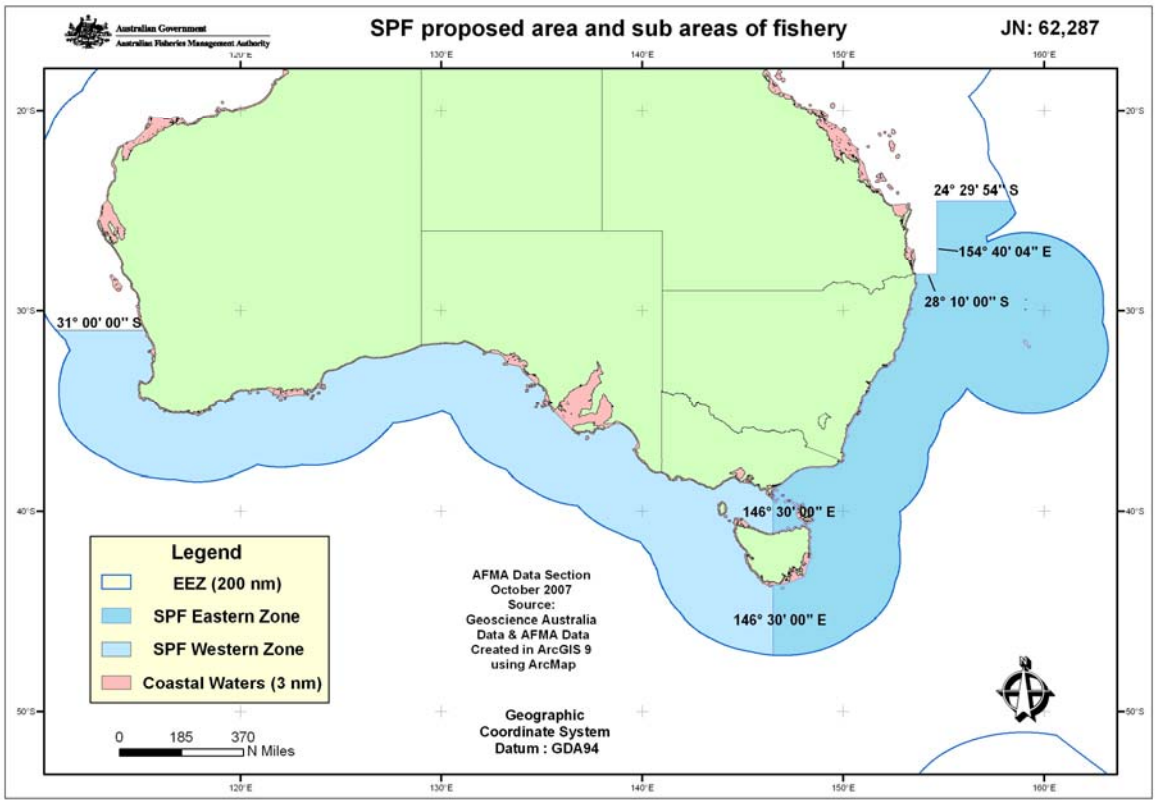

Figure 19.2 Eastern and western zones of the SPF implemented in July 2008 (AFMA, 2011).

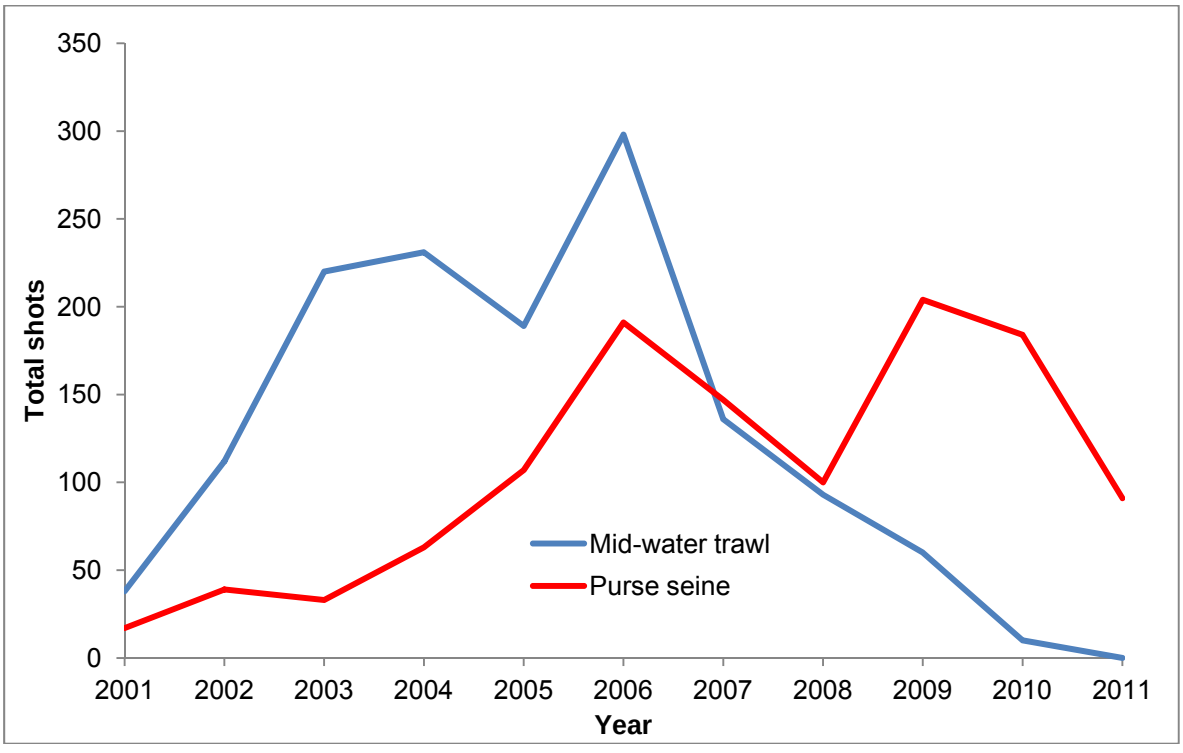

Figure 19.3 Total number of shots in SPF obtained from Commonwealth logbooks during 2002-2011 by gear type.

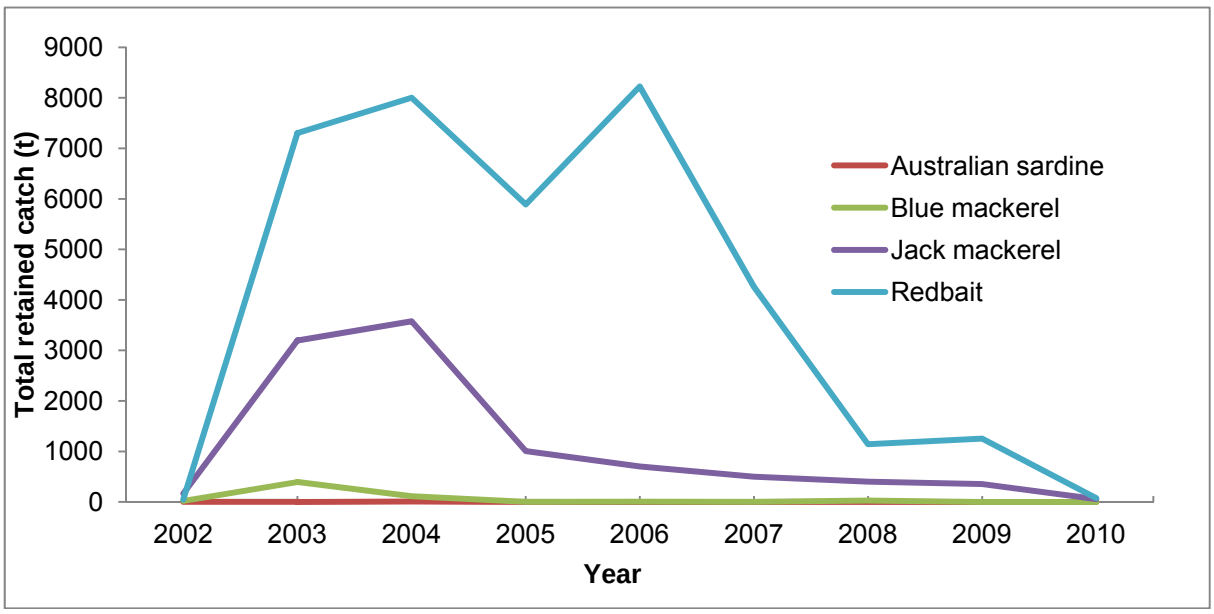

Figure 19.4 Total retained catch (t) of the four target SPF species during 2002-2010 based on mid-water trawl gear.

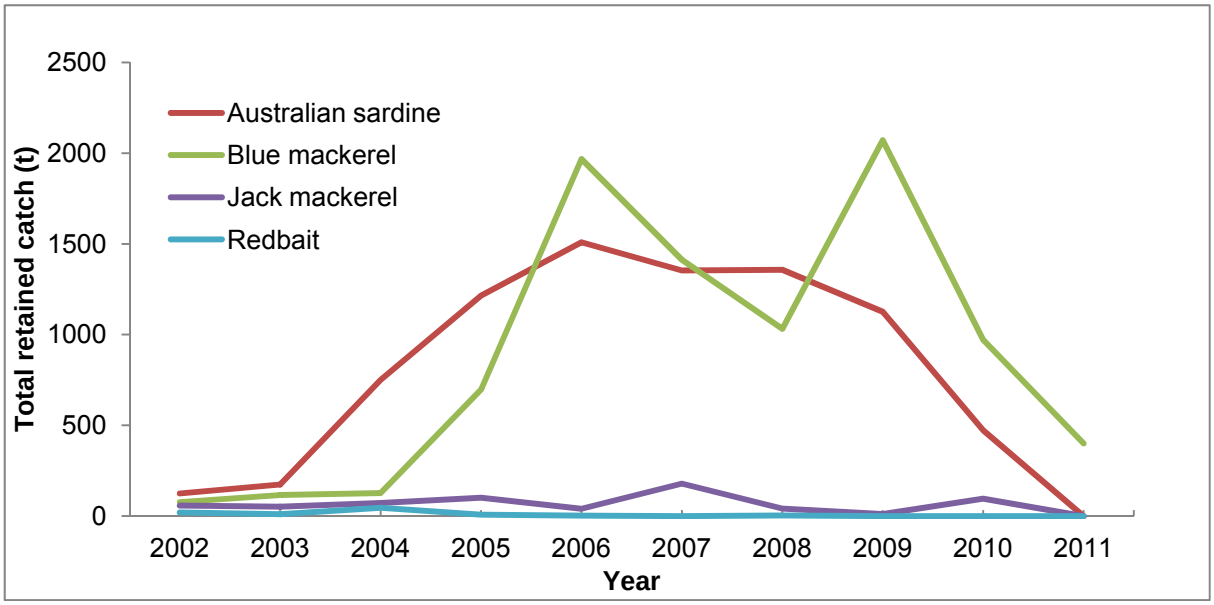

Figure 19.5 Total retained catch (t) of the four target SPF species during 2002-2011 based on purse-seine gear.

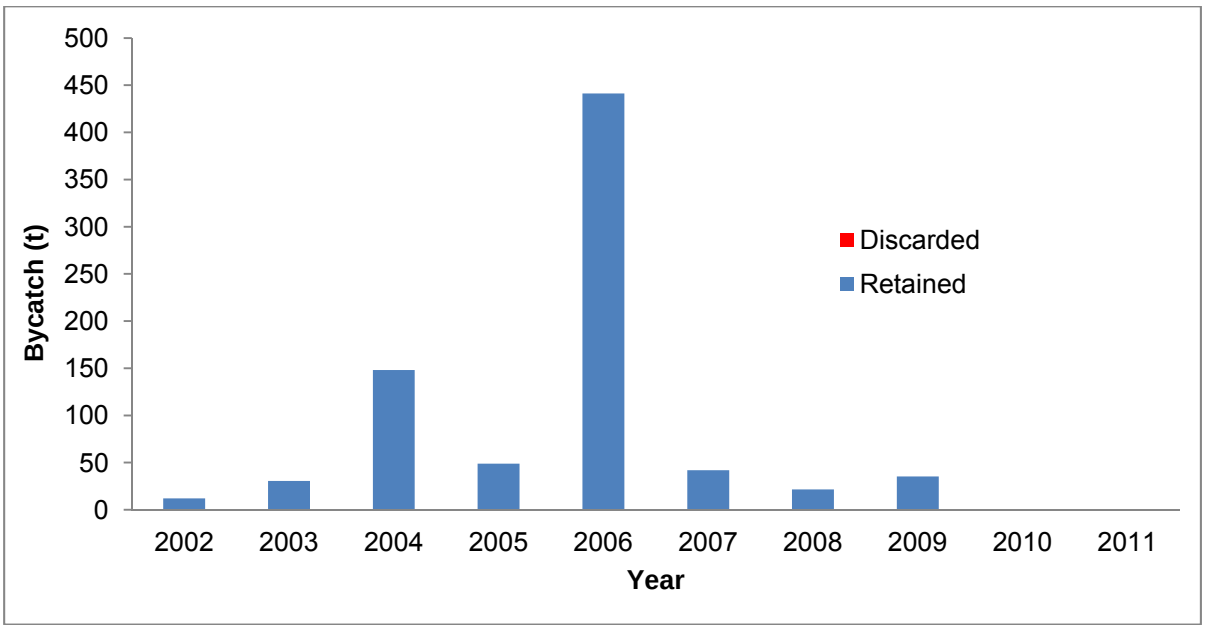

Figure 19.6 Total retained and discarded catch (t) of non-target SPF species during 2002-2011 based on mid-water trawl gear.

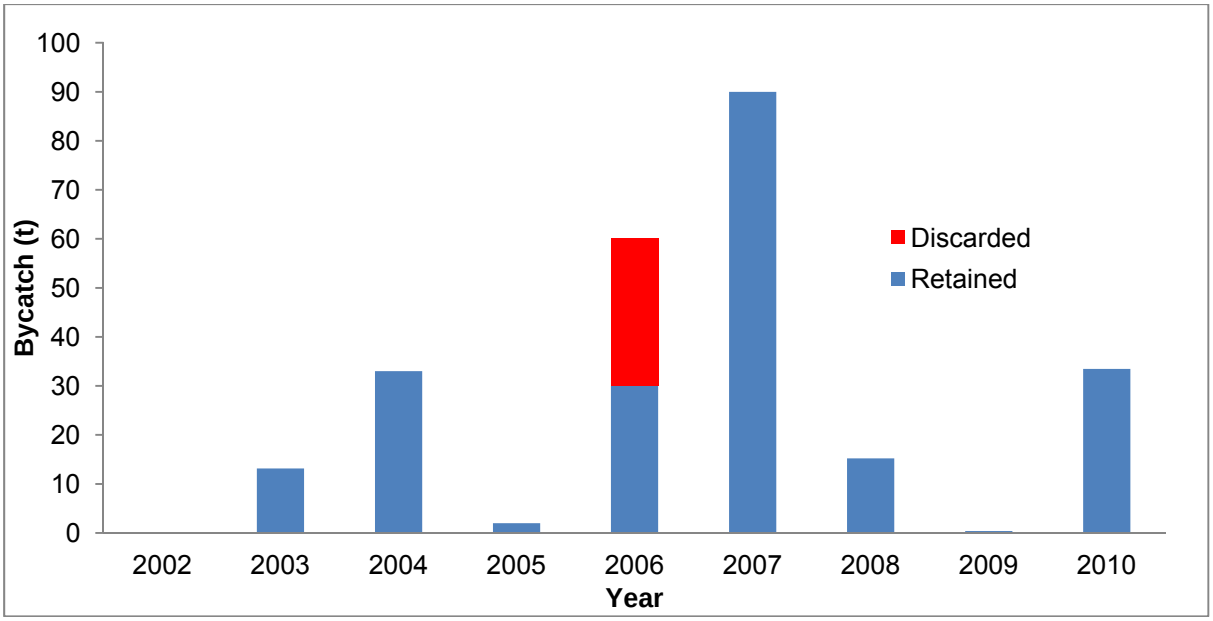

Figure 19.7 Total retained and discarded catch (t) of non-target SPF species during 2002-2011 based on purse-seine gear.

19.3 Bycatch Collection and Data Holdings

19.3.1 AFMA observer data

Since the early 2000's the collection of bycatch information has been conducted by (i) fishers reporting incidental catches of TEP species; (ii) AFMA observer trips; and (iii) scientific trials on Seal Excluder Devices (SEDs) in response to incidental catches of TEP species. Reported SPF-associated bycatch from observer trips since 2007 have been stored in the AFMA Observer database and held by AFMA. This

database also includes any interactions with TEP species other than fish, e.g. seabirds, seals and cetaceans. Observer records before 2007 are held by AFMA however have not been entered in a single database and data may not be complete.

19.3.2 Logbook data

The Commonwealth logbook data pertaining to the SPF is stored in one database and housed at AFMA; copies of this database are also stored at CSIRO (Hobart, Tas). The database contains information extracted from separate logbooks for the earlier JMF for the period 1996-2002 (i.e. TPB01, TPB02, GB03 and SEF1B) and the SPF since 2002 (e.g. EFT01, EFT01B, PS01, SWT01, SWT01A and TPB02). Data summaries provided in this review are based on extracts from the AFMA logbook database for the SPF from 2002 (Table 19.3A) and the JMF during 2001-02 inclusive (Table 19.3B).

19.4 Bycatch Management Measures

19.4.1 General

For the SPF, 'bycatch' refers to catch other than that of the four target species. It also refers to that part of the catch that does not reach the deck of the fishing vessel but is affected by interaction with fishing gear. Discard refers to catch (of either target species or bycatch) which is discarded because either it has low commercial value or because regulation precludes it from being retained (AFMA, 2011).

Species targeted by purse-seining and/or mid-water trawling in the SPF generally school into single, similar-sized species. Catch records support the view that there is minimal mixing between schools of SPF species. Consequently, bycatch of other fish species, including species managed under Commonwealth jurisdiction, is relatively low (AFMA, 2004). Bycatch and discard workplans implemented in 2009 and 2011 were primarily aimed at reducing the risk of interaction between SPF gear and TEP species (Table 19.1 and references therein).

19.4.2 Seabirds and marine mammals

Seabirds

Seabirds (e.g. black-browed albatross and shy albatross, shearwaters) present potential bycatch issues for the SPF as they have been observed during fishing operations. The risk of seabirds interacting with mid-water trawls resulting from the Level 2 Ecological Risk Assessment was found to be high (e.g. albatrosses), medium (e.g. albatrosses, petrels, shearwaters, prions) or low (e.g. gulls, terns) depending on species (Daley *et al*., 2007a). By contrast, the risk of all seabirds interacting with purse-seine gear was high (Daley *et al*., 2007b) although this was precautionary, due to the lack of information on the interaction of seabirds and purse-seine gear within the SPF. The residual risk of seabirds interacting with either mid-water trawls or purse-seine gear was assessed as medium or low following a subsequent level-2 guideline assessment by AFMA (AFMA, 2010a; 2010b).

There was one recorded seabird interaction with mid-water trawl gear in 2002 and 36 recorded in 2006 (Table 19.5). Observers on board purse-seiners and mid-water trawlers monitor any changes in seabird interactions (Table 19.1).

To minimise the risk of interactions with seabirds, AFMA require all SPF mid-water trawl vessels to develop and implement an approved seabird management plan for the vessel. This plan must contain measures that (i) minimise and avoid where possible, any discharge of biological material while the gear is in the water and (ii) require the holder to use mitigation devices in a particular way to avoid interactions with seabirds (AFMA general permit conditions, September 2012).

AFMA observers monitor seabird interactions while on board commercial vessels during fishing operations. Any interactions are reported by AFMA to the Department of Sustainability, Environment, Water, Population and Communities.

Marine mammals

Purse-seine operators use radar and visual methods to assess schools prior to gear deployment. If species other than the target species is detected within the fishing area, e.g. seals and/or dolphins, the gear is usually not deployed. However, if a TEP species is encircled within a purse-seine net, it is believed that the method allows continuous access to the water/air interface for marine mammals to breathe (AFMA, 2010c).

SPF industry members developed a voluntary Purse Seine code of practice in 2008 which covers issues such as vessel operation and avoidance of environmental impacts from fishing activities. The code of practice states that if TEPs are detected within a purse-seine net, the event is reported immediately to the Fishing Master and fishers will make every reasonable endeavour to return any captured individual TEP species alive (Table 19.1 and reference therein).

Mid-water trawl operators are also subjected to voluntary and mandatory management measures to mitigate seal and dolphin interactions during fishing operations (AFMA, 2009). From the inception of mid-water trawling in 2002, a soft rope mesh SED was incorporated in the gear, and scientific trials conducted to modify the SED to reduce gear interactions (Table 19.1). In 2004, larger top-opening excluder gaps were required on all nets, allowing seals to escape more easily. By late 2005, the soft mesh excluder was replaced with a metal grid and a bottom opening excluder device re-instated. This excluder device was enlarged around mid-2006 and made mandatory on all nets to minimise bycatch of seals and dolphins (Table 19.1).

It is expected that the seal management plan that would apply to any mid-water trawl operations will require that, in the event of a seal mortality in one fishing shot, a mid-water trawl operator must immediately cease fishing, consult with an AFMA observer on board and review the effectiveness of mitigation measures before recommencing fishing. Further mitigation measures in place in the event of a greater number of seal mortalities include that the operator is to suspend fishing or recommence fishing within 50 nautical miles of a mortality event. For further details refer to SEWPaC (2012).

AFMA also require certain mid-water trawl operators to comply with a dolphin management plan that contains mitigation measures to minimise interactions with dolphins. This plan includes suspending fishing if one or more dolphin mortalities

occur, and not recommencing fishing within 50 nautical miles from where the mortality was recorded (SEWPaC, 2012).

Voluntary rules for mid-water trawl operations were first implemented by the SPF industry members in October 2004 and again in May 2005 following the Cetacean Mitigation Working Group meetings to mitigate bycatch of TEP species. The first rule states that fishing must stop and the vessel relocate if dolphins were seen following incidental dolphin captures. The second rule involved conducting long wide turns to maintain net configuration rather than winching gear to blocks prior to turning (Table 19.1). Additional planned scientific trials to assess modifications of mid-water trawl gear are expected to be completed by 2013 but are dependent on fishing by that method taking place.

19.5 Bycatch Composition and Quantities

Discarding of fish target or bycatch species is not currently a concern in the SPF because (i) operators can selectively catch the four target species without catching significant amounts of other fish species; and (ii) catches of target species are generally well below the total allowable catch (TAC) limits.

19.5.1 Fishes

Reported SPF-associated bycatch of fish and other species in 2002 was based on AFMA observer(s) on-board commercial vessels conducting a trial using the pair mid-water trawl method. Fish bycatch included blue and silver warehou and barracouta (Table 19.2A). No information is available on whether the listed species (apart from redbait and jack mackerel) were retained or discarded. However, both frost fish and butterfly gurnard have previously been reported as discards by mid-water trawlers in the SPF (Daley *et al.*, 2007). Bycatch quantities from the pair mid-trawl trial were also not available to the author at the time of writing.

A total of 41 bycatch fish species were reported from AFMA observers on-board mid-water trawlers during 2002-2005 (Table 19.2B). These species were mostly demersal (above seabed but bottom-associated), followed by benthic (seabed-associated) and pelagic (water-column associated). The first two groups were either rare, very rare or were only recorded as traces. The two commonly occurring species, i.e. barracouta and silver warehou, occurred in small numbers and never exceeded 5% of the total catch (Table 19.2B).

A total of 10 bycatch fish species were reported by AFMA observers in 2006 (Table 19.2C). Of these, 70% were pelagic and the remaining demersal. Apart from barracouta, which accounted for the greatest overall discard (4.9 t), catches of other discarded bycatch species were generally low (150 - 280 kg), and did not exceed 5% of all recorded bycatch species. Discards of two target species, namely redbait and jack mackerel, were also recorded albeit very small.

Very few reported bycatch species were discarded during observer trips in the period 2007-2010 inclusive, based on the AFMA Observer database (Table 19.2D). Catches of these species ranged from as low as 0.4 kg (longfin pike) in purse-seines in 2010 to as high as 7 kg (ocean sunfishes) in mid-water trawls in 2008. Reported discarded target species in purse-seines were also low, and ranged from 200 kg

(Australian sardine) in 2010 to 300 kg (blue mackerel) in 2007. These discards were based on <9% observed shots (per annum) for purse-seines and <13% observed shots (per annum) for mid-water trawls (Table 19.4).

Almost all reported catch of bycatch species was retained during 2002-2011 based on Commonwealth logbook data (Table 19.3A). The most frequently recorded species was silver warehou, followed by barracouta, silver trevally and yellowtail scad. All other recorded species occurred either once or twice over that period. The most frequently recorded target species was blue mackerel, which occurred in all years. Australian sardine, jack mackerel and redbait were recorded in 9 years (Table 19.3A).

All reported bycatch species in the JMF during 2001-2002 were retained, with silver warehou as the most commonly reported species (Table 19.3B). All target species caught during that two year period were retained.

19.5.2 Cephalopods

Small amounts of Gould's squid were discarded during mid-water trawl operations in 2008 (Table 19.2A). This species was also reported as uncommon in shots between 2002-2005 (seen in more than 40% of shots, but never in amounts large enough to be quantified; Table 19.2B).

19.5.3 Bycatch of Threatened, Endangered and Protected (TEP) Species

Seabirds, seals and dolphins are known to interact with vessels operating in the SPF. The most prevalent recorded TEP interaction was the bycatch of seals and dolphins in mid-water trawls around Tasmania. A great white shark was also captured using mid-water trawl gear in 2009. The only other TEP species interaction involved a syngnathid (seahorse/pipefish) during 2004-2005 (AFMA, 2011).

Seabirds

A total of 38 seabird interactions with SPF vessels were reported during 2001-2011, four in Commonwealth logbooks and the remaining by observers (Table 19.5). A seabird interaction reported in 2002 comprised a fairy prion, found in a de-watering unit during pair mid-water trawling operations; the bird was unharmed and released alive. A further 36 shearwater interactions were reported in 2006 during mid-water trawling, while no interactions were reported for the 2007-2011 period; the latter period corresponds mostly to observer coverage of <13% of shots per annum (Table 19.4). Of the 36 reported interactions, 24 seabirds died: 3 shearwaters (species unknown), 17 flesh-footed and four short-tailed shearwaters. The 12 reported to survive comprised one shearwater (species unknown), seven flesh-footed and four short-tailed shearwaters.

A single interaction comprising a yellow-nosed albatross was reported in 2006 by observers during purse-seine operations; the bird was released alive. No further interactions were reported during purse-seine operations during 2001-2011. However, observer coverage was low (<10%) in most years except in 2006.

No seabird interactions in the JMF were recorded in 2001-2002 based on the Commonwealth logbook database.

Marine mammals

A total of 209 marine mammal interactions were recorded in the SPF during 2002-2011 and none in the JMF in 2001-2002.

Seals

The 184 seal interactions with mid-water trawl gear reported during 2001-2011 derive from scientific projects, observer trips and/or Commonwealth logbooks; most seals were believed to be Australian fur seals. Of these, 175 were incidentally caught during scientific trials (May–July 2005; February 2006; and January 2006–February 2007) aimed to assess the type and frequency of interactions and performance of various excluding devices as options to mitigate dolphin and seal interactions; the remaining three were recorded in observer data during standard commercial mid-water trawl trips, whereas six were recorded in the Commonwealth logbook database (Table 19.6). Of the captured seals, 145 were reported to be alive, 30 died, while the fate of the remaining 9 was unknown. There has been no incidental fur seal interactions reported since 2007 either by on-board observers or fishers (Table 19.6). These reports are based on observer coverage of <13% of shots per annum (Table 19.4) for mid-water trawl vessels since 2007.

There have been no reported incidental interactions between fur seal and purse-seines in observer or Commonwealth logbook databases. This is based on observations of <15% of shots per annum since 2001 (Table 19.4), noting that observers were on-board SPF vessels in only 49 shots of 1176 over the 11 year period.

Dolphins

There have been 25 reported dolphin mortalities using mid-water trawl gear during 2001-2009 (Table 19.6). Also, there have been no reported dolphin interactions since mid-2005 following the introduction of bycatch management measures. These observations are based on <13% observed shots per annum since 2007, noting that there was no observer coverage in 2010 and 2011, which corresponds to a reduction in mid-water trawl fishing (Table 19.4).

There have been no reported incidental interactions between dolphins and purse-seines in observer or Commonwealth logbook databases. However, the annual observer coverage has been <15% of shots since 2001 (Table 19.4), with no observer coverage in most years.

19.6 Conclusion

This chapter reviews the bycatch associated with the Small Pelagic Fishery (SPF) in temperate Australia during 2001-2011, and the management measures currently in place to mitigate interactions with non-targeted fauna.

The main species groups reported as SPF-associated bycatch comprise cephalopods, fishes, seabirds and marine mammals, particularly seals and dolphins. Very few bycatch fish species were discarded during observer trips for the period 2007-2010. Similarly, almost all reported bycatch fish species were retained during

2002-2011 based on Commonwealth logbook data. The most frequent bycatch species included silver warehou, barracouta, silver trevally and yellowtail scad. All other recorded species occurred either once or twice over that period. Fishery-wide estimates of total bycatch were not available as observations of catch rates need to be of sufficient magnitude and be representative of fishing effort both spatially and temporally before being scaled up.

A single interaction between a seabird and mid-water trawl gear was reported by on-board observers in 2002. A further 37 seabird interactions were reported in 2006, and no interactions have been reported since then. Only one seabird interaction occurred during purse-seine operations in 2006. Changes in seabird interactions are currently being monitored through observer coverage on purse-seiners and mid-water trawlers. Commonwealth logbooks show no reported seabird interactions in the JMF in 2001-2002 or the SPF during 2002-2005 or 2007-2011. SPF mid-water trawl operators are required to develop and implement an AFMA-approved seabird management plan for the vessel to minimize and avoid interactions with seabirds.

Seal interactions were observed with mid-water trawl gear during scientific SED trials. This has led to mitigation measures such as the compulsory use of upward opening SEDs. It is difficult to assess the overall seal bycatch levels and the effectiveness of the measures to reduce bycatch, given observer coverage has been intermittent between years on both mid-water trawl vessels (<13% observed shots per annum) since 2007 and purse-seine vessels (<15% observed shots per annum) since 2001.

There have been no reported dolphin interactions since mid-2005 and no seabird interactions reported since 2007 by either observers or in Commonwealth logbooks. Overall bycatch levels are difficult to estimate, given a decline in on-board observer coverage on mid-water trawls since 2007 which coincides with a reduction in effort in the fishery and little or no coverage on purse-seiners apart from 2006 and 2010. However, management measures are in place to minimise bycatch during SPF mid-water trawl and purse-seine operations.

Mid-water trawling operators in the SPF are subject to voluntary and mandatory management measures to mitigate seal and dolphin interactions during fishing operations. The SPF has been actively working to develop effective mitigation to reduce interactions between marine mammals and SPF fishing gear.

Industry members of the SPF have also developed a voluntary Purse Seine code of practice (2008) which outlines measures to (i) avoid TEP interactions and (ii) make every reasonable endeavor to return any captured individual TEP species alive. AFMA also require certain mid-water trawl vessels to comply with a seal and dolphin management plan that mandates mitigation measures be used to minimise interactions with these species.

19.7 References

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19.8 Tables – Reported SPF target and bycatch species

Table 19.1 Management measures implemented to minimise bycatch in the SPF during 2001–2011. Gear type: mid-water trawl (MT); pair mid-water trawl (PT); purse seine (PS).

Item No.	Feature	Date(s)	Description	Mitigation bycatch issue	Milestone	Completion status: Y/N or ongoing	Reference(s)
1	Bycatch – PT	2001	Seal excluder devices (SEDs) on PT trawls	Facilitate seal escape	-	-	AFMA
2	Bycatch – MT	2003	Soft rope bottom opening excluder device introduced	Mitigate seal and dolphin mortalities by facilitating escape	-	-	AFMA
3	Bycatch – MT	2004	• Excluder gaps enlarged; • Top opening excluder introduced (late Oct.)	Mitigate seal and dolphin mortalities by facilitating escape	-	-	AFMA
4	Bycatch – MT	10/2004	Voluntary rule introduced: stop fishing and move to another area if dolphins seen in area	Mitigate dolphin mortalities by facilitating escape	-	Ongoing	AFMA
5	Bycatch – MT	04/2005	Trawl-deck video system introduced	Observe potential mortalities	-	Ongoing	AFMA
6	Bycatch – MT	05/2005	Voluntary measure to conduct long wide turns to maintain net configuration rather than winching gear to blocks prior to turning	Mitigate interactions with TEP species	-	Ongoing	AFMA(2005a)
7	Bycatch – MT	late 2005	Based on underwater observations, excluder soft mesh replaced with metal grid; Return to bottom opening	Mitigate seal and dolphin mortalities by facilitating escape	-	Y	AFMA
8	Bycatch – MT	06/2006	Mandatory bottom opening excluder device enlarged	Facilitate seal escape	-	Y	AFMA
9	Bycatch – PS	2008	Small Pelagic Fishery Industry Voluntary Purse Seine Code of Practice adopted.	Minimise bycatch and interactions with TEP species			AFMA(2008)
10	SPF Management Plan	2009	SPF Management Plan declared	Part 2 specifies that the fishery must develop and implement a bycatch action plan.	-	-	AFMA
11	Bycatch Management Plan	09/2009	Small Pelagic Fishery Bycatch and Discarding Workplan September 2009	Reduce bycatch	-	-	AFMA (2009)
12	Bycatch – MT	2009	Conduct a trial and test an upward-excluding SED	Monitor and mitigate seal and dolphin mortalities	2013	N – very little MT trawl effort	AFMA (2011)
13	Bycatch – MT	2009	Monitor trial and use of upward opening SED in Commonwealth Trawl Sector and adapt for SPF MT boats.	Monitor and mitigate seal and dolphin mortalities	2012/13	Ongoing	AFMA (2011)
14	Bycatch – MT	2009	• Develop and implement individual vessel management plans (VMPs) to minimise TEP species interactions. • Record procedures for reporting catch and wildlife interactions. • VMPs developed for Commonwealth Trawl Sector; could be adapted for SPF-VMPs. Observer available to implement SPF-VMP when	High risk species and TEP species: e.g. marine mammals and seabirds	2013 (subject to MT effort)	Y – developed for seabirds, seals and dolphins	AFMA (2009)

Item No.	Feature	Date(s)	Description	Mitigation bycatch issue	Milestone	Completion status: Y/N or ongoing	Reference(s)
			effort recommences in fishery.				
15	Bycatch – MT	2009	Develop triggers to identify shifts or expansion of effort within SPF, including increased interaction with TEP species.	Monitor TEP interactions	late 2013	Ongoing – SPFRAG has developed a methodology for monitoring large scale effort	Goldsworthy *et al*. (2011)
16	Observer program coverage	2009	Identify coverage across jurisdictions to clarify level of dedicated observer coverage only (excludes presence of scientists conducting research).	Determine observer coverage level to aid design of improved monitoring program.	April 2010	Y – observer coverage targets set by SPFRAG.	AFMA (2009)
17	Bycatch – PS	2010	Observer coverage to be 10% of shots; coverage on the first five trips for new boats entering the fishery or existing boats moving to new areas.	Increase observer coverage level to monitor bycatch	-	Ongoing	AFMA (2011)
18	Bycatch – PS	2010	Perform fishing operations under the Commonwealth Small Pelagic Fishery Purse Seine Code of Practice	Minimize risk of interactions with TEP species	-	Ongoing	AFMA (2011)
19	Bycatch – MT	2010	Observer coverage to be 20% of shots; coverage on the first 10 trips for new boats entering the fishery or existing boats moving to new areas.	Increase observer coverage level to monitor bycatch	-	Ongoing	AFMA (2011)
20	Bycatch Management Plan	2011	Small Pelagics Bycatch and Discarding Workplan 2011-2013	Reduce bycatch	-	Ongoing	AFMA (2011)

Note: Due to almost zero effort in the MT fishery since the introduction of the Bycatch and Discarding Management Plan (2009), items 12-15 have been carried through to end of 2013.

Table 19.2A Reported catch (retained or unclassified) from observer trips during Dec 2001–2002. Gear type: pair mid-trawl (PT); Not recorded (nr); not available to author (na); Data obtained from McKinley 2002a; 2002b. See Table 19.4 for total number of observed shots.

Common name	Scientific name	CSIRO Code	Target (Y/N)	Gear type	Unclassified catch no. (n)	Unclassified catch (t)	Retained no. (n)	Retained catch (t)
10 trips; 28 fishing operations								
Redbait	*Emmelichthys nitidus*	37 345001	Y	PT	0	0	nr	1312
Redbait and jack mackerel	*Emmelichthys nitidus; Trachurus declivis*	37 345001 37 337002	Y	PT	0	0	nr	1277
Silver warehou	*Seriolella punctata*	37 445006	N	PT	na	na	0	0
Barracouta	*Thyrsites atun*	37 439001	N	PT	na	na	0	0
Frost fish	*Lepiedous caudatus**	37 440002	N	PT	na	na	0	0
Blue warehou	*Seriolella brama*	37 445005	N	PT	na	na	0	0
Mirror dory	*Zenopsis nebulosus*	37 264003	N	PT	na	na	0	0
Silver dory	*Cytuss australis*	37 264002	N	PT	na	na	0	0
Gould's squid	*Nototodarus gouldii*	23 636004	N	PT	na	na	0	0
Blue mackerel	*Scomber australasicus*	37 441001	N	PT	na	na	0	0
Butterfly gurnard	*Lepidotrigla vanessa**	37 288003	N	PT	na	0.03	0	0
Tiger flathead	*Platycephalus richardsoni*	37 296001	N	PT	na	0.015	0	0
Blue grenadier	*Macruronus novaezelandiae*	37 227001	N	PT	na	na	0	0
Rudderfish	*Centrolophus niger*	37 445004	N	PT	na	na	0	0
Ocean Sunfish	*Mola mola*	37 470002	N	PT	na	na	0	0

*: Reported as discard species in Daley *et al.* (2007)
Note: AFMA observer data before 2007 may be incomplete

Table 19.2B Reported bycatch from observer trips during January 2002–June 2005. Gear type: mid-water (MT), purse seine (PS); Not recorded (nr); not available to author (na). Information including ranks were provided by Jeremy Lyle, Institute for Marine and Antarctic Studies (IMAS).

Common name	Scientific name	CSIRO Code	Target (Y/N)	Gear type	Unclassified catch no. (n)	Rank unclassified catch^	Retained no. (n)	Retained catch (t)
Redbait*	*Emmelichthys nitidus*	37 345001	Y	MT	na	Very common	na	na
Jack mackerel*	*Trachurus declivis*	37 337002	Y	MT	na	Very common	na	na
Blue mackerel*	*Scomber australasicus*	37 441001	Y	MT	na	Very common	na	na
Barracouta	*Thyrsites atun*	37 439001	N	MT	na	Common	na	na
Silver warehou	*Seriolella punctata*	37 445006	N	MT	na	Common	na	na
Gould's squid	*Nototodarus gouldii*	23 636004	N	MT	na	Uncommon	na	na
Mirror dory	*Zenopsis nebulosus*	37 264003	N	MT	na	Rare	na	na
New Zealand dory	*Cyttus novaezealandiae*	37 264005	N	MT	na	Rare	na	na
Australian burrfish	*Allomycterus pilatus*	37 469002	N	MT	na	Rare	na	na
Tiger flathead	*Platycephalus richardsoni*	37 296001	N	MT	na	Rare	na	na
Blue grenadier	*Macruronus novaezelandiae*	37 227001	N	MT	na	Rare	na	na
Sandpaperfish	*Paratrachichthys spp.*	37 255905	N	MT	na	Rare	na	na
Butterfly gurnard	*Lepidotrigla spp.*	37 288901	N	MT	na	Rare	na	na
Threespine cardinalfish	*Apogonops anomalus*	37 311053	N	MT	na	Rare	na	na
Blue warehou	*Seriolella brama*	37 445005	N	MT	na	Rare	na	na
Lanternfish	*Lampanyctodes spp.*	37 122913	N	MT	na	Rare	na	na
Crested bellowsfish	*Notopogon lilliei*	37 279003	N	MT	na	Very rare	na	na

Common name	Scientific name	CSIRO Code	Target (Y/N)	Gear type	Unclassified catch no. (n)	Rank unclassified catch^	Retained no. (n)	Retained catch (t)
John dory	*Zeus faber*	37 264004	N	MT	na	Very rare	na	na
Velvet leatherjacket	*Parika scaber*	37 465005	N	MT	na	Very rare	na	na
Rock ling	*Genypterus tigerinus*	37 228008	N	MT	na	Very rare	na	na
Frostfish	Trichuridae	37 440000	N	MT	na	Very rare	na	na
Gurnard perch	*Neosebastes scorpaenoides*	37 287005	N	MT	na	Very rare	na	na
Pink ling	*Genypterus blacodes*	37 228002	N	MT	na	Very rare	na	na
New Zealand dory	*Cyttus novaezealandiae*	37 264005	N	MT	na	Very rare	na	na
Peruvian jack mackerel	*Trachurus murphyi*	37 337077	N	MT	na	Very rare	na	na
Spiny pipehorse	*Solegnathus spp.*	37 282935	N	MT	na	Very rare	na	na
Ray's bream	*Brama brama*	37 342001	N	MT	na	Very rare	na	na
Elephantfish	*Callorhynchus milii*	37 043001	N	MT	na	Very rare	na	na
Southern calamari	*Sepioteuthis australis*	23 617005	N	MT	na	Very rare	na	na
Stingaree	*Urolophus spp.*	37 038903	N	MT	na	Very rare	na	na
Australian anchovy	*Engraulis australis*	37 086001	N	MT	na	Trace	na	na
Barracudina	Paralepididae	37 126000	N	MT	na	Trace	na	na
Longsnout boarfish	*Pentaceropsis recurvirostris*	37 367003	N	MT	na	Trace	na	na
Unid. Phycid cod	*Pseudophycis spp.*	37 224916	N	MT	na	Trace	na	na
Gemfish	*Rexea solandri*	37 439002	N	MT	na	Trace	na	na
Jackass morwong	*Nemadactylus macropterus*	37 377003	N	MT	na	Trace	na	na
Butterfly perch	*Caesioperca lepidoptera*	37 311002	N	MT	na	Trace	na	na
Red rock cod	*Scorpaena papillosa*	37 287008	N	MT	na	Trace	na	na
Pilchard	*Sardinops sagax*	37 085002	N	MT	na	Trace	na	na
Starry toadfish	*Arothron firmamentum*	37 467005	N	MT	na	Trace	na	na
Eagle ray	*Myliobatis spp.*	37 039904	N	MT	na	Trace	na	na
Cuttlefish	*Sepia plangon*	23 607012	N	MT	na	Trace	na	na
Sunfish	*Mola spp.*	37 470902	N	MT	na	Trace	na	na
Banded whiptail	*Caelorinchus fasciatus*	37 232002	N	MT	na	Trace	na	na

^: very common (dominates most shots); common (species often seen in small numbers, never dominant, but is quantifiable as a small proportion (1-5%) of a few of shots); uncommon (species often seen in more than 40% of shots, but never in amounts large enough to be quantified (<<1%)); rare (a few individuals observed in less than 40%, but more than 5 % of shots, and never in amounts large enough to be quantified (<<1%)); very rare (a few individuals observed in 5% or less shots, but never in amounts large enough to be quantified (<<1%)); trace (specimen/s recorded from a single shot).
*: These species are caught in sufficient amounts to appear in logbook catch returns. All other species rankings are based on catch sampling (IMAS).

Table 19.2C Reported bycatch from observer trips and scientific projects during March 2005–2006. Gear type: mid-water (MT), purse seine (PS); Not recorded (nr); not available to author (na); Observer data obtained from AFMA. See Table 19.4 for total number of observed shots.

Common name	Scientific name	CSIRO Code	Target (Y/N)	Gear type	Discard no. (n)	Discarded catch (t)	Retained no. (n)	Retained catch (t)
Redbait	*Emmelichthys nitidus*	37 345001	Y	MT	0	0.06	nr	716
Jack mackerel	*Trachurus declivis*	37 337002	Y	MT	nr	0.36	nr	26.2
Blue mackerel	*Scomber australasicus*	37 441001	Y	MT	nr	0.9	nr	4
Barracouta	*Thyrsites atun*	37 439001	N	MT	nr	5.9	0	0.2
Arrow squid	*Todarodes filippovae*	23 636011	N	MT	20	nr	0	0
Silver warehou	*Seriolella punctata*	37 445006	N	MT	nr	0.25	0	0
Blue grenadier	*Macruronus novaezelandiae*	37 227001	N	MT	nr	0.15	0	0
Lantern fishes	*Myctophidae - undifferentiated*	37 122000	N	MT	nr	0.28	0	0
Ocean Sunfish	*Mola mola*[a,b]	37 470002	N	MT	2	nr	0	0
Thresher shark	*Alopias vulpinus*[b]	37 012001	N	MT	9	nr	0	0
Shortfin mako shark	*Isurus oxyrinchus*[b]	37 010001	N	MT	1	nr	0	0
Broad-billed swordfish	*Xiphias gladius*[a,b]	37 442001	N	MT	2	nr	0	0
Rays	*Unidentified*[b]		N	MT	2	nr	0	0

a: Based on electronic monitoring trial (McElderry *et al.* 2005); b: Based on scientific SED trial (Lyle and Willcox 2008);
Note: AFMA observer data before 2007 may be incomplete

Table 19.2D Reported retained and discard catches for target and bycatch species from observer trips during March 2007–2011. Gear type: mid-water (MT), purse seine (PS); Not recorded (nr); not available to author (na); Data obtained from AFMA observer database. c: Currently termed *Pyura praeputialis*; Previously known as *Pyura stolonifera*. See Table 19.4 for total number of observed shots.

Year	Common name	Scientific name	CSIRO Code	Target (Y/N)	Gear type	Discard no. (n)	Discarded catch (t)	Retained no. (n)	Retained catch (t)
2007	Redbait	*Emmelichthys nitidus*	37 345001	Y	PS	-	-	-	-
					MT	0	0	nr	97
	Blue mackerel	*Scomber australasicus*	37 441001	Y	PS	600	0.3	26250	10.5
					MT	0	0	nr	2.0
	Jack mackerel	*Trachurus declivis*	37 337002	Y	PS	0	0	14000	24.5
					MT	0	0	nr	14
	Barracouta	*Thyrsites atun*	37 439001	N	MT	0	0	nr	0.5
					PS	-	-	-	-
	Silver warehou	*Seriolella punctata*	37 445006	N	PS	-	-	-	-
					MT	0	0	nr	2.0
2008	Barracouta	*Thyrsites atun*	37 439001	N	PS	-	-	-	-
					MT	10	0.02	0	0
	Jack mackerel	*Trachurus declivis*	37 337002	Y	PS	-	-	-	-
					MT	0	0	nr	38
	Gould's squid	*Nototodarus gouldi*	23 636004	N	PS	-	-	-	-
					MT	12	0.006	0	0
	Lantern fishes	*Myctophidae - undifferentiated*	37 122000	N	PS	-	-	-	-
					MT	1000	0.02	0	0
	Mackerel scads	*Trachurus spp.*	37 337907	N	PS	-	-	-	-
					MT	19	0.01	42500	51.25
	Ocean sunfishes	*Molidae - undifferentiated*	37 470000	N	PS	-	-	-	-
					MT	1	0.07	0	0
	Redbait	*Emmelichthys nitidus*	37 345001	Y	PS	-	-	-	-
					MT	-	-	nr	42
	Silver warehou	*Seriolella punctata*	37 445006	N	PS	-	-	-	-
					MT	-	-	3800	2.9
	Squids	*Order Teuthoidea* -	23 615000	N	PS				

Year	Common name	Scientific name	CSIRO Code	Target (Y/N)	Gear type	Discard no. (n)	Discarded catch (t)	Retained no. (n)	Retained catch (t)
		undifferentiated			MT	100	0.08	0	0
	Starfish	*Class Asteroidea - undifferentiated*	25 102000	N	PS	-	-	-	-
					MT	3000	0.06	0	0
	Ascidians	*Pyura praeputialis*[c]	35 032041	N	PS	-	-	-	-
					MT	9	0.003	210000	139
2009	Mackerel scads	*Trachurus spp.*	37 337907	N	PS	-	-	-	-
					MT	0	0	nr	31.99
	Redbait	*Emmelichthys nitidus*	37 345001	Y	PS	-	-	-	-
					MT	0	0	25000	5
	Squids	*Order Teuthoidea - undifferentiated*	23 615000	N	PS	-	-	-	-
					MT	20	0.01	0	0
	Ascidians	*Pyura praeputialis*[c]	35 032041	N	PS	-	-	-	-
					MT	0	0	nr	33.587
2010	Australian pilchard	*Sardinops sagax*	37 085002	Y	PS	4800	0.2	5775	5.275
					MT	-	-	-	-
	Blue mackerel	*Scomber australasicus*	37 441001	Y	PS	-	-	nr	71
					MT	-	-	-	-
	Longfin pike	*Dinolestes lewini*	37 327002	N	PS	50	0.0004	0	0
					MT	-	-	-	-
	Ocean jacket	*Nelusetta ayraud*	37 465006	N	PS	10	0.054	-	-
					MT	-	-	-	-
	Red-eye round herring (Maray)	*Etrumeus teres*	37 085001	N	PS	0	0	4219	0.225
					MT	-	-	-	-
	Yellowtail scad	*Trachurus novaezelandiae*	37 337003	N	PS	0	0	1200	0.06
					MT	-	-	-	-
2011	-	-	-	-	-	-	-	-	-

Table 19.3A Target and discard species reported in Commonwealth logbook database in the SPF during 2002-2011. Data was extracted by CSIRO using the reporting database (April 2012).

Year	Common name	Scientific name	CSIRO code	Total discarded (t)	Total retained (t)
2002	Indian scad[a]	*Decapterus russelli*	37337023	0	0.8
	Redbait	*Emmelichthys nitidus*	37 345001	0	68.7[b]
	Australian sardine	*Sardinops sagax*	37085002	0	124.7
	Blue mackerel	*Scomber australasicus*	37441001	0	97
	Squid	*Teuthoidea*	23615000	0	0.1
	Barracouta	*Thyrsites atun*	37439001	0	12
	Jack mackerel	*Trachurus declivis*	37337002	0	222.4
2003	Indian scad[a]	*Decapterus russelli*	37337023	0.02	21
	Redbait	*Emmelichthys nitidus*	37 345001	0	7312
	Australian sardine	*Sardinops sagax*	37085002	0	174
	Blue mackerel	*Scomber australasicus*	37441001	0	509.95
	Silver warehou	*Seriolella punctata*	37445006	0	21.6
	Barracouta	*Thyrsites atun*	37439001	0	9.0
	Jack mackerel	*Trachurus declivis*	37337002	0.02	3248.2
	Yellowtail scad	*Trachurus novaezelandiae*	37337003	0	13.16
2004	Indian scad[a]	*Decapterus russelli*	37337023	0	30
	Redbait	*Emmelichthys nitidus*	37 345001	0	8048
	Silver trevally	*Pseudocaranx dentex*	37337062	0	25
	Australian sardine	*Sardinops sagax*	37085002	0	759
	Blue mackerel	*Scomber australasicus*	37441001	80	240.7
	Silver warehou	*Seriolella punctata*	37445006	0	5.15
	Barracouta	*Thyrsites atun*	37439001	0	142.9

Year	Common name	Scientific name	CSIRO code	Total discarded (t)	Total retained (t)
	Jack mackerel	*Trachurus declivis*	37337002	0	3650
	Yellowtail scad	*Trachurus novaezelandiae*	37337003	0	8.0
2005	Indian scad[a]	*Decapterus russelli*	37337023	0	46
	Redbait	*Emmelichthys nitidus*	37 345001	0	5896.26
	Rubyfish	*Plagiogeneion spp.*	37345900	0	0.75
	Australian sardine	*Sardinops sagax*	37085002	0	1214.8
	Blue Mackerel	*Scomber australasicus*	37441001	0	701
	Silver warehou	*Seriolella punctata*	37445006	0	0.3
	Barracouta	*Thyrsites atun*	37439001	0	47.8
	Jack mackerel	*Trachurus declivis*	37337002	0	1109.41
	Yellowtail scad	*Trachurus novaezelandiae*	37337003	0	2.0
2006	Redfish	*Centroberyx gerrardi*	37258004	30	30
	Longsnout dogfish	*Deania quadrispinosa*	37020004	0	0.045
	Redbait	*Emmelichthys nitidus*	37 345001	0	8226.21
	Pink Ling	*Genypterus blacodes*	37228002	0	0.032
	Blue grenadier	*Macruronus novaezelandiae*	37227001	0	0.048
	Ocean jacket	*Nelusetta ayraud*	37465006	0	0.015
	Not designated - oreos	*Neocyttus rhomboidalis, N. psilorhynchus, Allocyttus niger & A. verrucosus*	37266902	0	0.0225
	Gould's squid	*Nototodarus gouldi*	23636004	0	0.175
	Knifejaw	*Oplegnathus woodwardi*	37369002	0	0.256
	Rubyfish	*Plagiogeneion spp.*	37345900	0	118.09
	Gemfish	*Rexea solandri*	37439002	0	0.217
	Australian sardine	*Sardinops sagax*	37085002	0.01	1509
	Blue mackerel	*Scomber australasicus*	37441001	0	1972.1
	Mackerel - not designated	*Scombridae spp.*	37441911	0	10.18
	Blue warehou	*Seriolella brama*	37445005	0	0.672
	Silver warehou	*Seriolella punctata*	37445006	0	7.076
	Barracouta	*Thyrsites atun*	37439001	0	304.26
	Southern ribbonfish	*Trachipterus arawatae*	37271001	0	0.09
	Jack mackerel	*Trachurus declivis*	37337002	0	743.5
2007	Redbait	*Emmelichthys nitidus*	37 345001	0	4262
	Skipjack tuna	*Katsuwonus pelamis*	37441003	0	90
	Frostfish	*Lepidopus caudatus*	37440002	0	25
	Australian sardine	*Sardinops sagax*	37085002	0	1353.89
	Blue mackerel	*Scomber australasicus*	37441001	8	1416.22
	Silver warehou	*Seriolella punctata*	37445006	0	16.95
	Jack mackerel	*Trachurus declivis*	37337002	20	679.7
2008	Redbait	*Emmelichthys nitidus*	37 345001	0	1146.85
	Skipjack tuna	*Katsuwonus pelamis*	37441003	0	15.2
	Australian sardine	*Sardinops sagax*	37085002	0	1357
	Blue mackerel	*Scomber australasicus*	37441001	5.8	1059

Year	Common name	Scientific name	CSIRO code	Total discarded (t)	Total retained (t)
	Silver warehou	*Seriolella punctata*	37445006	0	11.5
	Barracouta	*Thyrsites atun*	37439001	0	10
	Jack mackerel	*Trachurus declivis*	37337002	0.03	444.45
2009	Redbait	*Emmelichthys nitidus*	37 345001	0	1253.02
	Bar rockcod	*Epinephelus ergastularius & Epinephelus septemfasciatus*	37311910	0	0.02
	Ruby snapper	*Etelis carbunculus*	37346014	0	0.2
	Tang's snapper	*Lipocheilus carnolabrum*	37346031	0	0.04
	Snapper	*Pagrus auratus*	37353001	0	0.03
	Boarfishes	*Pentacerotidae*	37367000	0	0.01
	Red Bullseye	*Priacanthus spp.*	37326901	0	0.01
	Silver trevally	*Pseudocaranx dentex*	37337062	0	0.4
	Latchet	*Pterygotrigla polyommata*	37288006	0	0.01
	Australian sardine	*Sardinops sagax*	37085002	0.05	1125.9
	Blue mackerel	*Scomber australasicus*	37441001	0	2071.6
	Silver warehou	*Seriolella punctata*	37445006	0	35
	Jack mackerel	*Trachurus declivis*	37337002	0	365.31
2010	Redbait	*Emmelichthys nitidus*	37 345001	0	75.05
	Maray	*Etrumeus teres*	37085001	0	8.2
	Silver trevally	*Pseudocaranx dentex*	37337062	0	24.25
	Australian sardine	*Sardinops sagax*	37085002	0	473.75
	Blue mackerel	*Scomber australasicus*	37441001	0	972
	Yellowtail kingfish	*Seriola lalandi*	37337006	0	1.0
	Jack mackerel	*Trachurus declivis*	37337002	91	151.18
2011	Leatherjacket	*Balistidae, Monacanthidae - undifferentiated*	37465000	0	0.02
	Pink ling	*Genypterus blacodes*	37228002	0	0.003
	Gould's squid	*Nototodarus gouldi*	23636004	0	0.003
	Octopods	*Order octopoda*	23650000	0	0.002
	Tiger flathead[c]	*Platycephalus richardsoni*	37296001	0.02	0.2
	Skate	*Rajidae*	37031000	0	0.075
	Blue mackerel	*Scomber australasicus*	37441001	0	400
	John dory	*Zeus faber*	37264004	0	0.02

Note:
a: Indian scad (*Decapterus russelli*) reported in logbooks during 2002-2005 requires verification as it appears to be a tropical reef species and possibly mis-identified as a pelagic species caught in SPF.
b: There was also 3988 t of redbait (*Emmelichthys nitidus*) retained in 2002 in JMF (see Table 19.3B).
c: Tiger flathead: requires verification from logbooks

Table 19.3B Target and bycatch species reported in Commonwealth logbook database in the Jack Mackerel Fishery during 2001-2002. Data was extracted by CSIRO using the reporting database (April 2012). Data was extracted by CSIRO using the reporting database (April 2012).

Year	Common name	Scientific name	CSIRO Code	Total discarded (t)	Total retained (t)
2001	Redbait	*Emmelichthys nitidus*	37 345001	0	722
	Blue mackerel	*Scomber australasicus*	37441001	0	140.5
	Silver warehou	*Seriolella punctata*	37445006	0	1.1
	Jack mackerel	*Trachurus declivis*	37337002	0	45
	Yellowtail scad	*Trachurus novaezelandiae*	37337003	0	1.53
2002	Swallowtail	*Centroberyx lineatus*	37258005	0	0.041
	Redbait	*Emmelichthys nitidus*	37 345001	0	3988
	Blue grenadier	*Macruronus novaezelandiae*	37227001	0	0.2
	Silver trevally	*Pseudocaranx dentex*	37337062	0	3.42
	Blue mackerel	*Scomber australasicus*	37441001	0	97.31
	Blue warehou	*Seriolella brama*	91445005	0	1.0
	Silver warehou	*Seriolella punctata*	37445006	0	7.98
	Barracouta	*Thyrsites atun*	37439001	0	45.7
	Jack mackerel	*Trachurus declivis*	37337002	0	582.2

Table 19.4 AFMA observed number of SPF trips, total Commonwealth trips and percentage of Commonwealth shots and trips by gear type (where available) during 2001-2011. Gear type: pair mid-trawl (PT), mid-water (MT), purse seine (PS). Data obtained from Gerner 2006a, 2006b; Kranz 2006a, 2006b; AFMA (2009); TAFI unpublished cruise reports and Commonwealth logbook databases (2007-2011). Total Commonwealth trips and shots also provided by AFMA.

Year	Gear type	Total observed trips	Total Commonwealth trips^	Percentage (%) observed trips	Total observed shots	Total Commonwealth shots^	Percentage (%) observed shots
2001	PT	5	6	83.3	36	38 #	94.7
	PS	0	11	0	0	17 #	0
2002	PT; MT	6	27	22.2	18[a]	**112**	16.1
	PS	0	23	0	0	39	0
2003	MT	11	94	11.7	35	220	15.9
	PS	0	19	0	0	33	0
2004	MT	9	91	9.9	26	231	11.3
	PS	0	59	0	0	63	0
2005	MT	26	68	38.2	55	189	29.1
	PS	0	69	0	0	107	0
2006	MT	19	77	24.7	139[b]	298	46.6
	PS	3	73	4.1	28[c]	191	14.7
2007	MT	1	63	1.6	5	136	3.7
	PS	5	60	8.3	5	147	3.4
2008	MT	2	50	4	12	93	12.9
	PS	0	61	0	0	100	0
2009	MT	2	43	4.7	3	60	5
	PS	0	73	0	0	204	0
2010	MT	0	5	0	0	10	0
	PS	7	88	8	16	184	8.7
2011	MT	0	0	0	0	0	0
	PS	0	55	0	0	91	0

a: 18: comprises 16 shots reported in McKinley (2002a) and two shots (January 2002 trip) reported in McKinley (2002b)
b: includes observed shots from Gerner 2006a; 2006b
c: includes two unsuccessful shots (due to gear problems) from one observer trip
^: values may also include state trips and/or shots that were mis-reported as part of the SPF (AFMA)
#: corresponds to JMF
Bold: PT & MT (**112**: 101 (JMF) and 11 (SPF))
Note: AFMA observer data before 2007 may be incomplete

Threatened, endangered and protected (TEP) species bycatch in SPF

Table 19.5 Reported seabird interactions in SPF during 2000-2011. Gear type: pair trawl (PT), mid-water (MT), purse seine (PS); Life status: dead (D), alive (A), uncertain (UC); not recorded (nr); not available to author (na). No. trips: number of Commonwealth trips; Obs. trips: number of observed trips; Obs. shots: number of observed shots.

Year	Project/cruise interaction date(s)	No. trips^ (obs. trips)	No. shots (obs. shots)	Total days	Gear type	No. of seabirds	Life status	Reference(s)
2001	2 June-29 Dec	6(5)	38 (36)	18	PT	0	-	AFMA observer data; McKinley(2002a); Commonwealth logbook database
2002	2 Jan-22 Feb	(6)	(18)	18	PT	1[a]	A	AFMA observer data; McKinley(2002b); SPFRAG Meeting 4 report 26-27 Feb 2004
	-	27	112	-	PT;MT	0	-	Commonwealth logbook database
2003	18 Jan-4 Aug	94 (11)	220 (35)	na	MT	0	-	AFMA observer data and Commonwealth logbook database
2004	27 Mar-23 Dec	91 (9)	231 (26)	na	MT	0	-	AFMA observer data and Commonwealth logbook database
2005	2 Mar-23 Dec	68 (26)	189 (55)	na	MT	0	-	AFMA observer data and Commonwealth logbook database
2006	13 Feb	77	298	na	MT	4[b]	1 D; 3 A	Commonwealth logbook database
	18 Jan-15 May	(19)	(139)	na	MT	24[c]	17 D; 7 A	Gerner 2006a; 2006b Kranz 2006b
				na	MT	8[d]	4 D; 4 A	Kranz 2006b
	11 Mar	(3)	(28)	na	PS	1[e]	1 A	Kranz 2006b
	-	73	191	na	PS	0	-	Commonwealth logbook database
2007	-	63 (1)	136 (5)	na	MT	0	-	AFMA observer and Commonwealth logbook databases
	-	60 (5)	147 (5)	na	PS	0	-	AFMA observer and Commonwealth logbook databases
2008	-	50 (4)	93 (12)	na	MT	0	-	AFMA observer and Commonwealth logbook databases
	-	61 (0)	100 (0)	na	PS	0	-	AFMA observer database and Commonwealth logbook databases
2009	-	43 (2)	60 (3)	na	MT	0	-	AFMA observer and Commonwealth logbook databases
	-	73 (0)	204 (0)	na	PS	0		AFMA observer and Commonwealth logbook database
2010	-	5 (0)	10 (0)	na	MT	0	-	Commonwealth logbook database
	-	88 (7)	184 (16)	na	PS	0	-	AFMA observer and Commonwealth logbook databases
2011	-	0 (0)	0 (0)	na	MT	0	-	AFMA observer and Commonwealth logbook databases
	-	55 (0)	91 (0)	na	PS	0	-	Commonwealth logbook database

a: Fairy prion (*Pachyptila turtur subantarctica*) found in de-watering unit, unharmed and released alive
b: Shearwater; species unknown; c: Flesh-footed shearwater (*Puffinus carneipes*)
d: Short-tailed shearwater (*Puffinus tenuirostris*); e: Yellow-nosed albatross (*Thalassarche chlororhynchos*); ^: values may also include state trips that were reported as part of the SPF (AFMA); Note: AFMA observer data before 2007 may be incomplete

Table 19.6 Reported marine mammal interactions with gear type (pair mid-trawl (PT), mid-water (MT), purse seine (PS)) in the SPF. Life status: dead (D), alive (A), uncertain (UC); not recorded (nr); not available to author (na); Small Pelagic Fishery Cetacean Mitigation Working Group (SPF-CMWG). Data type: Commonwealth trips (CT). No. trips: number of Commonwealth trips; Obs. trips: number of observed trips; Obs. shots: number of observed shots.

Year	Project/cruise interaction date(s)	No. trips (obs. trips)	No. shots (obs. shots)	Total time (day)	Bycatch rate	Gear type	Spatial zone	No. of dolphins	Dolphin life status	No. of Australian fur seals	Seal life status	Data type	Reference(s)
2001	2 June - 29 Dec	6 (5)	38 (36)	18	nr	PT	A	0	-	0	-	Observer, CT	AFMA (2005c); AFMA observer data and Commonwealth logbook database; McKinley (2002a)
2002	2 Jan - 22 Feb	(6)	(18)	18	nr	PT	A	0	-	1	1 D	Observer, CT	AFMA observer data and Commonwealth logbook database; McKinley(2002b)
2003	-	94 (11)	220 (35)	na	nr	MT	A	0	-	0	-	Observer, CT	AFMA observer data; TAFI unpublished cruise reports
2004	-	91 (9)	231 (26)	na	nr	MT		0	-	0	-	Observer, CT	AFMA observer data; Kranz 2006a; Commonwealth logbook database; TAFI unpublished cruise report
	8,10 Oct; 12 Nov	6	16	nr	nr	MT	A - east Flinders Island	14[c or d]; 3[d]	17 D	0	-	Scientific project	AFMA (2005b); also reported in: Browne *et al*. (2005) and Lyle and Willcox (2008)
2005	-	(26)	(55)	na	nr	MT	A	0	-	0	-	Observer, CT	AFMA observer data
	14 May; 6 July	68	189	nr	nr	MT	A	0	-	4	3 D; 1 A	CT	Commonwealth logbook database
	26 April	11	28	19	nr	MT	A - east Tas.	1	1 D	0	-	Scientific projects, CT	SPF-CMWG Meeting Minutes (13 May 2005); McElderry *et al.* (2005); also reported in Commonwealth logbook database
	4 May	1	1	nr	nr	MT	A - east Tas.	7	7 D	0	-	CT	SPF-CMWG Meeting Minutes (13 May 2005); also reported in Commonwealth logbook database
	30 May - 7 July	8	19	nr	nr	MT	A	0	-	3[a*]	2 D; 1 A	Underwater SED trials	Browne *et al*. (2005)
2006-02/07	Jan 2006 - Feb 2007	nr	98	nr	2.8/shot	MT	A (East & SW Tas.)	0	-	170[b]	143 A; 19 D; 8 UC	Scientific project	Lyle and Willcox (2008)
2006	23, 24 Feb	(19)	(139)	nr	nr	MT	A (E & SW Tas.)	0	-	2	2 D	Observer, CT	Kranz 2006b (also reported in Commonwealth logbook database)
	26 Mar; 5 June	77	298	nr	nr	MT	A	0	-	2	2 D	CT	Commonwealth logbook database

Year	Project/cruise interaction date(s)	No. trips (obs. trips)	No. shots (obs. shots)	Total time (day)	Bycatch rate	Gear type	Spatial zone	No. of dolphins	Dolphin life status	No. of Australian fur seals	Seal life status	Data type	Reference(s)
	27, 28 Feb	7	28	nr	nr	MT	Port Lincoln	0	-	2	1 D; 1 UC	Scientific projects	AFMA data; TAFI unpublished cruise reports
	-	73 (3)	191 (28)	nr	nr	PS	na	0	-	0	-	Observer, CT	AFMA observer and Commonwealth logbook databases
2007	-	63^ (1)	136^ (5)	nr	nr	MT		0	-	0	-	Observer, CT	AFMA observer and Commonwealth logbook databases
	-	60^ (5)	147 (5)	nr	nr	PS	na	0	-	0	-	Observer, CT	AFMA observer and Commonwealth logbook databases
2008	-	50^ (4)	93^ (12)	na	na	MT	na	0	-	0	-	Observer, CT	AFMA observer and Commonwealth logbook databases
	-	61^ (0)	100 (0)	na	na	PS	na	0	-	0	-	CT	Commonwealth logbook database
2009	-	43^ (2)	60^ (3)	na	na	MT	na	0	-	0	-	Observer, CT	AFMA observer and Commonwealth logbook databases
	-	73^ (0)	204 (0)	na	na	PS	na	0	-	0	-	CT	AFMA observer and Commonwealth logbook databases
2010	-	5^ (0)	10 (0)	na	na	MT	na	0	-	0	-	CT	Commonwealth logbook database
	-	88^ (7)	184 (16)	na	na	PS	na	0	-	0	-	Observer, CT	AFMA observer and Commonwealth logbook databases
2011	-	55^ (0)	91 (0)	na	na	PS	na	0	-	0	-	CT	Commonwealth logbook database

a: Seals could be either Australian fur seal (*Arctocephalus pusillus doriferus*) and/or New Zealand fur seal (*Arctocephalus forsteri*) as both are known to occur in area and interact with fisheries (Browne *et al.* (2005));
b: Most likely to be Australian fur seal than New Zealand fur seal; c: common dolphin (*Delphinus delphis*); d: bottlenose dolphin (*Turisops truncatus*).
^: values may also include state trips that were reported as part of the SPF (AFMA)
*: this is based on video footage of 19 trawl shots with individual recording time limited to three hours (Browne *et al*. 2005)
Note: AFMA observer data before 2007 may be incomplete

20 APPENDIX 9: SOUTHERN AND EASTERN SCALEFISH AND SHARK FISHERY

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20.1 Summary

Australia's Southern and Eastern Scalefish and Shark Fishery (SESSF) is a complex multi-species, multi-gear fishery, which includes the Commonwealth Trawl Sector (CTS; including the South East Trawl (SET), and Victorian Inshore Trawl (VIT) sectors), the Great Australian Bight Trawl sector (GABT); the Gillnet, Hook and Trap sector (GHAT), and the East Coast Deepwater Trawl sector (ECDWT).

Information on SESSF bycatch (including byproduct), discarding, and fishery interactions with TEPs is provided for the period 1993 to 2011 (SET), or since records are first available (for GHAT and GABT, since approximately 1999). The Integrated Scientific Monitoring Program (ISMP), which is focused on collecting information on fishery discards, is the primary source of the information. In addition to investigating trends in the SESSF bycatch, a summary is provided of research on bycatch reduction measures that have been trialled, some of which have been taken up or mandated by the fishery. Further, a summary of management changes is included to provide some context for interpreting trends in bycatch and discarding in the SESSF.

The composition and level of bycatch taken in each of the sectors of the SESSF is dependent on the target species and fishing methods used. Trawling in the SET and GABT, as well as Danish seine fishing, have the greatest bycatch levels and discard rates of the SESSF, but also take the majority of the landed catch. Monitoring by the ISMP for over 20 years in the south east trawl fishery has enabled trends in discards to be examined. These data indicate a reduction in the mass of trawl discards since the mid-2000s, with discard rates for quota species being variable and dependent on the influx of small fish, in particular of blue grenadier, as well as other factors, such as market prices and availability of quota. Fishing effort in the SESSF has reduced by approximately one third since the mid-2000s and probably accounts for the largest reduction in overall discard levels. A number of fish bycatch reduction measures have been trialled in this fishery, with varying degrees of success. Changes in TEP wildlife interactions are not able to be interpreted with confidence at this stage due to the recent redesign of the ISMP and introduction of new mitigation measures (for seabirds, gulper sharks and sea lions).

There are some caveats for interpreting trends and correlating these with management changes and other factors -whilst there is a reasonable time-series of observations for general bycatch, particularly for the SET fishery, changes to the ISMP design have added variability to the estimated trend in discards and bycatch of species over time. Similarly, spatial and temporal shifts in fishery dynamics may also impact on trends. As such, caution should be taken when interpreting trends in bycatch or discarding, as observations may be influenced by factors other than those either imposed by management (to reduce bycatch or discarding) or to due population changes.

20.2 Fishery Description

Australia's Southern and Eastern Scalefish and Shark Fishery (SESSF) is a complex multi-species, multi-gear fishery which encompasses almost half of the Australian Fishing Zone; from Fraser Island, Queensland to Cape Leeuwin in Western Australia, and from shallow coastal waters to depths of over 1000 m. More than 100 species of fish and invertebrates are regularly retained in the SESSF; most supplying the domestic markets in south east Australia, with some product exported (Bergh *et al.*, 2009). Landings from the SESSF during 2009 were about 20,000 t, and the fishery had an estimated gross value of around $82 million for the 2009-10 financial year (Woodhams *et al.,* 2011; ABARES, 2011). The fishery is managed primarily through output controls of Total Allowable Catches (TACs) managed under an Individual Transferable Quota (ITQ) system. TACs were first introduced in 1988 for Eastern Gemfish (*Rexea solandri*) to prevent overfishing and then for Orange Roughy (*Hoplostethus atlanticus*) in 1990. A further 15 species or species groups were put under TACs in 1992 (Blue Grenadier (*Macruronus novaezelandiae*), Pink Ling (*Genypterus blacodes*), Redfish (*Centroberyx affinis*), Mirror Dory (*Zenopsis nebulosis*), John Dory (*Zues faber*), Ocean Perch (*Helicolenus percoides*), Tiger Flathead (*Neoplatycephalus richardsoni*), Eastern School Whiting (*Sillago flindersi*), Silver Trevally (*Pseudocaranx dentex*), Jackass Morwong (*Nemadactylus macropterus*), Blue-eye Trevalla (*Hyperoglyphe antarctica*), Blue Warehou (*Seriolella brama*), Silver Warehou (*Seriolella punctata*) and Royal Red Prawn (*Haliporoides sibogae*)). Other output controls in the fishery include prohibited species (eg listed Threatened, Endangered and Protected (TEP) species, or those designated as no take through OCS agreements) and trip, bycatch and size limits for some species. Input controls include limited entry, gear restrictions and extensive area closures.

The SESSF was formed in 2003 from the amalgamation of four different fisheries: the Commonwealth Trawl Sector (CTS; including the South East Trawl (SET), and Victorian Inshore Trawl (VIT) sectors); the Great Australian Bight Trawl Sector (GABT); the Gillnet, Hook and Trap Sector (GHAT) and the East Coast Deepwater Trawl Sector (ECDWT). With the amalgamation of the sectors, there are now 34 species or species groups subject to TACs in the SESSF. These 34 species or species groups comprise about 80% of the fisheries total retained catch (Morrison *et al.*, 2008). These various sectors of the SESSF began independently, have different histories, encompass separate but often overlapping areas, and operate with different gears. As such, they each have very different bycatch issues and need to be analysed and discussed separately.

The following sections include a brief description of each of the SESSF sectors and a summary of management actions that are relevant for interpreting trends in bycatch and discarding of species for each of these. A large body of work relevant to bycatch and discarding in the SESSF already exists; a review of the research into bycatch reduction devices and strategies is included, as well as information on the main TEP wildlife interactions for each sector. Analyses and discussion of SESSF bycatch issues for each sector is divided into two main areas: 1) General bycatch, which includes the bycatch of mainly bony fish (teleosts) and cartilaginous fish (chondrichthyans), including quota, non-quota, byproduct and high risk species; and 2) TEP direct wildlife interactions. Information on the ECDWT sector, which mainly targets Alfonsino, is limited. Further information on this sector is therefore not

presented here but can be found in the fishery management plans (e.g. AFMA, 2008a).

20.3 Methods

Here methods that are used to analyse the SESSF data and assess potential trends in bycatch are described. A similar approach was adopted for each sector of the SESSF, although there is generally a greater extent and quality of data available for the SET compared to other sectors.

20.3.1 ISMP strata

Assessing trends in bycatch and fishery wildlife interactions requires a reasonable time-series of adequate fishery monitoring data, ideally over a period of decades. Historically, most of the catch in the SESSF was taken by the SET. Scientific monitoring of that sector has taken place since the end of 1992, as part of the Integrated Scientific Monitoring Programme (ISMP) and its predecessor, the SMP. This provides a time series of bycatch data ranging almost two decades. The ISMP has also been implemented to varying degrees in other sectors of the SESSF since 2000. Data collected by on-board observers during that program includes the composition of the retained and discarded catch, and size frequency and age composition of quota and important non-quota species (Smith *et al.*, 1997; Knuckey and Gason, 2001). An important aspect of the design of the ISMP is to provide unbiased estimates of discards for priority species and species groups (Bergh *et al.*, 2009). A secondary aim is to provide information on fishing vessel interactions with wildlife, especially threatened, endangered, or protected (TEP) species (Koopman *et al.*, 2008a). In this Chapter the ISMP data from 1993 – 2011 is relied upon to characterise the bycatch of the various sectors of the SESSF, and understand changes that have resulted from management actions and from bycatch reduction devices and strategies. There have also been changes to the ISMP sampling design and its implementation over the period (Smith *et al.*, 1997; Knuckey and Gason, 2001), culminating in a recent re-design, implemented on 01 July 2010, that uses a comprehensive sampling strategy to account for major changes in fishery dynamics across the SESSF (Bergh *et al.*, 2009). In particular, it should be noted that for 2007 and 2008 the ISMP data was generally limited and of poor quality, especially for the SET.

The ISMP provides the most useful data for general bycatch analysis in the SESSF. Across the entire ISMP time series, only a few years had levels of sampling judged to be inadequate for analysis (exception GHAT Gillnet). The original ISMP strata definitions for the SET fishery and the definitions for strata as they existed since 2001 (including GHAT and GAB sectors) but prior to the revision by Bergh *et al*. (2009), are reported in Upston and Klaer (2012). Estimates of annual discard rates for 19 main quota species (Table 20.9) across the SESSF (excluding GABT) were calculated using a weighting approach based on ISMP strata, and were sourced from Upston and Klaer (2012). The “historical” series refers to the period 1998 to 2006 inclusive. For other analyses by fishery sector, given that ISMP strata have changed considerably over time, all data were categorised by SESSF “zones” (Figure 19.6) to enable comparisons of discards over the entire timeframe of ISMP, since 1993. These zones, initially described for the SET by Klaer and Tilzey (1989) have remained relatively unchanged although they have been augmented to encompass the amalgamation of fisheries into the SESSF. For the GABT fishery data were

categorised by depth: inshore (0 to <250 m), midshore (250 to <850m), and offshore (850 to < 1500 m). Separate analyses for fishery sectors essentially separates out gear type (trawl, line, gillnet), however for the SET otter trawl were combined with Danish seine, the latter being a minor component of the overall SET effort. Only recently has the ISMP design been optimised to include effective coverage for recording of TEP species and species identified as high risk through the ecological risk assessment (ERA) process (Bergh *et al.,* 2009).

Most of the data processing was done using programmes written by the authors in the statistical software *R* Vers. 2.15 (R Development Core Team, 2012), and some final processing was done using either MS Excel Vers. 2003 or 2007 (for larger datasets). Multivariate analyses were completed using PRIMER Vers. 5.2.2.

20.3.2 Species catch composition and criteria for data selection

The selection criteria used for data selection for each of the SESSF quota species are reported in Upston & Klaer (2012). All other species were designated "non-quota", including high risk and byproduct species (Harris & Ward, 1999).

Interpretation of the bycatch data on non-quota species was facilitated by reducing the species list from over 1000 to 98 main species or species groups. This process also enabled links with previous work (Bergh *et al.* (2009) and historical ISMP reports) to be retained. A "first pass" at constructing the species list was achieved by constructing a Bray-Curtis similarity matrix with years as "samples" and using total observed catch (square root transformed) as the metric for species abundance, and then completing a hierarchical cluster analysis. The main species were identified that contributed to Bray-Curtis dissimilarity between year groups and to similarity within year groups using SIMPER (analysis of similarity percentages). This method preserved the species composition across years, and hence investigate trends over time.

The initial list was comprised of the main species identified by the SIMPER analysis and species groups based on animal type (after Bergh *et al*. (2009)): Chimaeras, Crustaceans, Dogfish, Echinoderms; Fish, Hagfish, Sawsharks, Molluscs (including squid and cuttlefish), Sharks, Stingarees, Whiptails, or Other (Cnidarians, Sponges; Tunics). Two groups with only recent observations were excluded: Agnatha and Annelid. Table 20.9 lists the CAAB codes used to assign species to the groups Hagfish, Whiptails, Dogfish, Sawsharks (all were quota species), and Stingarees. Note that some species were removed from all analyses or grouped as Unknown (Table 20.9).

The "second pass" integrated the Bergh *et al.* (2009) project keys (species) including high risk species (Tables 46 and 47 in Bergh *et al.* 2009), and species from current and historical ISMP reports (Upston and Klaer, 2012). These integrations added 20 species to the main species list, which totalled 98 "non-quota bycatch species and species groups". To assist with interpretation, species were categorised as mostly discarded (D) if the average observed discarded proportion averaged across all years was >= 50%, else mostly retained (R).

20.3.3 Discard calculation

ISMP observations of the retained and discarded catch of commercial fishing operations provide independent information about the catch of both quota and non-quota species. However, the ISMP only samples a small subset (2-10%) of all fishing operations and needs to be weighted up with information on retained catches and the number of fishing operations (shots) from fishers logbook data (GENLOG), where possible corrected to the landings data (SAN) to estimate discard tonnages for a given fishery sector.

For each fishery sector, the mean observed discard weight (d^{sp})for a species group (sp) within a SEF zone (st) and in a given year is calculated as:

$$\bar{d}_{st}^{sp} = \frac{1}{n} * \sum_{i \in st} d_i^{sp} \qquad (1)$$

Where species group refers to non-quota bycatch species or the main quota species and *n* is the total observed shots for a zone. If *n* < 10 shots for a zone in a given year the mean discard weight was not calculated.

Shots were defined as: Year and Month and Day and Latitude and Longitude and Gear and CallSign (vessel ID) and Depth (average).

The estimated discard tonnes for each SEF zone was then calculated by multiplying the mean observed weight of discards by the total shots (fishing operations) in the logbook database for a given zone (Bergh *et al.* (2009); Method A adapted). The SEF zone discard tonnage estimates were summed to obtain a fishery-wide (excluding GABT) discard weight. For the GABT fishery discard tonnage estimates were summed across depth strata to obtain a fishery-wide discard weight.

The fishery-wide discard rate was calculated as:

$$d^{sp} = \frac{DisTon^{sp}}{\left(DisTon^{sp} + RetTon^{sp}\right)} \qquad (2)$$

Where DisTon is the estimated total mass of fish discarded (across zones) and RetTon is the total retained tonnage recorded in the commercial logbook database. For non-quota species DisTon and RetTon refer to the quantities recorded in the ISMP database.

The method for calculating the fishery-wide discard rate estimate for quota species differed depending on the data source. For each of the 19 main quota species the estimated annual discard rates were calculated using a weighting approach based on ISMP strata in a given year, and were sourced from Upston and Klaer (2012), noting that the “historical” series refers to the period 1998 to 2006 inclusive. For the relative series that combines quota and non-quota species, the estimated discard rates were calculated back to 1993 using the method described for equation 2 above (i.e. not applying the weighting approach based on the ISMP strata).The methods are further explained in the respective sections of the results.

The design of the ISMP has historically focused on estimating the fishery discard rates for quota species, rather than non-quota species, but the bycatch composition

has generally been consistently sampled for the SET fishery and allows scaling up the observed discard quantities of bycatch to a fishery-wide estimate (all species combined). Estimated discards and total catch (t) across species and for all years are reported. For the SET, the estimated discard tonnage and rate is reported at the scale of the fishery. The estimated yearly discard tonnage for each zone was calculated from the average observed discard tonnes per shot, multiplied by the number of GENLOG shots in a zone.

Detailed tables on a species-by-species basis show which non-quota species / species groups, including high risk species, are contributing to the main discards over the period of observations. Each species / species group was cataegorised into mostly (>50%) retained "R" or discarded "D", judged by the average discard rate over the entire time series. The estimated yearly discard tonnage was not estimated on a species-by-species basis, since the ISMP design was limited in this regard (but see Walker *et al*. 2007).

20.3.4 Interactions with TEP species

TEP species interactions were summarised for each fishery (SET, GHAT and GABT) and for the years 2005, 2006, 2009 and 2010. In this Chapter the direct interactions only were considered, either capture of TEP species in the fishing gear, or direct contacts by TEP species with fishing gear or vessel. There were few observations (<10 for all years) from ECDW and none for VIT so these fisheries were not reported. The ISMP started sampling for TEPs in 2003/2004, so these years were not included, allowing for a period of observer learning and embedding of sampling protocols. Historical ISMP (PIRVIC) reports for 2005 and 2006 were used (Koopman *et al*., 2006; Koopman *et al.,* 2008a, b and c).

The ISMP protocols for recording direct interactions with fishing operations include: (a) "recording details of the interaction (time, shot number or position if it did not occur during a shot, vessel activity, CSIRO code, contact code, contact count, count point, contact mortality, sex and age code, seal length), and (b) recording a qualitative description of any techniques or modified gear being used to avoid interactions with protected species (Koopman *et al.*, 2008a). Item (a) above, was reported, consistent with previous reports. Codes and meanings for life status of species after contact (e.g. dead, in rigour) were sourced from AFMA. For the purposes of this report, mortalities were tabulated only if records defined the animal as dead, i.e. if their life status after contact was recorded by the observer as either "dead and damaged", "dead, in rigour" or "dead and flexible". Note that there are different interpretations, and mortalities could have resulted from one or more of the other life status descriptions: "alive, just" and "alive sluggish".

Overview of fishery changes and Bycatch management by sector

20.4 South East Trawl - Overview

The Commonwealth Trawl Sector (CTS) extends from State waters out to the EEZ from Barranjoey Point southward around NSW, Victorian and Tasmanian waters to Cape Jervis in South Australia. Within the CTS there are 21 Victorian Inshore Trawl (VIT) permits, but this is a very small component of the fishery and is not discussed further in this paper. The major component of the CTS is the South East Trawl (SET), which comprises 59 Boat SFRs that use predominantly otter board trawl and

Danish seine methods. In discussing trawling, often a distinction is made between highly targeted shots at single species aggregations (eg. Orange Roughy or Blue Grenadier) compared to generalist shots for multi-species catches. The latter is referred to as "market fishing" and often is associated with higher levels of bycatch.

AFMA developed the South East Trawl Fishery Bycatch and Discarding Workplan (Board trawl and Danish seine) during 2009 (AFMA, 2009) to identify strategies that would:

- Respond to high ecological risks assessed through AFMA's Ecological Risk Assessment for the Effect of Fishing (ERAEF) and other assessment processes;
- Avoid interactions with species listed under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act);
- Reduce discarding of target species to as close to zero as practically possible; and,
- Minimise overall bycatch in the fishery over the long-term.

Although covered together in the Discarding Workplan (AFMA, 2009; 2011), the bycatch and discarding issues are considerably different between the trawl and Danish seine methods and are discussed separately here.

20.4.1 Bycatch Management – General

Otter board trawl

The ISMP program provides robust information on the composition and amount of discards in the SET fishery for most quota species and some byproduct and bycatch species (eg. Koopman *et al.,* 2006; Upston and Klaer, 2012). Spanning two decades, this work has revealed that varying, but significant, levels of the catch (up to 50% by weight of quota and non-quota species combined) are caught and discarded in the "market" fishery. Although some commercial species are discarded, most of the discards are comprised of small fish species with little or no commercial value. This work has also showed that bycatch is minimal (<2%) in targeted fishing for Orange Roughy, and this component of the fishery is not further discussed.

One of the fundamental fishery characteristics that influences the level of bycatch in the SET is the minimum codend mesh size of 90 mm, originally introduced in 1965 to reduce the catch of undersized tiger flathead. At the time, this was applied to single-braid mesh, but over the following decades the use of double braid 90 mm mesh in the codend became the norm, effectively reducing the selectivity of the net. Nevertheless, even with double-braid mesh, codend-cover experiments have indicated that about 70% of the organisms swept into the codend (30% by weight) escape through the codend meshes (Figure 20.1). Those passing through were mainly small teleosts (Figure 20.2), the most common of which were small non-commercial species including Toothed Whiptails (*Lepidorhynchus denticulatus*), Grey Whiptails (*Caelorinchus parvifasciatus*), Threespine Cardinalfish (*Apogonops anomalus*) and Blacktip Cucumbefish (*Paraulopus nigripinnis*) (Knuckey and Ashby, 2010). Knuckey and Ashby (2010) tested a range of codend mesh sizes and square mesh configurations[11] to reduce bycatch and showed that depending on the area and

[11] Square mesh configuration is where normal mesh is rotated 45^{o} so that the mesh is hung "on the bar" (along the side) rather than on the knot.

depth of operation, a significant reduction in the bycatch of small fish could be achieved with a relatively minor loss of commercial catch through the use of larger or square mesh codends (Figure 20.3). Further, modelling revealed that improved selectivity of the gear (towards larger fish) would lead to a long-term improvement in biomass levels of many quota species (Knuckey and Ashby, 2010)

Ultimately, the work by Knuckey and Ashby (2010) and the subsequent extension project with the South East Trawl Fishing Industry Association (SETFIA) by Walker *et al.* (2010) led to the introduction of mandatory bycatch reduction devices in all SET nets. This was a gradual process, however, initiated by distributing modified codends of various mesh shape and mesh size configurations to fishers on 30 separate vessels operating throughout the SET and GABT so they could trial which configurations best suited their fishing operations. Fishers were encouraged to use codends constructed with single-braid mesh, double-braid diamond mesh larger than the 90 mm legal minimum or codends with panels of square mesh size 90 mm or more. Based on international experience, fishers were also encouraged to consider using codends with 'T-90[12] panels' or 'T-90 lengtheners'. Experimental sea trials of codend T-90 selector panels were subsequently conducted and were preferred by industry to the square mesh panels because the former maintained the strength of the codend.

Based on these trials, the following mandatory requirements for bycatch reduction were introduced into the SET during 2006 (Table 20.1). As yet, there has been no formal testing of the level of bycatch reduction achieved through these measures.

Table 20.1 Current requirements for minimum codend mesh size in the SET. If operators use 90mm single or 102mm double then no further BRD is required. Use of 90mm double braid mesh in the codend requires the use of a specified BRD.

Minimum codend mesh requirements	Net BRD requirements
90mm single braid mesh or	Nil
102mm double braid mesh or	Nil
90mm double braid mesh + one of the following BRDs	Single square mesh (≥90mm) panel in upper side of codend bag (15X20bars) or Large rotated mesh (T90) (≥90mm) in upper codend (15X18 meshes)

In parallel to the work on panels, a net-making company (Network TN) based in Portland, developed a net with a larger than usual top panel — called a "balloon trawl" or "high-lift" net. Anecdotal reports that this net was able to reduce bycatch were quantified through a range of trials during 2008. The high-lift net caught significantly less of several of the high-discard species including Blacktip Cucumberfish, Spikey Dogfish (*Squalus megalops*) and small Silver Dory (*Cyttus*

[12] T90 mesh configuration is where the mesh is turned 90° to normal so that the knots tend to keep the meshes open.

australis). This positive result was somewhat offset by reduced catches of at least one commercially important species — Deepwater Flathead (*Neoplatycephalus conatus*). The high-lift net also showed promise in reducing damage to the catch. Blue Grenadier caught by the high-lift net appeared to be in better condition than those caught by the control net. Apart from reduced damage while in the net, reduced bycatch resulted in shorter sorting times and increased the overall quality of all species retained. Suggested benefits of increased fuel efficiency while towing the high-lift net were not realised during the trials, but a number of vessels based out of Portland continue to use these nets while there was a low level of uptake in the east.

In addition to the general bycatch of small fish in trawl nets, a number of specific bycatch issues have had to be addressed in recent years. Commonwealth Trawl bycatch of Pink Snapper (*Pagrus auratus*) off Victorian waters has become an issue with respect to Offshore Constitutional Settlement arrangements. Working with AFMA, SETFIA has put in a range of controls to limit the targeting and bycatch of this species, which includes a trip limit of not more than 200 kilograms of Pink Snapper from Victorian State waters.

Due to previous overfishing, the bycatch of Gulper Sharks — particularly Harrisson's Dogfish (*Centrophorus harrissoni*), Southern Dogfish (*C. zeehani*) and Endeavour Dogfish (*C. moluccensis*) — is of concern and has lead to the implementation of a series of trawl and longline spatial closures in depths of 250 – 700 m (recently proposed to be in depths 200-1000 m) . It's estimated that these closures will greatly reduce bycatch of Gulper Sharks because they are particularly focused on areas of relatively high abundance, covering areas that protect ~25% of their core habitat (AFMA 2012a; Williams *et al.* 2012a). Further, AFMA's new Upper Slope dogfish Management Strategy (AFMA 2012a) has abolished trip limits for zero retention of gulper sharks.

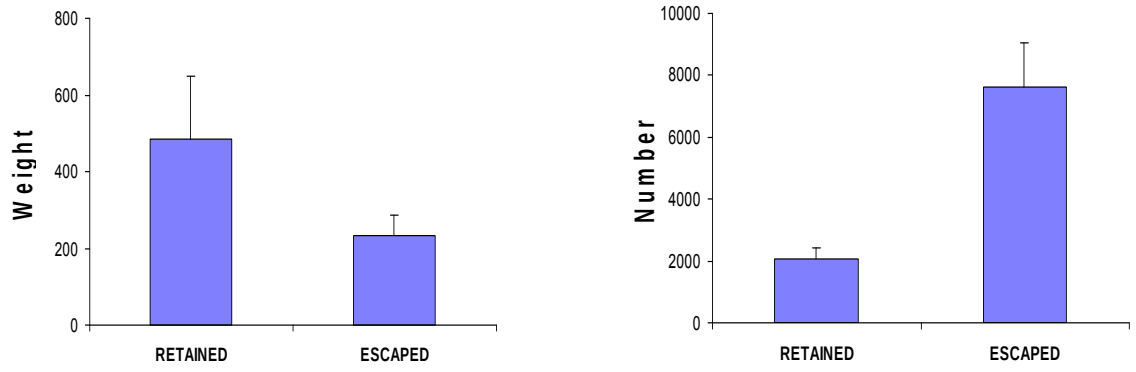

Figure 20.1 Mean weight (kg) (+/- 1 SE) and number of organisms per trawl that were retained in the codend or escaped into the cover. From Knuckey and Ashby (2010).

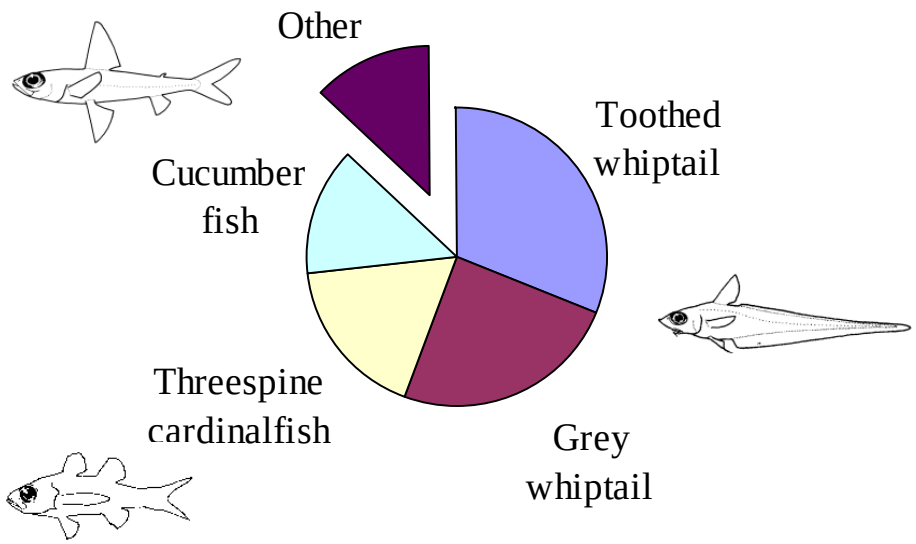

Figure 20.2 Species composition of teleosts that escaped through the codend and were caught in the cover (pictures adapted from Gomon *et al.* 1994).

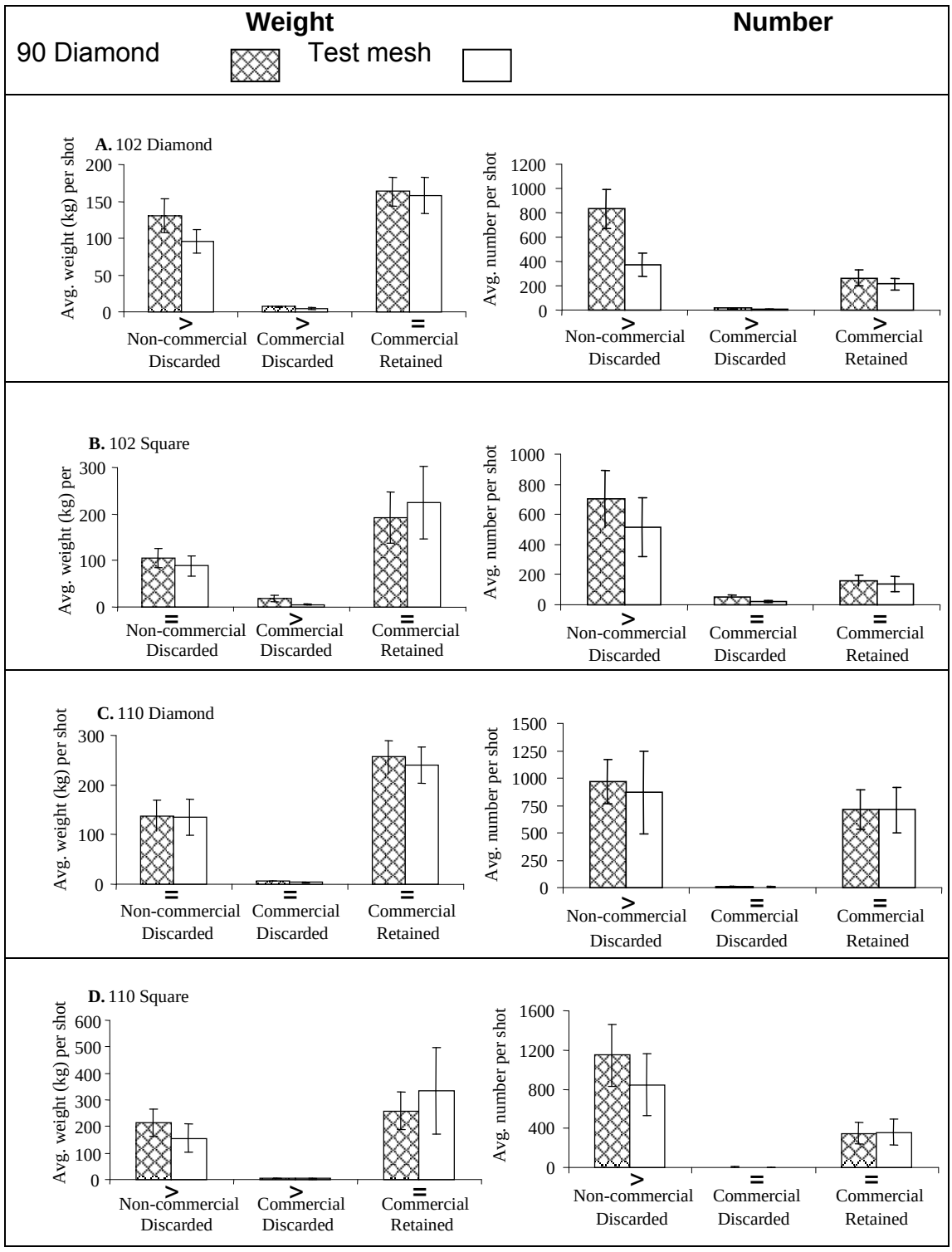

Figure 20.3 Average weight (left column) and number (right column) per shot of commercial and non-commercial fish discarded and retained from deep water (>150 fth) off Portland (west). The test mesh is: A, 102 mm Diamond; B, 102 mm Square; C, 110 mm Diamond; D, 110 mm Square. Error bars ±1SE. Symbols > and< denote significant differences and the direction of that difference; = denotes no significant difference. From Knuckey and Ashby (2010).

Danish Seine

Danish-seining was introduced to New South Wales, then Victorian waters during 1933–1947, and by the late 1960s the trawl fleet consisted entirely of Danish-seiners. Otter-board trawling gradually replaced Danish seining during the 1970s but a fleet of about 12 Danish seine vessels remains based out of Lakes Entrance. This method of fishing targets mainly Eastern School Whiting and Tiger Flathead and has changed little since it was first introduced.

The only major investigation into bycatch reduction for this sector of the fishery was by Koopman *et al.* (2010). This study quantified the selectivity of current 75 mm mesh codend used to target Tiger Flathead and the 45 mm Eastern School Whiting codend. Paired trawls were used to compare the 75 mm codend used for targeting Tiger Flathead and an experimental T-90 codend. There were no differences in catch weight of commercial species by the T-90 codend (including Tiger Flathead, Southern Sawshark (*Pristiophorus nudipinnis*), Ocean Jacket (*Nelusetta ayraudi*), Latchet (*Pterygotrigla polyommata*), Elephantfish (*Callorhinchus milii*) and Red Gurnard (*Chelidonichthys kumu*)) compared to the 75 mm control codend (Figure 20.4), but the T-90 codend caught about 27% less discarded non-commercial species (Sparsely Spotted Stingaree (*Urolophus paucimaculatus*), Blacktip Cucumberfish, Grooved Gurnard (*Lepidotrigla modesta*) and Family Triglidae).

Despite these results, at this stage there has been little uptake of the T-90 nets by Danish seine operators for a number of reasons. A prime reason n is that the project had limited spatial and temporal coverage of the fishery and operators were concerned that T90 codends may not be suitable at certain times of the year or in certain areas of their fishery, particularly considering that the size range and availability of Tiger Flathead and other commercial species can vary considerably at relatively small spatial and temporal scales. Also, the use of T90 netting is a somewhat new and “radical” change to net making in a fishery that is known for its conservative and traditional approach to fishing techniques across many generations (Koopman *et al.* 2010).

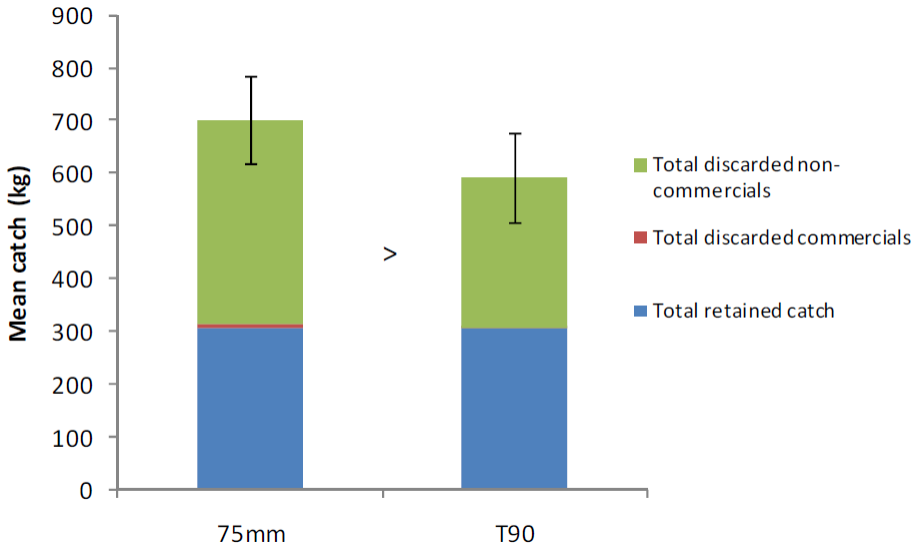

Figure 20.4 Mean total catch rates (+ SE) by the 75 mm control codend and the T90 codend. > indicates significant difference. From Koopman *et al.* (2010).

20.4.2 Bycatch management - TEP Wildlife interactions

Seals

Australian and New Zealand fur seals (*Arctocephalus pusillus doriferus* and *A. forsteri,* respectively) are commonly found in waters that overlap the SESSF. Since seals have been protected, the populations of both seal species has increased (Kirkwood *et al.,* 2010) and, not unexpectedly given the overlap of their distribution with the CTS, fishing interactions with seals are not uncommon (Knuckey *et al.,* 2002a). Reducing the bycatch of seals is an important issue for the CTS, particularly in the freezer boat sector of the winter Blue Grenadier fishery, but also more generally across the wet boat sector of the fishery.

The first major work on this looked at reducing the bycatch of seals in the winter Blue Grenadier fishery. A major component was the development of the Code of Fishing Practice which included: actively steaming away from seals before shooting the trawl net; removing meshed fish ('stickers') from the net prior to use; and no discarding of unwanted fish or offal on the fishing grounds. Figures suggested that adoption of the Code halved the incidence of seal bycatch per trawl shot (Tilzey *et al.,* 2006).

In addition to the Code, Tilzey *et al.* (2006) also experimented with Seal Excluder Devices (SEDs), which had varied results over the years of the trials (2001–2003) and with different SED designs. Problems of fish-loss via the SED escape hatch and net blockage via the SED grid were encountered and solved by changes in SED design. The forward-facing 'top-hatch' SED had a significantly lower occurrence of seal bycatch than other SED designs and nets without a SED. An overall seal bycatch survival rate of 48% was achieved in nets fitted with SEDs, compared to zero for nets without a SED, largely because the SEDs prevented seals entering the codend where most drownings probably occur (Tilzey *et al.,* 2006). SED performance however, remains largely unquantified because underwater video footage is limited and the numbers of seals interacting with the trawl net and successfully exiting the net via the SED escape hatch during this study were unknown. Obtaining significant results on SED performance by comparing replicate sets of trawl shots with and without a SED is difficult, because of the generally low level of seal bycatch and the complex suite of factors influencing seal interactions with the trawl net (Tilzey *et al.,* 2006). The use of a SED is now mandatory for freezer boats operating in this sector of the CTS.

Other seal bycatch reduction work has been carried out on the "wet-boat" trawl sector (non-freezer boats) of the CTS. In 2002, an estimated (but highly uncertain) average of 720 seals was captured annually in the wet boat component of the CTS (Knuckey *et al.,* 2002a), based on ISMP data collected from 1996 to 2001. This represented about one seal for every 50 shots on average although this figure is highly variable and uncertain. Of those seals caught, about a third was released alive (Knuckey *et al.,* 2002a). Despite these relatively high numbers, industry reporting of interactions was low at the time, and a project to improve industry reporting of seal interactions was initiated during 2005 (Knuckey and Stewardson, 2008). As part of this project, an industry-based monitoring and education program was developed, the latter including an information booklet and DVD/video on seal bycatch (Stewardson and Knuckey, 2005; 2006), and an Industry Code of Practice to Minimise Interactions with Seals (SETFIA, 2007). A SETFIA Liaison Officer was employed to speak with industry members about the need for improved reporting of interactions and to

distribute sampling kits to enable selected fishers to collect biological data on seals. As a result, levels of reporting of seal interactions have improved substantially. Unlike the factory vessels, the wet-boats have had more difficulty in developing suitable technical solutions to minimise seal bycatch. SETFIA conducted a trial of three different SED designs on wet-boats using underwater video footage to examine the results (SETFIA, 2009). Each SED suffered from the problem of skates getting stuck on the vertical bars, and on at least two of these occasions, this resulted in the loss of large quantities of commercial species through the escape hatch. Of the three SED designs trialled, the Bennett SED showed most promise as it was easy for the crew to handle, stowed neatly onto the net drum and maintained a rigid shape during towing. Further work was suggested to get the correct water flow, improve posture and to more easily allow unwanted catch such as seals and large skates through the escape hatch. Overall, the managing of OH&S issues using large grids on the relatively small wet-boats has proved problematic and other solutions are being explored. More recently, SETFIA has initiated a project to investigate the use of shortened trawl codends to reduce the bycatch of seals. Funding has been obtained to conduct a 1-year trial of the shortened codend in its effectiveness of reducing seal captures compared to the industry standard.

Seabirds

The potential bycatch of sea birds is another issue being addressed in the CTS. From November 2011, it has been mandatory for all CTS vessels to have approved seabird management plans (SMPs). The SMPs have requirements to manage the discharge of biological material from the vessel, and at least one AFMA approved physical mitigation device is to be used on each warp when fishing gear is in the water. These devices include warp scarers, bird bafflers, paired streamer lines and warp deflectors. There is no quantitative assessment of the effectiveness of seabird management plans, but AFMA is currently undertaking this work. SETFIA reports that there have been OH&S issues in the practical application of these methods, but although there has been some non-compliance, uptake across the fleet has been reasonably good and industry members are continuing to trial improved or different methods of avoiding interactions of seabirds and trawl warps. The most recent trials involve the use of water spray encircling the warp to scare away birds.

20.5 Great Australian Bight Trawl Sector - Overview

The Great Australian Bight Trawl Sector (GABT) extends from Cape Leeuwin, Western Australia, to Cape Jervis near Kangaroo Island, South Australia. The Sector excludes State (SA and WA) fishery shelf waters to the extreme east and west which have traditionally been fished by State based fishers. In 2008–09 the real gross value of production (GVP) of the fishery was $9 million; a decline from recent years due to declining catches (Wilson *et al.,* 2009).

Although commercial fishing began in this area during 1912, there were only sporadic periods of fishing until the 1980s. Initial fishing ventures were short-lived, hindered by inadequate boats, poor cold storage facilities and the distance of the fishing grounds from major markets. Interest in the fishery was renewed during the late 1980s by the discovery of Orange Roughy. During 1993, the GABTS became the first Commonwealth fishery to be managed under the 1991 Fisheries Management Act. Under the plan, AFMA granted SFRs to 10 operators that had fulfilled the performance criteria during the preceding three-year development phase of the

sector. Since this time, the seasonal deepwater slope fishery for Orange Roughy has reduced and the fishery now largely consists of a continental shelf/upper slope fishery mainly targeting Bight Redfish (*Centroberyx gerrardi*) and Deepwater Flathead. TACs were introduced for these main species during 2006.

20.5.1 Bycatch Management – General

There has been good independent data on the bycatch of trawl fishing in the GABTS, starting from the initial work by Knuckey and Brown (2002c), and continuing through with the ongoing monitoring by the ISMP (eg. Koopman *et al.,* 2008c), and during fishery independent surveys (eg. Knuckey *et al.,* 2006). As in the CTS sector, the Orange Roughy component of the fishery is characterised by very low levels of bycatch (< 1%; Knuckey and Brown, 2002) and is not referred to again in this document, but there is bycatch from market fishing on the shelf.

Over a range of studies, the annual quantity and composition of bycatch in the market fishery has remained similar (Brown and Knuckey, 2002; Talman and Brown, 2003; Talman *et al.,* 2004; 2005; Koopman *et al.,* 2006; 2007). The percentage (by weight) of the catch retained in GABTS market shots usually ranged from 40% – 60% depending on the region and time. During market fishing, the retained catch was dominated by Deepwater Flathead, Bight Redfish, Blue Grenadier, King Dory (*Cyttus traversi*), Blue Eye Trevalla, Ornate Angel Shark (*Squatina tergocellata*) and large (>35cm TL) Ocean Jacket. The discarded catch was dominated by Latchet, Wide Stingaree (*Urolophus expansus*), Draughtboard Shark (*Cephaloscyllium laticeps*), Southern Frostfish (*Lepidopus caudatus*), Sponge, Hard Coral and small Ocean Jacket (Knuckey and Brown 2002). Ocean Jacket and Latchet have some commercial value and there have been numerous efforts to improve markets for these species to reduce discard levels.

During 2007, the Great Australian Bight Fishing Industry Association (GABIA) initiated bycatch reduction work in the GABTS, which has largely focussed on the use of T-90 mesh (Knuckey *et al.,* 2008b). T-90 nets have been shown in international studies to improve both selectivity and towing efficiency. It is also suggested that T-90 nets have the added benefit of being “gentler” on the catch than standard nets because turbulence in the codend is reduced, thereby resulting in a higher value catch. GABIA had a purpose-built T-90 net designed and purchased in order to conduct tests to determine if the benefits observed in other countries could be replicated in the Great Australian Bight, without compromising catch of target species, with the overall aim of increasing the profitability of fishing operations.

During an alternate tow experiment (Knuckey *et al.,* 2008b), the T-90 net caught significantly less bycatch (516 kg/shot) compared to the control net (878 kg/shot). This difference was particularly large during day time shots. The catch of high discard species such as Sponge, Barracouta (*Thyrsites atun*), Spikey Dogfish (*Squalus megalops*), Australian Burrfish (*Allomycterus pilatus*), Jack Mackerel (*Trachurus declivis*), Rusty Carpetshark (*Parascyllium ferrugineum*) and Sergeant Baker (*Aulopus purpurissatus*) was considerably less than the standard net. There was, however, some degree of loss of commercial species. During night shots, the control net had higher catch rates of Bight Redfish and Deepwater Flathead, while the T-90 net caught more Deepwater Flathead during the day. Overall, the control net had higher catch rates of these two key commercial species, but these differences were not significantly different. In 2007, based on the results of these trials, GABIA

endorsed AFMA to make the use of T-90 extensions and/or codends mandatory in shelf component of the fishery.

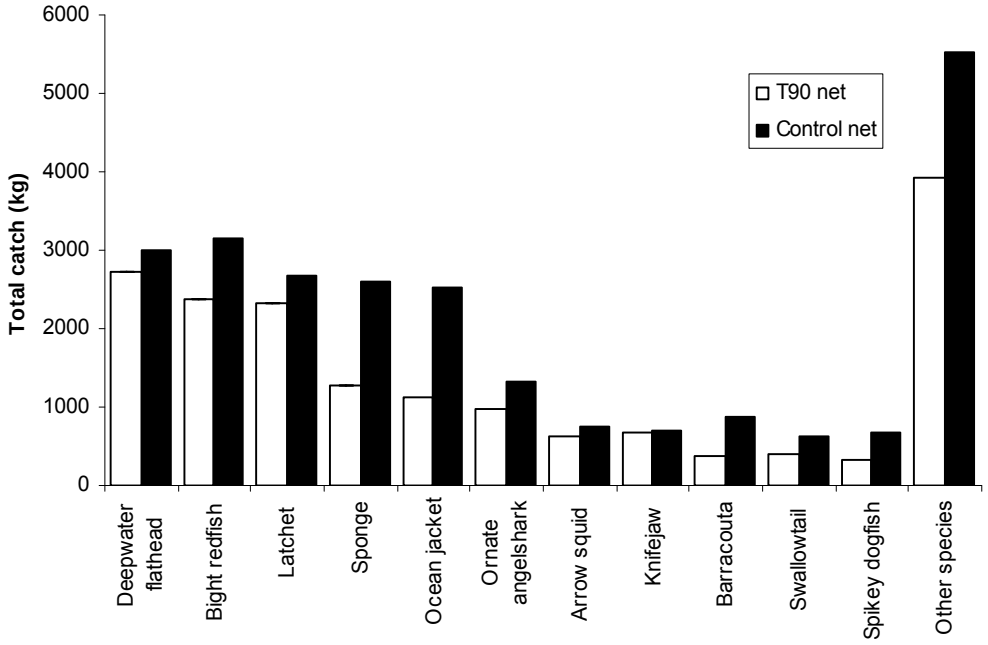

Figure 20.5 Comparison of catches (kg) of the top eleven species caught using the T-90 net (open bars) and the control net (dark bars).

Deepwater sharks and Gulper Sharks (Centrophoridae) are taken as a minor byproduct in the GABTS. There are management arrangements in place to reduce the bycatch of these species including extensive deepwater spatial closures, a number of which are specifically designed to protect the western stock of Southern Dogfish, and known populations of the central stock. Further, GABIA members have agreed that they are not to target Gulper Sharks and, are expected to return all live Gulper Sharks to the water carefully and quickly. This is included in their Boat Operations Procedures Manual carried on all vessels. Catch limits of 15 kg per day or 90 kg per trip for trips over six days were in place for Harrison's Dogfish, Southern Dogfish, Endeavour Dogfish and Greeneye Spurdog (*Squalus chloroculus*) combined, but this has now been replaced by a zero retention requirement as part of the new Upper-Slope Dogfish Management Strategy (AFMA 2012a).

The GABTS have also greatly improved their recording of discards in the logbooks. This was facilitated by the introduction of Olfish DDL™ electronic logbooks on all vessels, and the allocation of a small list of grouped categories specific to discarding which enabled skippers to easily record the total weight of discards in every shot. Reporting of discards in the daily logbooks can be compared to records from ISMP observations, and provides an opportunity to explore the spatial and temporal variations in bycatch across the fishery at a far finer spatial scale than is enabled through the 4% ISMP observer coverage. This also may provide a mechanism to quantify the overall impact of different bycatch reduction methods within the fishery.

20.5.2 Bycatch management - TEP Wildlife interactions

Despite many years of independent observer coverage and fishery independent surveys, records of the capture of or interaction with marine mammals by GABTS

vessels are extremely low (eg. Knuckey and Brown, 2002; Koopman *et al.,* 2007). It is difficult to quantify fishing vessel interactions with protected species, which often have highly variable species distributions.

Like the SET, the GABTS has had mandatory seabird management plans (SMPs) in place since 1 November 2011 for each vessel. This involves management of the discharge of offal, and the use of at least one mitigation device when fishing gear is in the water. Currently, there is no quantitative assessment of the effectiveness of seabird management plans, but AFMA is currently undertaking this work.

20.6 GHAT – Overview of Shark Gillnet and hook sector

The Gillnet Hook and Trap Sector consists of separate sub-sectors. The two largest sub-sectors in terms of catch and effort are the Shark Gillnet and Shark Hook Fishery and the Scalefish Hook Fishery.

The Shark Gillnet and Shark Hook Fishery operates in Commonwealth waters off South Australian, Tasmania and Victoria between the Western Australian and New South Wales borders. Longlining for shark began off southern Australia during the 1920s and expanded with the demand for vitamin A from shark liver oil during the 1940s. During the 1960 – 1970s, declining catches of School Shark (*Galeorhinus galeus*), concern over mercury in shark (Walker, 1976), and the introduction of gillnets saw the fishery change to become mainly a gillnet fishery targeting Gummy Shark (*Mustelus antarcticus*). Gillnets remain the dominant fishing method but permits for unlimited (manually-baited) hooks remain in the fishery. TACs managed under ITQs were introduced for Gummy Shark and School Shark during 2001. Various restructures have occurred over the last two decades to reduce overall fishing capacity, and the fishery now comprises 62 Gillnet Fishing permits and 13 Hook permits managed under the SESSF Management Plan (2003). The real gross value of production during 2008–09 was $21.5 million (Wilson *et al.,* 2010).

20.6.1 Bycatch Management – General

The main target species in this fishery are Gummy Shark, Southern Sawshark, Common Sawshark (*Pristiophorus cirratus*) and Elephant Fish. School shark was a major target species for the historical line and gillnet fisheries, but overfishing lead to stock declines and this species is now managed under a Conservation Strategy to allow rebuilding (AFMA, 2008b). Discarding of target species is minimal, with 2% of teleosts and 3% of chondrichthyans discarded (Walker *et al.,* 2005). However, there have been increased reports of discarding of School Shark under the Bycatch TAC (e.g. Upston and Klaer, 2012). The main byproduct species include Whiskery Shark (*Furgaleus macki*), Broadnose Shark (*Notorynchus cepedianus*), and some finfish including Queen Snapper (*N. valenciennesi*), Knifejaw (*Oplegnathus woodwardi*), Longsnout Boarfish (*Pentaceropsis recurvirostris*) and Pink Snapper.

A Sustainability Assessment for Fishing Effects (SAFE) was conducted for the shark gillnet fishery on 195 species and highlighted 13 high risk species (Zhou *et al.,* 2007). The residual risk assessment reduced this down to 9 high risk species (AFMA, 2010a): Bronze Whaler (*Carcharhinus brachyurus*), Broadnose Shark, Dusky Shark (*Carcharhinus obscures*), Whiskery Shark, Shortfinned Mako (*Isurus oxyrinchus*), Smooth Hammerhead (*Sphyrna zygaena*) and White Shark (*Carcharodon carcharias*).

Levels of independent monitoring of bycatch in shark gillnets are historically low compared to other sectors of the SESSF, and as a result, there has been little quantitative information on bycatch and discarding. Increased levels of independent monitoring across the fishery has occurred since 2010 due to the incidence of sea lion and dolphin catches off South Australia, but these data have yet to be analysed. However, gillnet shots undertaken as part of the 2007–08 independent surveys (Braccini *et al.* 2009) give an indication of gillnet bycatch levels. These surveys involved six different commercial vessels during 16 cruises for sampling at 48 sites and 187 stations (106 stations in South Australia, 60 in Bass Strait and 21 in Tasmania) at depths ranging 9–230 m. During these surveys, discards accounted for 32–36% of the catch (by number), in commercial nets (6 inch) and experimental nets ≥ 6 inch. The most commonly discarded species were Draughtboard Shark, Port Jackson Shark (*Heterodontus portusjacksoni*) and Spikey Dogfish, and these species are expected to have a very low post-capture mortality. The level of discarding was heavily influenced by the mesh size used with the percentage of individuals discarded increasing to 40% for 5-inch mesh and 79% for 4-inch mesh (Braccini *et al.* 2009). Thus, although chosen to optimise the size range of Gummy Sharks caught in the fishery, the mandatory 6-inch gill net also is effective at minimising the level of bycatch.

Shark gillnet closures have been used to limit bycatch levels of School Shark, Gulper Sharks and other deepwater shark species. All waters within 3 nm of Victorian coast and specific areas in waters off Tasmania and South Australia are closed to protect School Shark during pupping. Current management arrangements restrict all gillnet operations to waters shallower than 183 m. These area closures are in addition to the South-east network of marine protected areas declared under EPBC Act to protect biodiversity.

As a developmental fishery, there is no information yet available on the bycatch of automatic longlines used to target Gummy Shark in waters off South Australia. Information is only available from trials recently conducted by Knuckey *et al.* (In prep). These trials showed that the discarded catch comprised 24 species, mostly Smooth Stingray (*Dasyatis brevicaudata*), Southern Eagle Ray (*Myliobatis australis*), Melbourne Skate (*Spiniraja whitleyi*), and Port Jackson Shark. Other discarded species included Common Gurnard Perch (*Neosebastes scorpaenoides*), Sponge, Southern Fiddler Ray (*Trygonorrhina dumerilii*) and Red Cod (*Pseudophycis bachus*). Overall, discards accounted for 30–60% of the catch weight (quota and non-quota species combined) depending on the region fished.

20.6.2 Bycatch management - TEP Wildlife interactions

Again, analyses of recent observer data are not yet available to apply to the commercial gillnet fishery, but information from Braccini *et al.* (2009) provides an indication of which TEP species have interactions with shark gillnets. For gillnet entanglements (7% of interactions), 3 White Sharks, 2 Short-tailed Shearwater (*Puffinus tenuirostris*), 1 unidentified seal, 1 Bottlenose Dolphin (*Tursiops truncatus*), and 2 Common Dolphins (*Delphinus delphis*) were caught in the commercial nets (Braccini *et al.* 2009).

Information on seabird interactions with automatic longlines used to target Gummy Shark is only recent (Knuckey *et al.,* in prep). The bird species sighted during setting

and particularly hauling were Short-tailed Shearwater, Shy Albatross (*Thalassarche cauta*), Australasian Gannet (*Morus serrator*), Grey-headed Albatross (*Thalassarche chrysostoma*), Pacific Gull (*Larus pacificus*), Silver Gull (*Larus novaehollandiae*), Yellow-nosed Albatross (*Thalassarche chlororhynchos*), Crested Tern (*Sterna bergii*), Black-browed Albatross (*Thalassarche melanophrys*), Cape Petrel (*Daption capense*) and Southern Giant Petrel (*Macronectes giganteus*). Australian Sea Lions (*Neophoca cinerea*) (ASL) were also sighted around the boat. However, the only interactions observed during these trials were with Short-tailed Shearwaters during summer; these interactions occurred during the full moon with clear skies. In line with the SESSF Threat Abatement Plan (TAP2), tori lines were deployed at all times while setting, and setting was generally conducted in the dark during the early morning. Further methods to mitigate these interactions are being explored.

By far the biggest bycatch issue affecting the shark gillnet fishery is the interactions with Australian Sea Lions and Common Dolphins off South Australia. The ASL population was significantly depleted by sealing activities in the 18th and 19th centuries but although they have been protected since the 1970s, populations have remained low (Goldsworthy *et al.,* 2008; 2009). Although the current breeding range of ASLs extends from the Page Islands (South Australia) to the Houtman Abrolhos Islands (Western Australia), most (86%) known breeding locations are found in the waters off South Australia (Goldsworthy *et al.,* 2009). State and Commonwealth shark gillnet fisheries operate over much of this range and in SA, there is significant overlap of historic and current fishing effort with the modelled ASL foraging distributions. ASLs are vulnerable to entanglement and drowning in demersal shark gillnets and Goldsworthy *et al.* (2010) suggested that high levels of bycatch mortality from the shark gillnet sector of the SESSF are limiting the recovery of most ASL colonies in South Australia.

Goldsworthy *et al.* (2010) monitored a total of 5,794 km hours of gillnets over 146 sea days, during which twelve ASLs bycatch mortalities were recorded, equating to 0.0021 seals/km-hr. Modelling based on effort during 2006–2009 estimated that 374 (272-506 ± 95%CL) ASL bycatch mortalities occurred off South Australia during each breeding cycle as a result of shark gillnets. This level of mortality was suggested to threaten the survival of many of the smaller ASL colonies. Although industry strongly disputed this figure, there was no fishery independent monitoring of the fishery that could provide an alternative quantitative estimate.

More recently, dolphin interactions with the shark gillnet fishery have been observed in one region of SESSF waters off South Australia. A large gillnet closure was implemented off the Coorong during 2011 following the spate of dolphin captures over a period of a few months. This region has subsequently remained closed pending trials of mitigation devices (acoustic pingers), which have yet to begin.

Although there may be technical solutions to the capture of ASLs and dolphins in gillnets (eg. pingers, slinging ratios, gear dimensions), the main management solution to date has been the implementation of ASL bycatch limits which trigger regional closures of extensive areas of the fishery to gillnets (AFMA, 2010). These trigger levels were revised down to a total of 15 individual mortalities across the fishery (triggers of 1 – 5 ASL mortalities depending on the zone) to demonstrably protect each of the sub-populations (breeding colonies), several of which have been recognised as being at risk of becoming locally extinct (AFMA, 2012b).

In addition to the measures above, there are currently ongoing trials of automatic longlines to target Gummy Shark in Commonwealth waters off South Australia. The expected interactions with ASLs and dolphins by this method are negligible but different bycatch species and the capture of birds may be an issue. The viability of this method to target Gummy Shark is still being evaluated.

20.7 GHAT – Overview of Scalefish hook, meshnet and trap sector

The Scalefish Hook Sector of the SESSF (formerly the South East Non-trawl Fishery) began as primarily a dropline fishery targeting Blue-eye Trevalla, mainly in waters off Tasmania. It was amalgamated with the SESSF during 1996 and now encompasses Commonwealth waters off the coast from the Western Australian border, around Tasmania and to waters off southern Queensland (south of Sandy Cape). Commonwealth waters generally extend out from the 3 nm coastal waters except off New South Wales, which retains jurisdiction over non-trawl fishers out to 80 nm. TACs were introduced for Blue-eye Trevalla, Blue Warehou and Pink Ling during the late 1990s and by the early 2000s, global TACs extended to all SESSF quota species and groups. Fishing concessions in this sector were halved as a result of the 2006 Structural adjustment package to 59, and although a variety of hook methods still exist in the fishery, the bulk of the catch is now taken by automatic longline fishing vessels. The real GVP of the Scalefish Hook Sector during 2008–09 was $9.4 million (Wilson *et al.,* 2010).

20.7.1 Bycatch Management – General

The first study into the bycatch of the various methods in the then South East Non-trawl Fishery was conducted by Knuckey *et al.* (2001). The total effort monitored during the study was about 33,000 dropline hooks and 70,000 longline hooks, with estimated discard rates of 9% and 3% by weight respectively. They also monitored 130 km of scalefish mesh-nets and 230 traps and found discard rates (by weight) of 19% and 4% respectively.

Dropline catches from a total of 289 shots, by eight vessels using 32,742 hooks were monitored during 2000. 91% of the catch was retained and consisted mostly of Blue-eye Trevalla (80%). The other retained species were Hapuku (*Polyprion oxygeneios*), Pink Ling, Porbeagle Shark (*Lamna nasus*) and Blue Grenadier. Virtually no quota species were discarded, except those that were damaged by predators such as shark, killer whales, seals or birds. Of the 9% bycatch, the most common discarded species were Greeneye Spurdog, Whitespotted Dogfish (*Squalus acanthias*) and Swellsharks (*Cephaloscyllium spp.*). Subsequent ISMP dropline monitoring during 2001/02 recorded bycatch levels <1% by weight (Knuckey *et al.,* 2002b).

Knuckey *et al.* (2001) monitored two demersal longline vessels working on the Gascoyne Plateau and the west coast of Tasmania. On the Gascoyne, a total of 43,000 hooks were monitored which caught 5,570 kg of fish comprising 19 species, of which only 122 kg (2% by weight) were discarded. King Tarakihi (*Nemadactylus sp.*) was the most common retained species caught (80%), but significant amounts of Yellowtail Kingfish (*Seriola lalandi*), Striped Trumpeter (*Latris lineata*), Greeneye Spurdog, Blue-eye Trevalla and Hapuku were also caught. The bycatch was mainly small Greeneye Spurdog, Ringed Toadfish (*Omegophora armilla*), Australian Burrfish and Moray Eels (Family Muraenidae). Off Tasmania, 27,250 hooks were monitored, catching 7,781 kg of fish of which almost all (92%) was Pink Ling. Bycatch

accounted for only 4% of the catch by weight and consisted mainly of whiptails, skates and various small shark and dogfish species. Similar discard rates (6%) were recorded by the ISMP during 2001/02 (Knuckey *et al.,* 2002b).

The monitored shots of the trap fishery targeted Pink Ling, which accounted for ~90% of the catch. Other retained species were Jackass Morwong, Ocean Perch, Ribaldo (*Mora moro*) and Hapuku. The bycatch was only 1% by weight and was largely Draughtboard Shark (Knuckey *et al.,* 2001). Similarly, low discard rates (2%) were recorded for the trap fishery by the ISMP during 2001/02 (Knuckey *et al.,* 2002b), with discards comprising mainly starfish and crabs.

On scalefish mesh net vessels working in eastern Bass Strait, Knuckey *et al.* (2001) monitored 91 shots, consisting of over 128 km of net. About 80% of the catch was retained, consisting of Blue Warehou (37%), Blue-eye Trevalla (24%) and Pink Ling (24%). The shallower shots (140–320 m) were targeted at Blue Warehou and had a bycatch of Jack Mackerel and Greeneye Spurdog. Eight percent (by weight) of Blue Warehou were discarded, usually because they were damaged. The deeper shots targeting Blue-Eye Trevalla and Pink Ling had a bycatch of Eastern Gemfish, Greeneye Dogshark and Draughtboard Sharks. Significant discarding of Eastern Gemfish was a result of trip limits imposed on non-trawl vessels (zero in 1999 and 50 kg in 2000).

20.7.2 Bycatch management - TEP Wildlife interactions

Despite monitoring over 300,000 dropline and longline hooks, and sighting of many hundreds of birds following the vessels and feeding, Knuckey *et al.* (2001; 2002b) observed no mortalities of seabirds. There was no bycatch of marine mammals or any other TEP species in any observed longline, trap or scalefish mesh-net operation. The only observed TEP mortality was an Australian Fur Seal that was entangled and drowned in a dropline set in eastern Tasmania.

During 2002, all waters shallower than 183 m were closed to automatic longlining to prevent targeting and bycatch of Gummy Sharks and School Sharks. More recently, a number of closures to hook and mesh net fishing have been introduced to protect Gulper Shark in eastern Bass Strait and the Great Australian Bight.

In addition to the closures, the automatic longlining sector developed a Code of Conduct to reduce the incidental mortality of Gulper Sharks that may be accidentally caught as a bycatch of their fishing operations (SEFA, 2006). As well as providing biological information and identification keys, the Code details “encounter procedures” which require stopping the hauler, assessing the life state, and then cutting off the snood to release the shark whilst still in the water. Independent scientific surveys have demonstrated that if handled correctly, the survival rate of Gulper Shark caught on longline can be very high (Williams *et al.,* 2012b). More recently, the Upper-Slope Dogfish Management Strategy (AFMA 2012a) has introduced zero retention of gulper sharks.

The incidental bycatch of seabirds during oceanic longline fishing operations was listed as a key threatening process during 1995. Under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), a Threat Abatement Plan was developed in 1998 and revised in 2006 (TAP2). SESSF automatic longline vessels must comply with the TAP2, which has strict requirements for the deployment of

approved mitigation devices, 10% observer coverage and seabird bycatch/interaction limits of 0.01 birds per 1000 hooks. Bycatch limits have not been breached by SESSF longline operators since implementation of the TAP.

SESSF Bycatch composition and quantities

20.7.3 General Bycatch

As discussed in the preceding sections, the level of bycatch taken in each of the sectors of the SESSF is very much determined by the fishing methods used. Trapping and droplining have the lowest estimated levels of bycatch (<5%), but now represent only a very small proportion of fishing effort in the SESSF; there has been no effort to mitigate bycatch in these methods and it is not further explored here. At the other end of the scale, trawling accounts for the bulk of the landed fish from the SESSF, and also has the highest bycatch rate. In between, shark gillnets have a bycatch rate of around 35% and scalefish longlines have a discard rate of approximately 10% of the weight of the catch. The difference in these gears and bycatch figures indicates the difficulty in broadly "characterising" bycatch in such a multi-gear, multi-species fishery such as the SESSF, but this difference has also greatly influenced the bycatch mitigation work that has been undertaken in each of the sectors, and whether it has focused on general bycatch, or TEP wildlife interactions.

A breakdown of the SESSF effort by gear shows that the trawl (SET and GABT and Danish seine) makes up most of the effort (Figure 20.6a) and these are also the gears that have the greatest bycatch level and discard rate. The impact of the 2006 Government restructure package on the SESSF is clear, particularly for the trawl fleet in the east of the fishery (Figure 20.6b) where effort was greatly reduced.

In this section the focus is on the SET and GABT sectors, including the analyses of observed discard quantities of non-quota species (including high risk species) for the GHAT (line and gillnet sectors), in the form of tables (Table 20.4 and Table 20.5). For the main quota species, species composition of the discards were reported across the SESSF (excluding GABT). Confidence intervals were not estimated as this would have required technical analyses beyond the scope of this project. Broad trends are highlighted.

The number of ISMP observations by year and fishery sector (and gear) is reported at the top of tables, and can be compared to the fishery effort (Figure 20.6a and Figure 20.6b) to gauge overall observer coverage. For the SET observer coverage since 2000 has ranged between 2-3% of the commercial fishery (exception 2007, 1.5%). GABT observer coverage for 2000 to 2002 is 5%, and ranges between 3-4.5% in subsequent years. Observer coverage in the GHAT gillnet sector is 1-2% in 2009, 2010, and approximately 4% in 2011. For the GHAT line sector observer coverage ranges between 25-30% since 2002, except for 2004, 2005, and 2006, when coverage is 6-9% of the commercial fishery. For wildlife interactions, the variability in these data between years suggests that the data are a subset of the total ISMP observations for a given sector and year (at least for part of the time series).

SET

Most work on the mitigation of general bycatch (teleosts and chondrichthyans) has been focused on the SESSF trawl sectors: the SET and GABT. Discard rates whilst "market fishing" (fishing to meet the market demand) in the SET are variable but fluctuate around 40–50% across the fleet, for quota and non-quota species combined. This contrasts markedly to target fishing by trawl for Orange Roughy as an example, where trawl bycatch levels may be as low as <5%. Despite the work that has been conducted on improving selectivity of SET market fishing, there is no obvious trend in the quantity of bycatch apart from that which accompanied the 2006 structural adjustment package. This had a significant impact on bycatch, when the discard quantity almost halved within two years to the lowest levels on record (Figure 20.7), including a substantial reduction in the discards of main quota species (exception 2011; (Figure 20.8). Interestingly, this change in the fishery was also accompanied by a drop in the discard rate (Figure 20.7). Unfortunately, this trend may be confounded by the poor quality of observer coverage during 2007 and 2008. In 2011 the discard quantity has increased, although not to the historical high levels, and the discard rates have risen back to around the long term average of 40% (Figure 20.7).

Within this level of discarded catch, most (85–95%) consists of non-quota species (Figure 20.8), significant components of which include Barracouta, New Zealand Dory (*Cyttus novaezealandiae*), Whiptails, Cocky Gurnard (*Lepidotrigla modesta*), Frostfish, Skates/Rays. Blacktip Cucumberfish, Spikey Dogfish, Swellsharks, Draughtboard Sharks and Stingarees (Figure 20.9). In general, these species are a consistent component of the observed discard weight over time (Table 20.2). The estimated discard rate for non-quota species (including byproduct and highrisk species) is generally 70% to 80% of the total weight caught (Figure 20.12).

Whilst the composition of the discarded catch of non-quota species is reasonably consistent and predictable, it is noteworthy that the greatest tonnage (and rate) of discards occurred (Figure 20.8) when an extremely large cohort of juvenile Blue Grenadier entered the fishery during 1998 (Figure 20.10; see Tuck *et al.*, 2011) and were prevalent throughout the western region of the fishery (W Bass and W Tas; Figure 20.11). At this time, most vessels used 90 mm double braid codends and they could not avoid the small Blue Grenadier that were meshed and caught in the nets. Discarding of Blue Grenadier reduced in subsequent years as the fish grew and markets for the small fish developed. Subsequently, many industry members have agreed to use large codend mesh should this situation occur again and indeed, most of the trawl vessels in the western regions of the SESSF now do use larger (102 mm) codends as a matter of course. Since the recruitment event in 1998, large numbers of juvenile Blue Grenadier also entered the fishery in 2004/ 2005, and although there was increased discarding of Blue Grenadier, it was at a lower level this time (Figure 20.10). The high estimated discard rate of 15% during 2011 is from preliminary data, but may be associated with another larger than average cohort of juvenile Blue Grenadier entering the fishery.

The species composition of discards for main quota species each year are shown in Figure 20.10. Apart from juvenile Blue Grenadier, another quota species contributing most to discarding is Redfish, particularly from 2000–2004. Like Blue Grenadier, this occurred when a pulse of small juveniles entered the fishery and were largely discarded, as evidenced in the higher discarding apportioned to NSW during these

years (Figure 20.11). Silver Warehou is also a significant but variable component of the discards of quota species. In most recent years Redfish, Silver warehou, and Blue grenadier comprise the greatest proportion of quota species discards (Figure 20.10). Inshore Ocean Perch, whilst only a small component of the catch, is a quota species that nearly always experiences high rates (>75%) of discarding, while the larger sized Ocean Perch is usually retained. Eastern Gemfish has been under a bycatch TAC of 100 t for the last decade, but has seen an overall increase in discarding over this time, attributed to a slow rebuilding of the severely depleted stock. The estimated discard rates for the 19 main quota species across the SESSF (excluding GABT) are shown in Figure 20.13.

It is difficult to attribute the reduced level of discard tonnage in the SET to gear modifications. Overall, if the move towards using larger mesh codends or square or T90 panels has had any impact on reducing discards rates, it is not evident in the data. The change in gear may have been partly responsible for the reduced level of discarding subsequent to 2005, but if so, the effect has been over-ridden by the effect of the structural adjustment package around the same time. Alternatively, based on their morphology, changes in mesh size may be beneficial for escapement of some species but not others (Knuckey and Ashby, 2010), and this might lead to only a limited net overall escapement of fish. It's quite possible that this level of detail is not able to be detected from the ISMP data. It is important to note that the work of Knuckey and Ashby (2010) that suggested significant changes in bycatch from larger or alternate mesh configuration was based on the mesh in the entire codend being changed, not just that from a small panel.

GABT

Data from the GABTS is less comprehensive than that from the SET, so weighted estimates of total discards are not available for every year across the time series. Nevertheless, there are estimates of total discard rates during the early 2000s that ranged between 30–60% for quota and non-quota species combined (Figure 20.14), albeit less certain estimates than those in the SET. There are only three major quota species in the GABT and only two in the market fishery (Bight Redfish and Deepwater Flathead), and unlike the SET, there is virtually no (<1%) discarding of quota species. The non-quota species that comprise the bulk of the discarded catch are Latchets, Ocean Jackets, skates and rays (Figure 20.15 and Table 20.3). The estimated discard rate has fluctuated between 60% and 80% of the total catch for non-quota species. There appears to have been a decrease in the discard rate in recent years based on figures from industry logbook data, but unfortunately, the ISMP data obtained during 2010 was not sufficient to enable an estimate of discard rate that is independent to that reported by industry. Nevertheless, if the logbook data is reasonably accurate, it is quite possible that this reduction in discarding can be attributed to the introduction of T-90 mesh during 2007 (although the 2008, which is highly uncertain, shows a high discard rate). Unlike the SET, the structural adjustment package was not targeted at the GABT, and did note remove any vessels, so changes in discarding cannot be attributed to this. Until more detailed data is collected by the ISMP to verify the logbook estimates of discards, the change in discard rate and detailed composition of the bycatch cannot be further scrutinised.

Figure 20.6 Breakdown of SESSF effort (operations) by a) gear and b) zone. Source: Klaer *et al.* 2012.

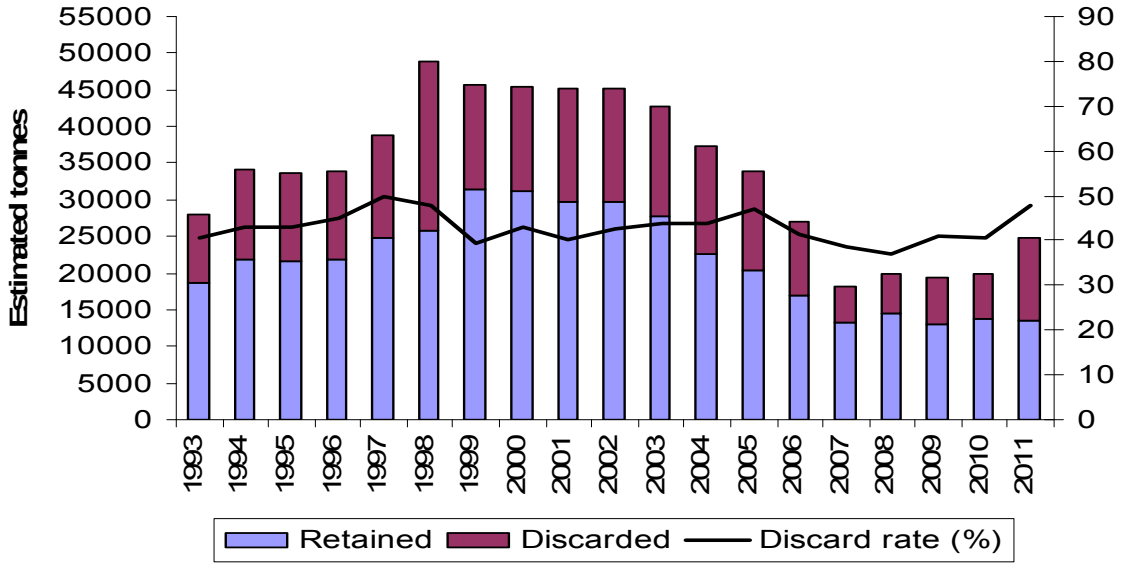

Figure 20.7 Estimated retained and discarded catch (t) and estimated discard rate (%) for the SET, quota and non-quota species combined. The 2011 discard estimates are preliminary. Note there were no observations for NSW prior to 1998 in the AFMA database.

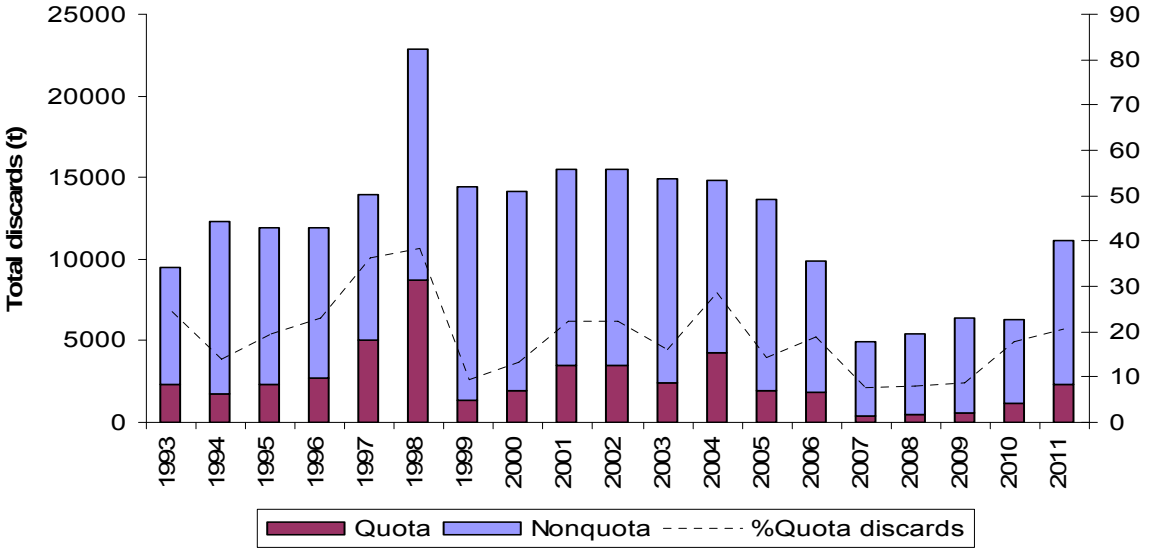

Figure 20.8 Estimated quota and non-quota discards (t) in the SET and the percentage of discards that were quota species. The 2011 discard estimates are preliminary. Note there were no observations for NSW prior to 1998 in the AFMA database.

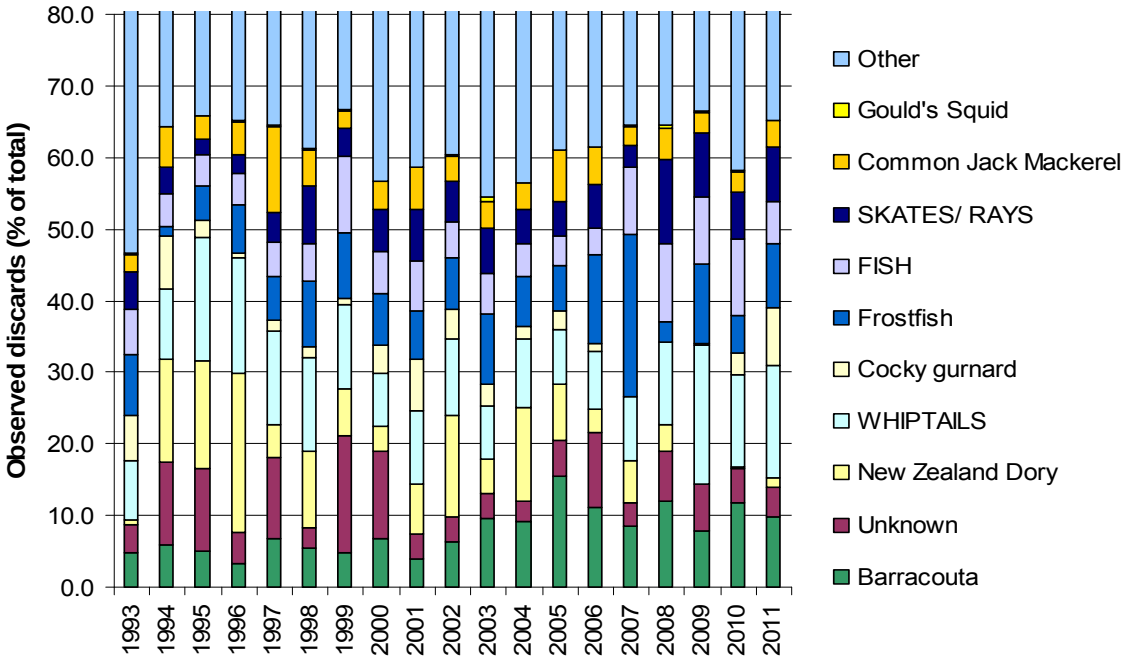

Figure 20.9 Species composition (by weight) of discarded non-quota species in the SET fishery. 86 species / species groups were included in the analysis (Table 20.2).

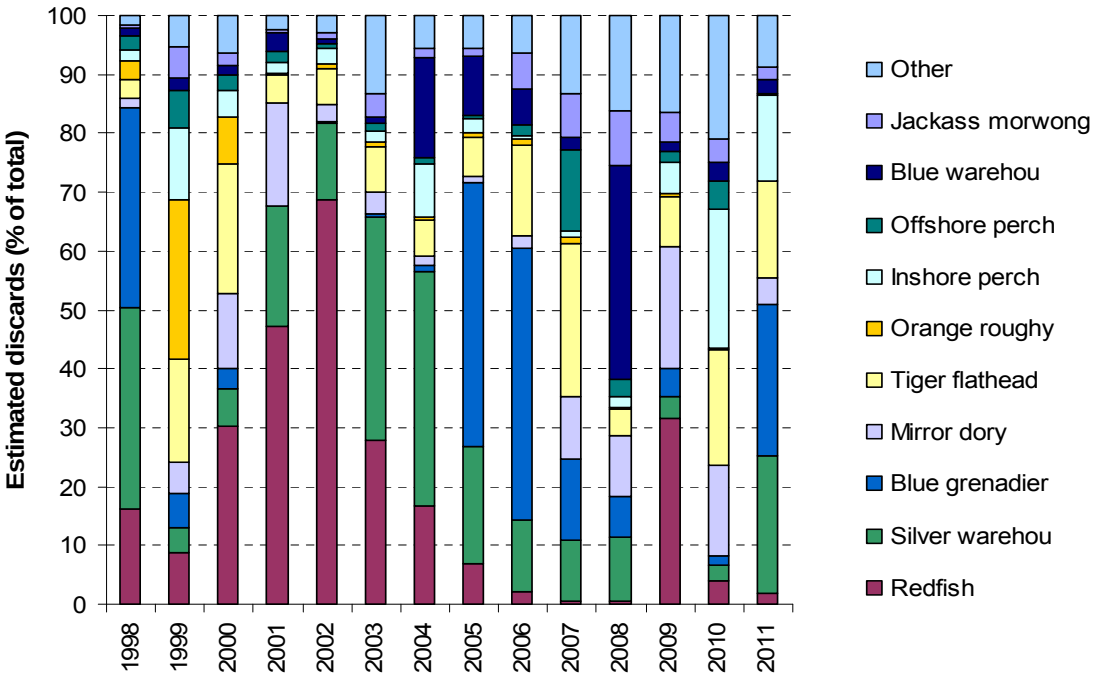

Figure 20.10 Species composition (by weight) of discarded SESSF quota species (excl GABT). 19 main quota species were included in the analysis (Table 20.9).

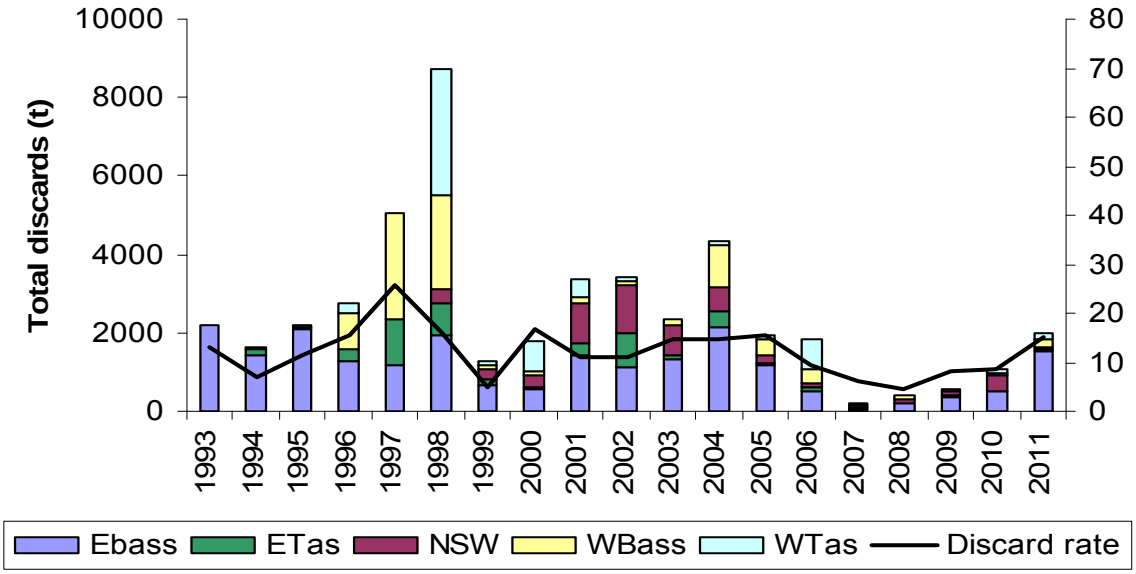

Figure 20.11 Estimated discard tonnes and estimated discard rate (%) across 19 main quota species in the SET fishery. Note: there were no observations for NSW prior to 1998 in the AFMA database and the 2011 discard estimates are preliminary. The 1998 peak is difficult to estimate and is likely exaggerated.

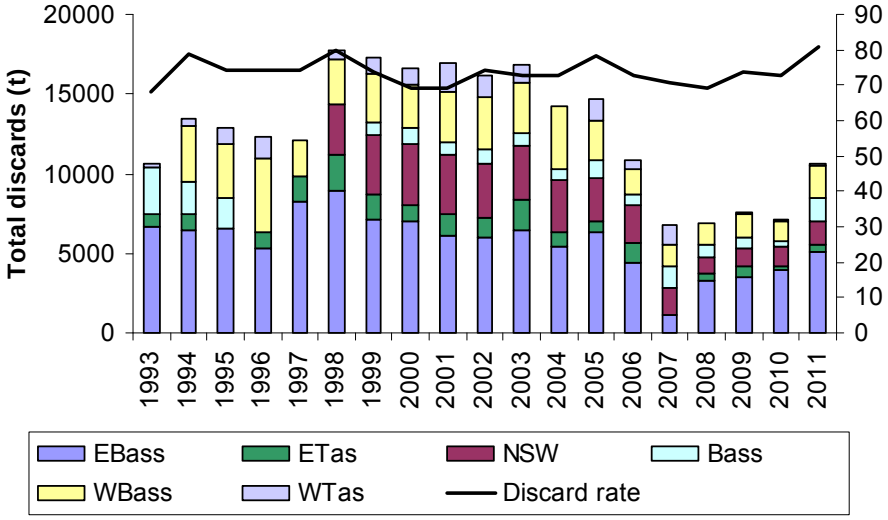

Figure 20.12 Estimated discard tonnes and estimated discard rate (%) of non-quota species in the SET fishery. Note: there were no observations for NSW prior to 1998 in the AFMA database.

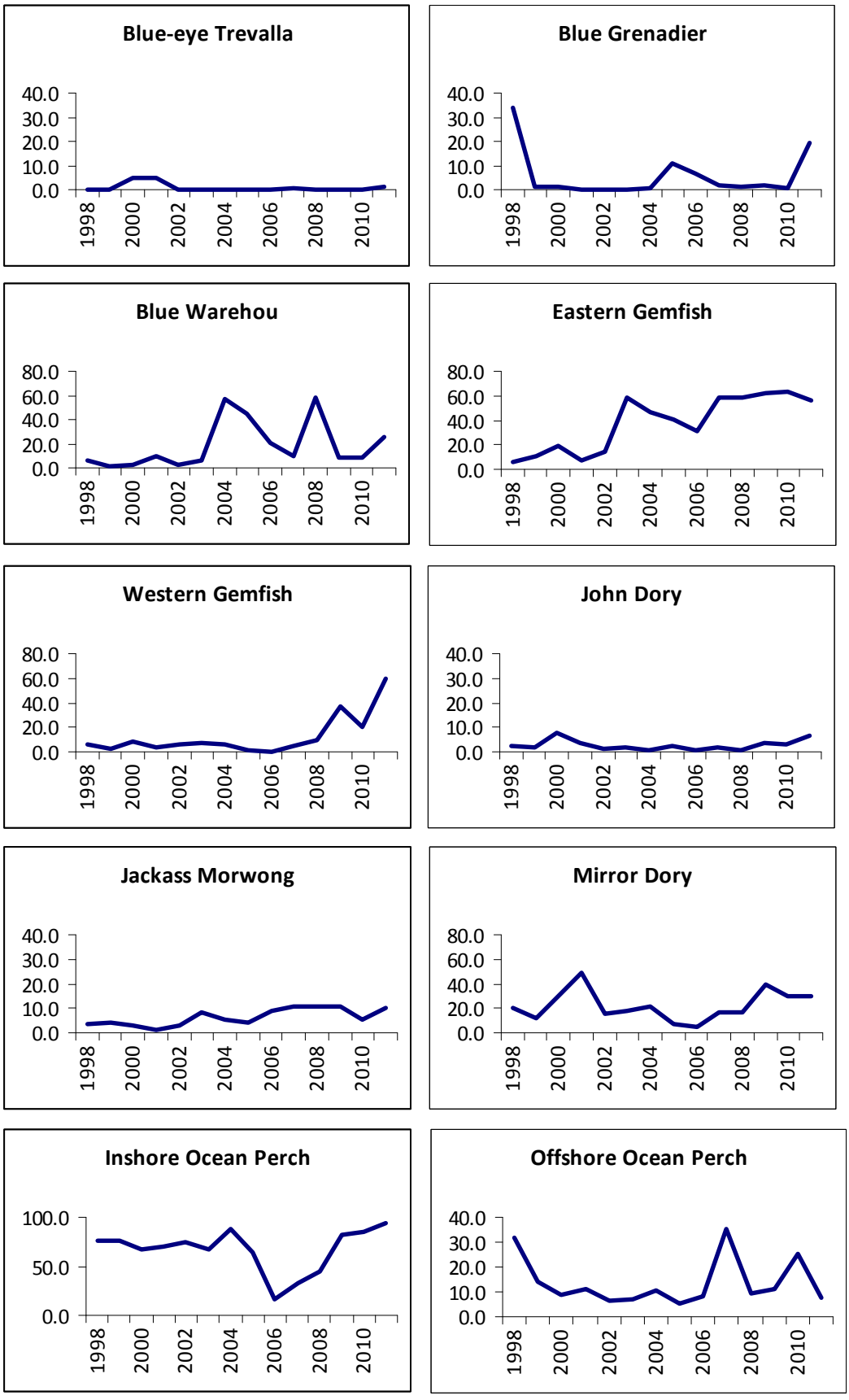

Figure 20.13 SESSF (excluding GABT) wide discard rates (%) for 19 main quota species, for the period 1998 to 2011.

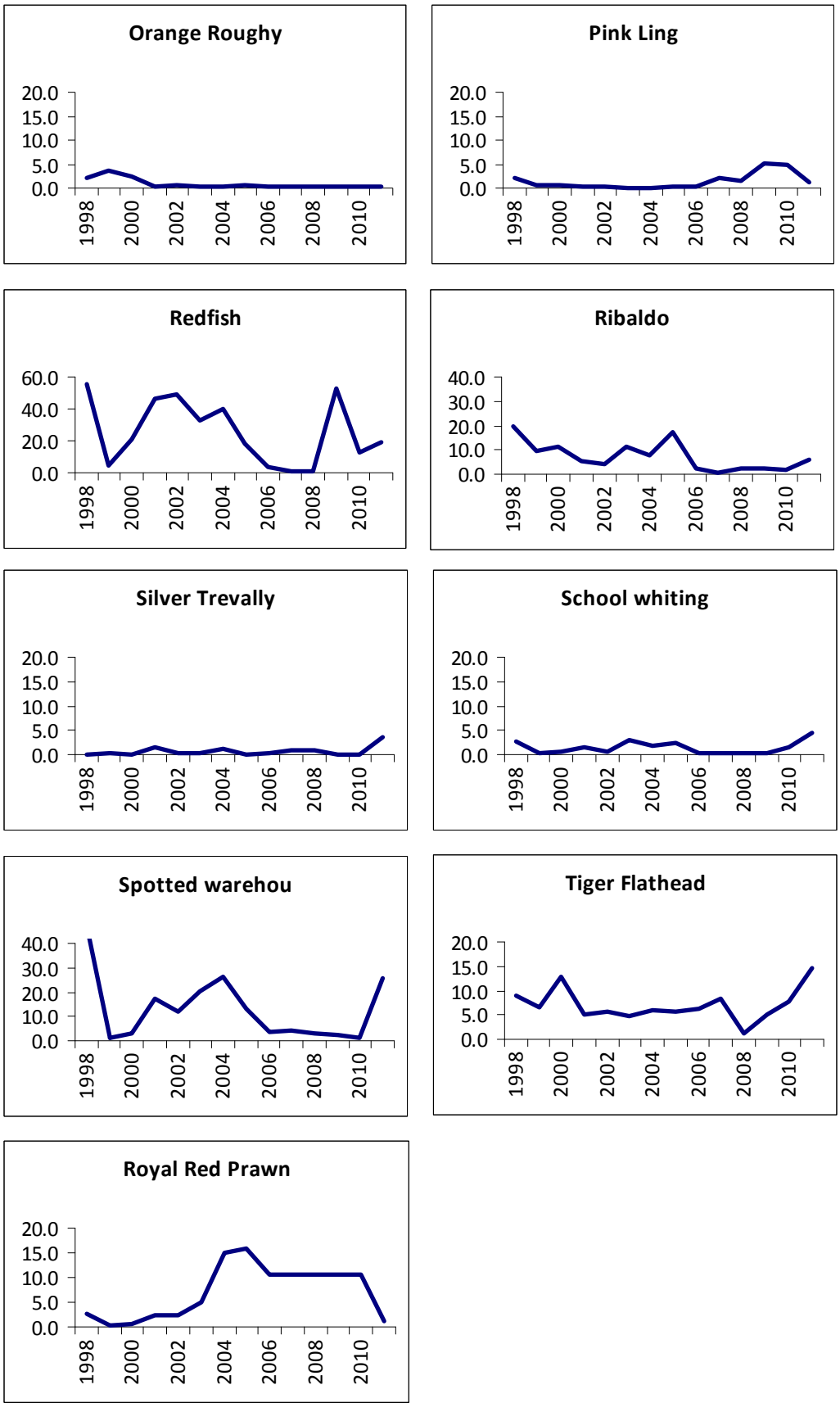

Figure 20.13 continued. SESSF (excluding GABT) wide discard rates (%) for 19 main quota species, for the period 1998 to 2011. Note: Spotted warehou are referred to as Silver warehou in the text.

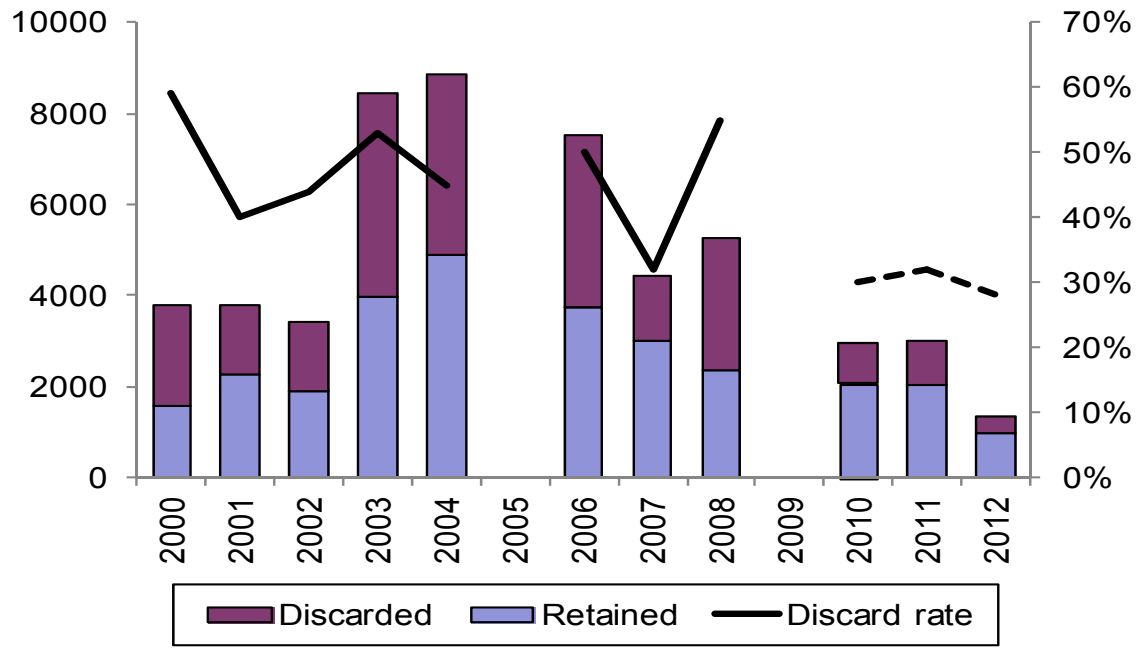

Figure 20.14 Estimated retained and discarded catch (t) and estimated discard rate (%) for the GABT, quota and non-quota species combined (noting <1% discarding of quota species). The solid lines represent discard rates estimated from the ISMP data and the dashed lines (2010 – 2012) represent discard rates obtained from industry logbooks. Note: 2012 represents a partial year of data.

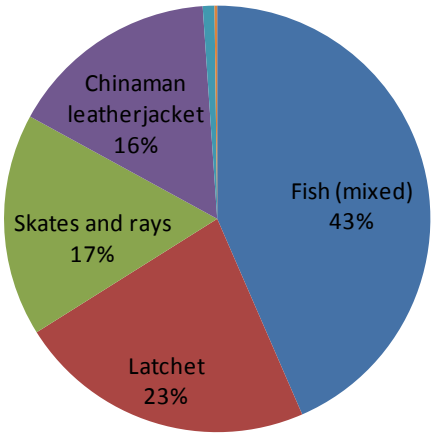

Figure 20.15 Broad species composition of discarded non-quota species in the GABT fishery. Data summarised from 2010 industry logbooks.

Table 20.2 SET fishery ISMP observed total catch (t) for non-quota bycatch species (descending order by total in period 1992-1994; top 15 spp highlighted) by year. A nominal colour scheme indicates high, low values for TOTAL across species. TOTAL observations indicate sampling effort (limited sampling for 2007, 2008). Dis: D=mostly discarded; R=mostly retained. High risk (Hrisk) species indicated by "HR".

Ord	Species (Project Key)	Dis	Hrisk	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
	TOTAL Observations (shots)			518	838	594	595	745	692	946	824	977	848	935	829	949	855	317	452	633	706	679
	TOTAL Observed Catch (t)	D		213.9	416.7	283.7	312.1	374.1	335.7	414.3	305.0	401.9	330.5	372.3	336.1	425.1	348.4	98.2	155.3	196.8	188.7	248.1
1	BARRACOUTA	D		24.3	44.9	15.5	20.9	23.2	18.2	18.9	18.3	15.7	17.8	29.3	24.8	55.5	29.3	7.3	13.7	12.5	16.9	20.8
2	UNKNOWN	D		6.9	45.8	32.9	12.0	40.2	8.3	51.6	27.1	10.5	8.9	9.1	7.1	18.3	29.0	2.9	12.3	12.4	8.7	8.4
3	NEW ZEALAND DORY	D		<1	47.6	31.9	51.5	12.6	28.5	20.4	7.0	19.2	34.8	13.5	31.8	25.8	8.7	3.9	4.2	<1	<1	2.9
4	WHIPTAILS	D		12.3	32.0	37.3	38.6	36.1	36.2	37.1	15.8	28.6	26.2	19.8	23.5	25.5	20.4	5.8	12.7	28.9	19.9	32.3
5	COCKY GURNARD	D		9.2	24.4	5.3	1.4	4.5	4.1	2.1	8.4	20.1	10.0	8.5	4.5	8.9	2.7	-	-	<1	4.0	16.0
6	FROSTFISH	D		22.7	8.8	16.0	21.5	18.9	32.3	35.9	19.9	28.1	23.1	30.4	23.4	26.8	37.2	22.2	3.6	19.5	13.9	20.9
7	FISH	D		11.9	17.1	10.4	12.5	16.4	19.0	39.8	21.5	30.1	17.8	20.5	15.8	19.2	16.0	9.1	15.7	21.8	18.4	16.1
8	SKATES/ RAYS	D		10.0	14.2	6.3	8.2	13.8	23.9	19.6	18.0	26.3	17.3	21.4	16.9	22.0	20.3	2.5	14.2	14.9	10.0	17.0
9	COMMON JACK MACKEREL	D		4.6	19.5	8.4	13.5	37.6	14.5	7.8	9.5	17.8	11.3	11.4	10.2	24.8	14.3	1.8	5.2	5.0	4.1	8.3
10	GOULD'S SQUID[R]	R		12.8	10.0	20.5	14.5	14.1	9.2	13.7	8.0	22.6	15.4	28.3	13.4	15.4	16.8	3.4	8.3	7.0	8.4	1.3
11	BLACKTIP CUCUMBERFISH	D		12.4	9.5	8.3	8.6	10.4	11.3	16.0	16.6	16.8	11.3	14.7	11.6	10.5	7.6	-	-	-	2.2	7.1
12	PIKED SPURDOG	D		10.3	8.7	3.5	6.4	19.0	10.6	8.7	10.9	12.7	8.8	13.8	23.3	16.8	23.2	3.6	3.7	2.3	5.7	8.9
13	WHITEFIN SWELL SHARK	D		2.3	16.5	12.8	7.0	11.9	11.8	11.3	7.4	10.4	10.1	9.3	9.2	8.2	4.2	<1	<1	1.1	1.4	2.1
14	DRAUGHTBOARD SHARK	D		15.4	3.3	<1	1.4	9.0	7.9	7.1	3.5	4.8	4.3	6.1	3.3	6.2	7.2	<1	3.8	3.1	1.6	1.5
15	STINGAREES	D		8.6	9.1	2.7	6.4	6.4	5.2	3.5	15.7	25.4	12.7	21.0	19.1	14.6	13.2	4.2	3.6	5.3	6.1	15.7
16	ROUNDSNOUT GURNARD	D		7.3	6.4	1.4	4.0	3.5	4.4	2.6	5.2	4.2	4.0	7.7	6.1	19.9	8.5	-	-	<1	1.7	<1
17	DEEPWATER BURRFISH	D		4.5	8.5	1.6	5.7	5.2	2.0	3.0	3.7	12.3	9.8	13.8	8.5	7.4	7.2	<1	<1	2.8	3.0	3.6
18	VELVET LEATHERJACKET	D		4.5	8.3	5.7	5.4	5.7	5.2	3.9	4.9	7.8	3.2	4.2	4.4	2.1	1.1	<1	<1	<1	<1	<1
19	SILVER DORY	D		1.9	7.4	1.7	5.4	6.6	3.2	2.4	1.9	1.4	1.6	2.4	3.3	4.7	4.1	<1	6.0	4.7	9.2	2.8
20	OCTOPUS_HRISK	R	HR	3.0	6.2	3.3	1.9	1.5	3.2	2.8	1.8	1.9	<1	1.6	1.9	1.1	1.8	<1	<1	<1	<1	<1
21	LATCHET	R		1.5	6.5	2.0	3.4	3.2	2.2	3.5	3.4	6.7	4.0	3.7	5.5	5.8	4.9	2.0	6.2	3.2	1.2	6.0
22	COMMON STINKFISH	D		<1	7.7	6.5	<1	<1	<1	<1	2.2	<1	1.4	<1	<1	<1	<1	<1	<1	<1	<1	2.0
23	GARGOYLE FISH	D		<1	6.3	5.8	3.4	3.7	7.6	2.6	1.8	2.0	6.2	5.8	5.8	7.4	6.6	-	-	-	<1	<1
24	SPECKLED STARGAZER	R		3.1	3.5	3.5	4.6	5.4	2.7	4.1	4.5	5.2	6.4	3.1	3.4	4.4	5.9	-	-	-	1.4	2.4
25	PORT JACKSON SHARK	D		2.9	3.5	1.7	1.4	2.4	4.6	3.9	4.3	5.0	3.6	6.5	4.9	4.6	4.5	<1	2.1	4.9	3.0	1.9
26	SKATE SP A_HRISK	D	HR	3.2	3.0	<1	<1	1.3	<1	<1	<1	1.5	<1	<1	<1	<1	-	-	-	-	<1	2.5
27	TASMANIAN NUMBFISH	D		2.9	1.8	<1	1.2	2.9	1.3	<1	<1	<1	<1	1.6	1.1	1.7	3.0	<1	<1	<1	1.3	2.3
28	SHARK	D		1.3	2.8	<1	2.7	4.3	2.2	3.4	1.7	3.8	2.1	2.9	2.1	2.6	3.4	1.4	1.0	1.7	1.3	1.2
29	CUTTLEFISH (UNSPECIFIED)_HRISK	R	HR	1.3	2.5	<1	2.2	2.8	2.9	4.5	3.0	2.8	1.8	1.3	1.3	1.4	2.6	<1	-	-	<1	-
30	BIGSCALE RUBYFISH	D		-	3.4	1.4	7.7	<1	8.4	2.1	1.1	<1	1.8	6.2	1.6	11.2	1.4	-	<1	-	<1	<1
31	RED GURNARD	R		1.5	1.9	<1	<1	2.5	1.4	2.4	1.5	2.8	2.0	1.6	1.6	2.0	1.3	<1	<1	1.1	1.5	<1

[R] Gould's squid are mostly retained thus a decrease in catch over time might be unintended

Table 20.2 continued. SET fishery ISMP observed total catch (t) for non-quota bycatch species. Dis: D=mostly discarded; R=mostly retained. High risk (Hrisk) species indicated by "HR". Species 61-86 are reported in Table 20.11.

Ord	Species (Project Key)	Dis	Hrisk	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
	TOTAL Observations (shots)			518	838	594	595	745	692	946	824	977	848	935	829	949	855	317	452	633	706	679
32	STARGAZERS	R		<1	2.4	-	-	-	<1	<1	<1	-	-	-	-	<1	<1	<1	<1	<1	<1	<1
33	KING DORY	R		1.3	1.4	7.5	5.1	6.8	2.9	4.1	3.3	3.1	5.0	5.0	2.1	3.0	<1	1.7	1.4	4.4	4.7	4.7
34	GREY MORWONG	R		<1	1.4	<1	1.8	<1	1.9	1.8	2.2	3.1	2.6	2.9	3.3	2.7	2.7	<1	1.2	<1	1.3	<1
35	CALAMARI	R		<1	2.2	4.1	<1	<1	3.0	7.2	11.1	4.8	5.0	8.0	6.4	6.8	9.8	<1	-	-	-	-
36	ECHINODERMS	D		0.2	3.5	2.4	2.8	2.1	6.2	5.0	3.3	3.0	1.4	2.1	1.3	1.8	2.0	0.1	0.2	0.7	0.2	1.2
37	GLOBEFISH	D		<1	1.9	2.6	<1	3.0	<1	1.1	<1	<1	<1	<1	<1	1.2	<1	-	-	-	<1	-
38	COMMON GURNARD PERCH	D		<1	1.9	2.9	<1	<1	<1	8.2	<1	<1	<1	1.4	<1	<1	<1	<1	-	-	<1	<1
39	THREE-SPINED CARDINALFISH	D		<1	1.1	3.4	<1	1.7	<1	2.0	<1	2.7	1.6	3.2	1.5	2.1	1.1	1.3	<1	<1	<1	<1
40	GREENEYE DOGFISH_HRISK	D	HR	1.2	<1	<1	10.0	4.7	7.2	8.7	5.8	5.8	6.3	1.2	1.4	2.3	<1	1.2	5.7	5.2	2.6	<1
41	SWIMMER CRAB	D		<1	1.0	1.1	3.6	1.2	<1	<1	<1	<1	1.6	<1	1.5	1.1	<1	-	-	-	-	-
42	MOLLUSC	R		<1	1.0	<1	<1	5.4	1.5	1.2	<1	<1	<1	<1	<1	1.4	<1	<1	<1	<1	<1	<1
43	EASTERN ORANGE PERCH	D		<1	<1	<1	<1	1.8	1.4	1.6	5.2	2.2	1.4	1.4	<1	2.3	<1	-	<1	<1	<1	<1
44	CRUSTACEANS	D		0.3	1.5	1.8	1.9	4.2	5.6	14.5	4.9	8.2	5.6	4.6	2.9	2.7	3.4	1.3	3.5	3.9	3.7	2.1
45	OGILBY'S GHOSTSHARK	R		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
46	BIGHT SKATE	D		<1	<1	<1	<1	<1	<1	<1	<1	<1	2.4	2.1	2.8	2.4	1.5	<1	1.5	2.4	1.6	<1
47	BANDED BELLOWSFISH	D		<1	<1	2.2	2.1	4.8	1.4	2.7	1.2	1.1	1.4	<1	<1	<1	1.3	1.0	<1	2.2	3.0	1.8
48	HAPUKU_HRISK	R	HR	<1	<1	<1	1.1	1.7	1.5	3.5	1.9	<1	<1	<1	<1	1.3	<1	<1	<1	<1	<1	<1
49	KNIFEJAWS	R		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
50	BLUESTRIPED GOATFISH	R		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	-	<1	<1
51	OTHER	D		<1	<1	<1	<1	<1	1.5	<1	<1	2.6	<1	<1	<1	<1	<1	<1	<1	1.5	<1	1.6
52	HIGH RISK UPPER SLOPE DOGFISH	R	HR	<1	<1	<1	1.2	2.7	<1	1.5	1.8	1.1	1.0	1.0	<1	<1	<1	<1	<1	<1	<1	<1
53	LONGSNOUT BOARFISH	R		<1	<1	<1	<1	<1	<1	<1	-	-	<1	<1	<1	<1	<1	-	-	<1	<1	<1
54	CHIMAERAS	R		<1	<1	<1	<1	<1	<1	1.2	1.0	<1	1.1	1.1	<1	<1	<1	<1	<1	<1	<1	<1
55	REDBAIT	D		<1	<1	<1	<1	1.0	<1	<1	1.3	1.4	1.8	1.3	<1	3.7	2.8	<1	<1	<1	<1	1.2
56	SNAPPER	R		<1	<1	<1	<1	1.0	<1	<1	<1	<1	<1	<1	1.5	<1	2.0	<1	<1	<1	<1	<1
57	HIGH RISK TELEOSTS	D	HR	<1	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
58	BRONZE WHALER_HRISK	R	HR	-	<1	<1	-	-	-	<1	<1	<1	<1	<1	<1	<1	<1	-	<1	-	<1	<1
59	STRIPED TRUMPETER	R		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	-	<1	<1
60	AUSTRALIAN ANGELSHARK	R		-	<1	<1	<1	<1	2.8	8.2	7.3	6.6	5.3	8.7	11.3	9.4	5.9	<1	<1	<1	1.7	1.1

Table 20.3 GABT fishery observed tonnes (discarded D+ retained=total T) for non-quota bycatch species A nominal colour scheme indicates high, low values for TOTAL observed discard tonnage across species. TOTAL observations indicate sampling effort (limited sampling for 2007, 2008; no observations for 2009). R=mostly retained. High risk (Hrisk) species indicated by "HR".

				2000	2000	2001	2001	2002	2002	2003	2003	2004	2004	2005	2005	2006	2006	2007	2007	2008	2008	2010	2010
Ord	Species (Project Key)	Dis	Hrisk	D	T	D	T	D	T	D	T	D	T	D	T	D	T	D	T	D	T	D	T
	Number of unique CAABs				146		117		133		182		170		148		166		155		158		135
	TOTAL Observations (shots)				122		164		142		132		173		215		173		143		151		139
	TOTAL Observed Catch (t)	D		95.9	120.2	77.7	112.6	72.3	93.1	107.2	137.3	108.1	150.5	167.1	200.8	103.8	145.3	41.3	71.0	99.5	125.2	101.6	120.4
1	LATCHET	D		51.6	52.6	26.2	26.3	30.1	30.3	21.8	23.9	12.1	15.9	48.6	49.4	12.4	20.2	11.9	16.2	17.1	19.0	34.1	35.8
2	STINGAREES	D		8.9	8.9	16.5	16.5	10.2	10.2	20.3	20.3	8.0	8.0	32.4	32.4	13.3	13.3	<1	<1	7.5	7.5	24.3	24.7
3	UNKNOWN	D		10.6	10.6	8.2	8.4	10.0	10.0	18.7	18.8	19.5	19.5	20.1	20.2	19.9	20.1	1.7	14.2	3.8	6.5	<1	<1
4	YELLOWSPOTTED BOARFISH	R		-	2.2	<1	15.0	<1	3.5	-	8.7	<1	6.7	<1	6.6	<1	3.6	<1	1.4	-	2.7	-	1.9
5	ORNATE ANGELSHARK	R		<1	3.2	2.8	12.3	2.7	10.5	2.6	10.0	2.6	13.0	5.8	18.8	3.4	14.3	<1	<1	<1	5.8	<1	5.2
6	SKATES/ RAYS	D		3.3	4.0	7.6	7.6	5.4	5.4	13.0	13.0	17.5	17.5	22.7	22.7	13.9	14.0	5.8	5.8	23.3	23.3	13.3	13.3
7	FISH	D		4.0	7.5	2.1	2.8	2.4	3.2	4.3	5.8	5.0	6.3	4.3	6.3	7.2	9.9	4.7	8.3	1.9	5.3	3.6	9.1
8	GREENEYE DOGFISH_HRISK	D	HR	3.1	5.2	<1	2.0	<1	1.0	3.0	3.3	1.1	1.4	<1	<1	2.7	2.7	1.7	1.8	9.9	9.9	2.2	2.2
9	DEEPWATER BURRFISH	D		4.0	4.0	1.7	1.7	2.1	2.1	1.1	1.1	2.0	2.0	3.8	3.8	1.5	1.5	<1	<1	<1	<1	5.2	5.2
10	KNIFEJAWS	R		<1	1.5	1.2	2.6	1.2	2.5	<1	2.1	<1	3.9	1.1	2.9	<1	4.2	<1	1.9	<1	1.1	<1	2.4
11	GOULD'S SQUID	R		<1	2.1	<1	1.9	<1	3.5	<1	3.4	<1	7.3	1.1	3.4	1.1	7.6	<1	<1	<1	<1	<1	<1
12	BLUE MORWONG	R		-	2.0	<1	1.7	<1	1.5	-	1.2	-	2.6	-	2.4	-	1.8	-	<1	-	<1	-	<1
13	BARRACOUTA	D		<1	1.2	2.0	2.0	1.1	1.1	6.8	6.8	15.7	15.7	12.2	12.2	4.8	4.8	<1	<1	7.1	7.1	1.1	1.1
14	PIKED SPURDOG	D		<1	<1	2.7	2.7	2.3	2.3	1.5	1.5	2.5	2.5	4.7	4.7	5.7	5.7	<1	<1	-	-	2.0	2.0
15	BIGSCALE RUBYFISH	D		1.4	1.6	1.4	1.4	<1	<1	4.2	4.2	1.7	1.7	1.1	1.1	1.6	1.6	-	-	<1	<1	<1	<1
16	SHARK	D		<1	<1	<1	1.6	<1	1.7	<1	2.2	<1	1.1	<1	1.7	2.4	2.9	<1	<1	<1	<1	1.7	1.9
17	SWALLOWTAIL	D		1.5	1.5	<1	<1	<1	<1	<1	<1	2.0	2.4	3.5	3.5	1.8	1.8	3.0	3.0	<1	<1	3.6	3.6
18	KING DORY	R		<1	2.3	-	-	-	-	<1	<1	<1	2.8	-	-	-	<1	-	<1	<1	<1	-	-
19	OTHER	D		<1	<1	1.3	1.3	<1	<1	<1	<1	<1	<1	<1	<1	1.3	1.3	1.9	1.9	<1	<1	2.8	2.8
20	COMMON JACK MACKEREL	D		1.1	1.6	<1	<1	<1	<1	<1	<1	<1	1.3	1.2	1.2	1.0	1.3	<1	<1	1.2	1.2	-	-
21	RED GURNARD	R		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.2	<1	<1	-	<1	-	<1	<1	<1
22	WHITEFIN SWELL SHARK	D		1.1	1.1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	-	<1	<1	<1	<1
23	CALAMARI	D		<1	<1	<1	1.0	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	-	-	-	-	-
24	HIGH RISK UPPER SLOPE DOGFISH	R	HR	<1	<1	-	-	-	-	-	<1	<1	<1	-	-	-	-	-	-	<1	<1	-	-
25	FROSTFISH	D		<1	<1	-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
26	MOLLUSC	R		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	-	-	<1
27	PORT JACKSON SHARK	D		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.1	1.1	<1	<1	<1	<1	<1	<1
28	WHIPTAILS	D		<1	<1	<1	<1	<1	<1	<1	<1	3.5	3.5	<1	<1	1.2	1.2	<1	<1	<1	<1	-	-
29	HAPUKU_HRISK	R	HR	-	<1	-	<1	-	<1	-	<1	-	<1	-	<1	-	<1	-	-	-	<1	-	<1
30	CRUSTACEANS	D		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.1	1.4	<1	<1	<1	<1	<1	<1
31	REDBAIT	D		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	-

Table 20.3 continued. GABT fishery ISMP observed tonnes (discarded D+ retained=total T) for non-quota bycatch species by year. Dis: D=mostly discarded; R=mostly retained. High risk (Hrisk) species indicated by "HR". Species 63-75 are reported in Table 20.12.

				2000	2000	2001	2001	2002	2002	2003	2003	2004	2004	2005	2005	2006	2006	2007	2007	2008	2008	2010	2010
Ord	Species (Project Key)	Dis	Hrisk	D	T	D	T	D	T	D	T	D	T	D	T	D	T	D	T	D	T	D	T
	Number of unique CAABs				146		117		133		182		170		148		166		155		158		135
	TOTAL Observations (shots)				122		164		142		132		173		215		173		143		151		139
32	ECHINODERMS	D		<1	<1	<1	<1	<1	<1	1.0	1.0	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
33	VELVET LEATHERJACKET	R		<1	<1	-	<1	<1	<1	-	-	-	<1	<1	<1	-	<1	-	-	<1	<1	-	-
34	COMMON GURNARD PERCH	D		-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	-	-	-	-	<1
35	BLACKTIP CUCUMBERFISH	D		<1	<1	<1	<1	<1	<1	<1	<1	2.6	2.6	<1	<1	2.2	2.3	-	-	-	-	<1	<1
36	BANDED BELLOWSFISH	D		<1	<1	-	-	-	-	<1	<1	<1	<1	-	-	-	-	<1	<1	<1	<1	-	-
37	CHIMAERAS	R		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	<1	-	-
38	NEW ZEALAND DORY	R	HR	<1	<1	-	-	-	-	<1	<1	2.9	2.9	-	-	-	-	-	-	-	<1	-	-
39	SNAPPER	R		-	<1	-	<1	-	<1	-	<1	-	<1	-	<1	<1	<1	-	<1	-	<1	-	<1
40	SILVER DORY	R	HR	<1	<1	-	-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
41	BROADNOSE SHARK_HRISK	R	HR	<1	<1	-	-	-	-	-	-	-	<1	-	-	-	-	<1	<1	-	-	-	-
42	OCTOPUS_HRISK	D		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	-	<1	<1
43	DRAUGHTBOARD SHARK	R		<1	<1	-	-	-	-	<1	<1	-	-	-	-	-	-	<1	<1	-	-	<1	<1
44	SPECKLED STARGAZER	R		-	<1	-	-	-	-	-	<1	-	<1	-	-	-	<1	-	-	-	-	-	-
45	WHISKERY SHARK_HRISK	R		-	<1	-	-	-	<1	-	<1	-	<1	-	<1	<1	<1	-	<1	-	<1	-	-
46	BIGHT SKATE	D		<1	<1	-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.1	1.1
47	HIGH RISK SHARKS	R	HR	-	-	<1	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
48	LONGSNOUT BOARFISH	R		-	<1	<1	<1	-	-	-	-	-	-	-	<1	-	-	-	-	-	-	-	<1
49	DOGFISH	D		<1	<1	-	-	-	-	<1	<1	<1	<1	-	-	-	-	<1	<1	<1	<1	-	-
50	OGILBY'S GHOSTSHARK	R		-	<1	-	-	-	<1	-	-	<1	<1	-	-	-	-	-	-	-	-	-	-
51	AUSTRALIAN ANGELSHARK	R		-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<1	-	-	-	-
52	BARRACUDAS	R		-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.7	1.7	-	-	-	-
53	BRONZE WHALER_HRISK	R		-	-	-	-	-	<1	-	<1	-	<1	-	-	-	<1	-	-	-	-	-	<1
54	BUTTERFLY GURNARD	R		-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<1	16.8	17.1	1.3	1.9
55	COCKY GURNARD	R		-	-	-	-	<1	<1	-	-	-	-	<1	<1	-	-	-	-	-	-	-	-
56	CUCUMBERFISHES GREENEYES[L]	R		-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<1	-	-	-	-
57	EASTERN ORANGE PERCH	R		-	-	-	-	-	-	-	-	-	<1	<1	-	-	-	-	-	-	-	-	-
58	GREY MORWONG	R		-	-	-	-	-	-	<1	<1	-	-	-	-	-	-	-	-	-	-	-	-
59	HAPUKU AND BASS GROPER	R	HR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	-	-	-	<1
60	HIGH RISK MOLLUSCS	R	HR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<1	<1	<1	<1	<1
61	HIGH RISK SKATES / RAYS	R	HR	-	-	-	-	-	-	<1	<1	<1	<1	-	-	<1	<1	-	-	-	-	-	-
62	HIGH RISK TELEOSTS	R	HR	-	-	-	-	<1	<1	<1	<1	<1	<1	-	-	-	-	-	-	<1	<1	-	-

[L] Includes Lizardfishes

Table 20.4 GHAT Line (AL, DL) fishery ISMP observed tonnes (discarded D + retained=total T) for non-quota bycatch species by year. A nominal colour scheme indicates high, low values for TOTAL observed discard tonnage across species. TOTAL observations indicate sampling effort (limited sampling for 2007, 2008). Dis: D=mostly discarded; R=mostly retained. High risk (Hrisk) species indicated by "HR".. 1999, 2000, and 2001 had few observations or CAAB codes and were omitted from analyses (range for total observed discarded catch was < 1t to 1.5t).

				2002	2002	2003	2003	2004	2004	2005	2005	2006	2006	2007	2007	2008	2008	2009	2009	2010	2010	2011	2011
Ord	Species (Project Key)	Dis	Hrisk	D	T	D	T	D	T	D	T	D	T	D	T	D	T	D	T	D	T	D	T
	Number of unique CAABs				118		163		223		127		115		179		218		232		175		177
	TOTAL Observations (shots)				260		276		211		133		126		205		230		192		163		267
	TOTAL Observed Catch (t)	D		6.8	8.4	11.6	15.1	18.1	25.3	25.0	31.4	4.7	7.9	30.1	36.9	31.2	54.9	26.1	37.3	19.7	21.6	33.0	42.4
1	WHITEFIN SWELL SHARK	D		4.6	4.7	7.4	7.4	4.6	4.7	2.0	2.0	<1	<1	1.2	1.2	3.2	3.4	8.5	8.5	7.4	7.4	9.0	9.0
2	BIGHT SKATE	D		<1	<1	1.9	1.9	2.3	2.4	1.4	1.4	<1	<1	2.8	2.8	2.5	2.5	1.7	1.7	<1	<1	2.6	2.6
3	HAPUKU_HRISK	R	HR	0.0	<1	0.0	1.0	0.0	2.6	0.0	5.0	<1	2.1	0.0	3.1	0.0	6.6	0.0	5.1	<1	<1	0.0	5.8
4	PIKED SPURDOG	D		<1	<1	<1	<1	<1	<1	<1	<1	1.6	1.6	<1	<1	2.8	2.8	1.9	1.9	<1	<1	2.4	2.4
5	RED GURNARD	R		-	-	<1	<1	0.0	<1	0.0	<1	-	-	-	-	-	-	-	-	0.0	<1	-	-
6	GREENEYE DOGFISH_HRISK	D	HR	<1	<1	<1	<1	2.4	3.6	16.8	16.8	<1	<1	12.4	12.4	11.6	11.6	4.8	4.8	3.3	3.3	13.8	13.8
7	CHIMAERAS	R		0.0	<1	<1	<1	<1	<1	<1	<1	0.0	<1	<1	<1	<1	<1	0.0	<1	-	-	0.0	<1
8	WHIPTAILS	D		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
9	SKATE SP A_HRISK	D	HR	-	-	<1	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10	FISH	R		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.2	<1	13.7	<1	<1	<1	<1	<1	<1
11	SHARK	D		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	7.6	7.9	<1	<1	<1	<1	<1	1.3
12	SKATES/ RAYS	D		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	2.9	2.9	<1	<1	1.1	1.1
13	HIGH RISK SKATES / RAYS	D	HR	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	-	-	-	-	-	3.3	3.3	<1	<1
14	DOGFISH	D		<1	<1	<1	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
15	HIGH RISK SHARKS	R	HR	0.0	<1	0.0	<1	-	-	<1	<1	-	-	<1	<1	0.0	<1	<1	<1	<1	<1	0.0	<1
16	HIGH RISK UPPER SLOPE DOGFISH	D	HR	<1	<1	<1	<1	<1	<1	2.9	2.9	<1	<1	<1	<1	<1	<1	3.2	3.2	1.4	1.4	1.5	1.5
17	OGILBY'S GHOSTSHARK	R		0.0	<1	0.0	<1	<1	<1	-	-	0.0	<1	<1	1.0	<1	<1	0.0	<1	<1	<1	<1	<1
18	BARRACOUTA	D		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
19	DRAUGHTBOARD SHARK	D		<1	<1	-	-	6.6	7.2	<1	<1	-	-	3.3	3.7	<1	<1	1.6	1.7	<1	<1	<1	<1
20	BASS GROPER	R		0.0	<1	0.0	<1	0.0	<1	0.0	<1	0.0	<1	0.0	<1	0.0	<1	0.0	2.2	0.0	<1	0.0	<1
21	CRUSTACEANS	D		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.0	<1	<1	<1	<1
22	BLUE SHARK	R		-	-	<1	<1	<1	<1	<1	<1	0.0	<1	<1	<1	0.0	<1	<1	<1	<1	<1	<1	<1
23	UNKNOWN	D		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	5.7	6.2	<1	2.0	<1	<1	<1	<1	0.0	<1
24	IMPERADOR	R		0.0	<1	0.0	<1	0.0	<1	-	-	0.0	<1	0.0	<1	0.0	<1	0.0	<1	<1	<1	<1	<1
25	GIANT GUITARFISH	D		<1	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
26	OTHER	D		<1	<1	-	-	<1	<1	-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
27	STRIPED TRUMPETER	R		0.0	<1	0.0	<1	-	-	-	-	-	-	-	-	0.0	<1	0.0	<1	-	-	-	-
28	HIGH RISK HAGFISH	D	HR	-	-	0.0	<1	-	-	<1	<1	-	-	-	-	-	-	-	-	-	-	-	-
29	FROSTFISH	R		-	-	0.0	<1	0.0	<1	-	-	0.0	<1	-	-	-	-	-	-	-	-	<1	<1
30	REDBAIT	D		-	-	<1	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31	SPECKLED STARGAZER	R		-	-	0.0	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 20.4 continued. GHAT Line (AL, DL) fishery ISMP observed tonnes (discarded D+ retained=total T) for non-quota bycatch species by year. D=mostly discarded; R=mostly retained. High risk (Hrisk) species indicated by "HR".

				2002	2002	2003	2003	2004	2004	2005	2005	2006	2006	2007	2007	2008	2008	2009	2009	2010	2010	2011	2011
Ord	**Species (Project Key)**	**Dis**	**Hrisk**	**D**	**T**	**D**	**T**	**D**	**T**	**D**	**T**	**D**	**T**	**D**	**T**	**D**	**T**	**D**	**T**	**D**	**T**	**D**	**T**
	Number of unique CAABs				118		163		223		127		115		179		218		232		175		177
	TOTAL Observations (shots)				260		276		211		133		126		205		230		192		163		267
32	COMMON JACK MACKEREL	D		-	-	<1	<1	<1	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
33	AUSTRALIAN ANGELSHARK	R		-	-	-	-	-	-	-	-	-	-	0.0	<1	-	-	-	-	-	-	-	-
34	BANDED BELLOWSFISH	D		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<1	-	-
35	BARRACUDAS	D		-	-	-	-	-	-	-	-	-	-	<1	<1	<1	<1	-	-	<1	<1	-	-
36	BIGSCALE RUBYFISH	D		-	-	-	-	-	-	-	-	0.0	<1	<1	<1	-	-	-	-	-	-	-	-
37	BLACKTIP CUCUMBERFISH	D		-	-	-	-	<1	<1	<1	<1	<1	<1	-	-	-	-	-	-	<1	<1	<1	<1
38	BROADNOSE SHARK_HRISK	R	HR	-	-	-	-	<1	<1	-	-	-	-	0.0	<1	-	-	<1	<1	<1	<1	<1	<1
39	BRONZE WHALER_HRISK	D	HR	-	-	-	-	<1	<1	-	-	-	-	-	-	-	-	-	-	-	-	0.0	<1
40	BUTTERFLY GURNARD	R		-	-	-	-	0.0	<1	-	-	-	-	-	-	0.0	<1	-	-	-	-	-	-
41	COMMON GURNARD PERCH	R		-	-	-	-	-	-	-	-	0.0	<1	-	-	-	-	-	-	-	-	-	-
42	CUCUMBERFISHES GREENEYES[L]	R		-	-	-	-	-	-	<1	<1	-	-	-	-	<1	<1	0.0	<1	0.0	<1	-	-
43	DEEPWATER BURRFISH	D		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
44	EASTERN ORANGE PERCH	R		-	-	-	-	-	-	-	-	-	-	0.0	<1	-	-	-	-	-	-	-	-
45	ECHINODERMS	D		-	-	-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
46	GOULD'S SQUID	D		-	-	-	-	-	-	-	-	<1	<1	-	-	-	-	-	-	-	-	-	-
47	GREY MORWONG	R		-	-	-	-	-	-	-	-	0.0	<1	-	-	-	-	-	-	-	-	0.0	<1
48	HAGFISH	D		-	-	-	-	-	-	-	-	0.0	<1	-	-	-	-	<1	<1	<1	<1	<1	<1
49	HAPUKU AND BASS GROPER	R		-	-	-	-	0.0	<1	-	-	-	-	0.0	<1	0.0	<1	0.0	<1	0.0	<1	0.0	<1
50	HIGH RISK TELEOSTS	D	HR	-	-	-	-	<1	<1	-	-	-	-	-	-	<1	<1	-	-	-	-	-	-
51	KNIFEJAWS	R		-	-	-	-	0.0	<1	0.0	<1	0.0	<1	<1	<1	0.0	<1	0.0	<1	0.0	<1	0.0	<1
52	LATCHET	R		-	-	-	-	<1	<1	0.0	<1	-	-	<1	<1	<1	<1	0.0	<1	-	-	0.0	<1
53	MOLLUSC	D		-	-	-	-	<1	<1	-	-	-	-	-	-	<1	<1	-	-	-	-	-	-
54	OCTOPUS_HRISK	D	HR	-	-	-	-	<1	<1	-	-	-	-	-	-	-	-	-	-	-	-	<1	<1
55	PORT JACKSON SHARK	D		-	-	-	-	-	-	-	-	-	-	-	-	<1	<1	<1	<1	-	-	-	-
56	RAY'S BREAM	R		-	-	-	-	0.0	<1	-	-	0.0	<1	0.0	<1	-	-	<1	<1	0.0	<1	<1	<1
57	SEAROBINS ARMOUR GURNARDS	R		-	-	-	-	-	-	-	-	0.0	<1	-	-	-	-	-	-	-	-	-	-
58	SQUID (GENERAL)	D		-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<1	-	-	-	-
59	STARGAZERS	R		-	-	-	-	-	-	<1	<1	-	-	-	-	-	-	0.0	<1	0.0	<1	-	-
60	STINGAREES	D		-	-	-	-	-	-	<1	<1	-	-	<1	<1	<1	<1	<1	<1	-	-	<1	<1
61	SWALLOWTAIL	R		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
62	WHISKERY SHARK_HRISK	R	HR	-	-	-	-	0.0	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
63	YELLOWTAIL KINGFISH	R		-	-	-	-	-	-	-	-	-	-	-	-	0.0	<1	0.0	1.3	-	-	-	-

[L] Includes Lizardfishes

Table 20.5 GHAT Gillnet fishery ISMP observed tonnes (discarded D+ retained= total T) for non-quota bycatch species by year. A nominal colour scheme indicates high, low values for TOTAL observed discard tonnage across species. TOTAL observations indicate sampling effort Dis: D=mostly discarded; R=mostly retained. High risk (Hrisk) species indicated by "HR". 1999, 2000, 2002, 2007 and 2008 had few observations or CAAB codes and were omitted from analyses (range for total observed discarded catch was < 1t to 13.4t, most of the latter was unknown species).

				2009	2009	2010	2010	2011	2011					2009	2009	2010	2010	2011	2011
Ord	Species (Project Key)	Dis	Hrisk	D	T	D	T	D	T	Ord	Species (Project Key)	Dis	Hrisk	D	T	D	T	D	T
	Number of unique CAABs				177		161		297										
	TOTAL Observations (shots)				173		135		404	28	RED GURNARD	R		-	<1	<1	<1	<1	<1
	TOTAL Observed Catch (t)	D		13.3	18.3	15.1	17.9	45.8	53.6	29	LATCHET	D		<1	<1	<1	<1	<1	<1
1	DRAUGHTBOARD SHARK	D		10.1	11.8	11.3	12	33.9	35.4	30	COMMON JACK MACKEREL	D		<1	<1	-	-	<1	<1
2	PORT JACKSON SHARK	D		1.5	1.5	1.8	1.8	5.7	5.7	31	DOGFISH	D		-	-	<1	<1	<1	<1
3	FISH	D		<1	1.5	<1	1	<1	<1	32	OCTOPUS_HRISK	R	HR	<1	<1	-	-	<1	<1
4	BROADNOSE SHARK_HRISK	R	HR	<1	<1	<1	<1	<1	1.6	33	LEATHERJACKETS	R		<1	<1	-	<1	<1	<1
5	WHISKERY SHARK_HRISK	R	HR	<1	<1	-	<1	<1	1.4	34	BUTTERFLY GURNARD	D		<1	<1	<1	<1	-	-
6	BRONZE WHALER_HRISK	R	HR	<1	<1	-	<1	<1	<1	35	GREENEYE DOGFISH_HRISK	D	HR	<1	<1	-	-	<1	<1
7	SKATES/ RAYS	D		<1	<1	<1	<1	1.7	1.7	36	SEAROBINS ARMOUR GURNARDS	D		-	<1	-	-	<1	<1
8	LONGSNOUT BOARFISH	R		<1	<1	<1	<1	<1	<1	37	SILVER DORY	D		<1	<1	-	-	<1	<1
9	SHARK	R		<1	<1	<1	<1	<1	1.5	38	SPECKLED STARGAZER	R		-	-	-	<1	<1	<1
10	PIKED SPURDOG	D		<1	<1	<1	<1	<1	<1	39	BARRACOUTA	D		-	-	-	-	<1	<1
11	SNAPPER	R		<1	<1	<1	<1	<1	<1	40	BARRACUDAS	D		-	-	-	-	-	-
12	SMOOTH HAMMERHEAD_HRISK	R	HR	<1	<1	-	<1	<1	<1	41	BLACKTIP CUCUMBERFISH	D		-	-	-	-	-	-
13	UNKNOWN	D		<1	<1	<1	<1	<1	<1	42	COMMON GURNARD PERCH	D		-	-	-	-	<1	<1
14	AUSTRALIAN ANGELSHARK	D		<1	<1	<1	<1	<1	<1	43	DEEPWATER BURRFISH	D		-	-	-	-	<1	<1
15	GREY MORWONG	R		-	-	-	<1	<1	<1	44	ECHINODERMS	D		0	0	0	0	<1	<1
16	KNIFEJAWS	R		<1	<1	<1	<1	<1	<1	45	HAPUKU_HRISK	R	HR	-	-	-	-	-	-
17	YELLOWTAIL KINGFISH	R		-	<1	<1	<1	-	<1	46	HIGH RISK MOLLUSCS	R	HR	-	-	-	-	-	<1
18	BLUE MORWONG	R		<1	<1	-	-	<1	<1	47	HIGH RISK SKATES / RAYS	D	HR	-	-	-	-	<1	<1
19	STINGAREES	D		<1	<1	<1	<1	<1	<1	48	HIGH RISK UPPER SLOPE DOGFISH	R	HR	-	-	-	-	-	-
20	CRUSTACEANS	D		<1	<1	<1	<1	<1	<1	49	IMPERADOR	R		-	-	-	-	-	-
21	HIGH RISK SHARKS	R	HR	-	<1	<1	<1	-	<1	50	MOLLUSC	D		-	-	-	-	<1	<1
22	OTHER	D		<1	<1	-	-	<1	<1	51	OGILBY'S GHOSTSHARK	R		-	-	-	-	-	-
23	STRIPED TRUMPETER	R		-	<1	-	<1	-	-	52	PORCUPINE FISH	D		-	-	-	-	<1	<1
24	YELLOWSPOTTED BOARFISH	R		<1	<1	-	<1	<1	<1	53	REDBAIT	D		-	-	-	-	-	-
25	ORNATE ANGELSHARK	D		<1	<1	<1	<1	-	-	54	SQUID (GENERAL)	D		-	-	-	-	-	-
26	STARGAZERS	D		<1	<1	<1	<1	<1	<1	55	WHIPTAILS	D		-	-	-	-	-	-
27	SWALLOWTAIL	D		<1	<1	<1	<1	<1	<1	56	WHITEFIN SWELL SHARK	D		-	-	-	-	-	-

20.7.4 TEP Wildlife Interactions

In this section the number of TEP wildlife interactions is reported. In accordance with AFMA's definition of a direct interaction, this includes any physical contact a person, boat or gear has with a protected species including catching and colliding with any of these species.

Although the ISMP has been recording wildlife interactions since about 2003, the ISMP sampling design was only recently re-designed (Bergh *et al.,* 2009) to obtain effective and statistically robust coverage for recording of species identified as high risk through the ecological risk assessment (ERA) process, and to include TEP species (Daley *et al.,* 2007). Given limitations of the historical ISMP design and the infrequency and variability of TEP species distributions, it is difficult to detect any trends in interactions, even in focused studies. The observed wildlife interactions are reported in tables. It is expected that the revised sampling design will provide a more robust time-series for assessment of trends in TEP interactions into the future. There has historically been a poor level of reporting of TEP interactions in the logbook data (Knuckey and Koopman, 2011), and so only ISMP data are reported here. Various projects have been completed to improve the rate of industry reported TEP interactions, with positive results (e.g. Boag *et al.,* 2011).

Based on ISMP data, there has been an apparent decrease in the number of observed interactions (but not mortalities) with Australian Fur Seals in the SET (Table 20.6). It is unlikely that this reduction is a function of observer focus, priorities or data collection, as many interactions result in the seal landing on the deck with the catch, and it would be easily seen and reported by the observer.

For the years 2009 and 2010, observations of wildlife directly interacting with fishing vessels (e.g. species entanglement in fishing gear) are reported for the SET (Table 20.6), GABT (Table 20.7) and GHAT (Table 20.8) fisheries (noting there was less sampling effort in the GABT than the other sectors). These were compared with the 2005 and 2006 historical estimates that are reported in Koopman *et al.* (2006a; 2006b; 2008a; 2008b), hereafter "historical ISMP reports". Due to the smaller sampling effort in 2007, 2008, these years are not reported, and the processed 2011 data are not yet available. Note that the 2010 calendar year incorporated only 6 months of the revised sampling design.

There have been changes in the focus of the ISMP, and implementation of specific bird observation protocols for observers, and it is unwise to try and interpret any changes in bird interaction levels. For example, whilst there was an increase in the number of birds recorded directly interacting with the vessels in the SET from 2009 to 2010, this is almost certainly a result of poor observer coverage during 2009, and an increased focus on seabird interactions in recent years (Table 20.6). Seabird interactions were also apparently higher in recent years in the GABT (Table 20.7) but reflect the increased focus on monitoring of seabird interactions.

The main concern regarding TEP wildlife interactions for the GHAT longline method is for seabirds and Gulper sharks. Logbook recording of bird interactions appears to be reasonably good amongst the few current vessels and indicated that levels of interactions are low (Daley *et al.,* 2007). Logbook data on Gulper Shark interactions is difficult to interpret because it includes data on surveys designed to target gulper

shark for research purposes. Changes in observer focus, priorities and data collection are also reflected in ISMP TEP interaction data for the GHAT, and again make this data difficult to interpret.

Overall, statistically interpreting SESSF TEP wildlife interaction data for the purposes of management cannot be undertaken at this stage because of the differences in between-year observation effort (in magnitude, distribution and focus). Interactions observed in the 2011 calendar year (12 months under the revised ISMP sampling schedule) may be more indicative of the time-series (i.e. sampling effort) from which changes can be interpreted into the future.

As a minimum, a sufficiently long time-series of consistent observations of wildlife abundance near fishing vessels and of fishery interactions, as well as mitigation measures that are implemented, are needed to detect and interpret trends in fishery interactions with wildlife. Some of the difficulties associated with interpreting historical ISMP wildlife interactions data include: inconsistent sampling effort between years; an apparent change in emphasis on a particular species group (e.g. birds or mammals) between years; and, inconsistent species identification and coding. The combination of improved reporting by industry, highly variable ISMP estimates and the introduction of various mitigation measures over the same time, means that the TEP wildlife interaction data is impossible to interpret with any level of certainty at this stage. When a reasonable time series of data from both the ISMP and logbooks are available, the trends in the two series could then potentially be compared.

Table 20.6 Summary of observed wildlife interactions in the SET fishery for 2005, 2006, 2009 and 2010 (mortalities in brackets). The total number of observed shots is listed in Table 20.2.

SET	2005*	2006*	2009	2010
Albatrosses	297 (1)	590		
Black Browed Albatross	27 (2)	178	1	94
Buller's Albatross		294		
Shy Albatross	167 (12)	10	4 (1)	349 (13)
Cape Petrel				5
Crested tern				
Eagles, Hawks, Kites and Sea-eagles	15	1		
Flesh footed shearwater	157			
Great Winged Petrel		1		
Petrels, Prions and Shearwaters	31 (2)	530		
Eared Seals			1 (1)	
Australian fur seal	175 (28)	100 (5)	293 (27)	24 (20)
New Zealand fur seal				11 (10)
Loggerhead turtle			2	
Shortfin Mako				1 (1)
Seahorses, Pipefishes	35 (35)	1		
Sygnathidae	4 (4)			

*Source: Historical ISMP reports

Table 20.7 Summary of observed wildlife interactions in the GABT fishery for 2005 and 2010 (mortalities in brackets). The total number of observed shots is listed in Table 20.3.

GABT	2005*	2010
Flesh Footed Shearwater		4
Shy Albatross	1 (1)	31 (1)
Pipe horses	1	

*Source: Historical ISMP reports

Table 20.8 Summary of observed wildlife interactions in the GHAT fishery for 2005, 2006, 2009 and 2010 (mortalities in brackets). Fish and reptiles (and numbers observed in 2009) not listed in the table that were hooked, caught or entangled in net and associated with mortality included: Angel shark (1); Elegant seasnake (1); Golden seasnake (1); *Hydrophis ornatus*, seasnake (3). The total number of observed shots is listed in Table 20.4 and Table 20.5).

GHAT	2005*	2006*	2009	2010
Albatrosses		118		
Black Browed Albatross			1	
Buller's Albatross		128		
Shy Albatross			1 (1)	2 (1)
Sooty albatross	1			
Yellow-nosed albatross			2	
Antartic prion			2	
Cormorants				1
Flesh Footed Shearwater				10 (9)
Petrels, Prions and Shearwaters		22		
Short Tail Shearwater				3 (3)
White Chinned Petrel				4 (3)
Australian fur seal		86	108	
Australian sea lion				4 (3)
Eared seals				1
Common dolphin			2(2)	3 (1)
Harrison's Dogfish				127 (24)
Shortfin Mako				1
Seahorses, Pipefishes			13 (13)	
White shark			1	2 (1)

*Source: Historical ISMP reports

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20.9 Supplementary Tables and Figures

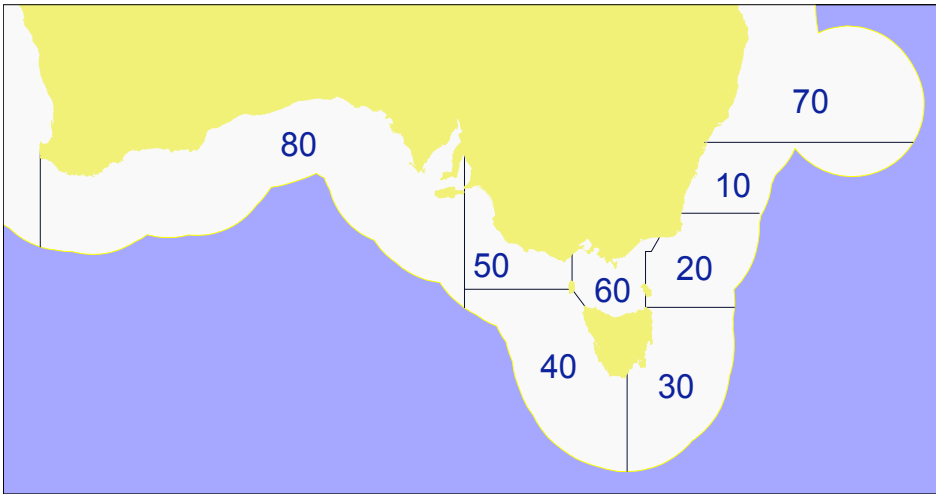

Figure 20.16 Map of the SESSF region showing the eight zones. Sourced from Klaer 2009. Zone 10=NSW; 20=EBass; 30=ETas; 40=WTas; 50=WBass; 60=Bass; 70=ECDW; 80=GAB.

Table 20.9 List of SESSF quota species (includes stock split by areas). Asterisk indicates quota species that are NOT included in the SESSF-wide or GABT analyses.

*Alfonsino**	*Ocean Perch –Offshore*
Bight Redfish	*Orange Roughy Eastern Zone*
Blue Grenadier	*Orange Roughy Southern Zone*
Blue-eye Trevalla	*Orange Roughy Western Zone*
Blue Warehou – East	*Orange Roughy Cascade Zone*
Blue Warehou – West	*Orange Roughy GAB Zone*
Deepwater Flathead	*Oreo Smooth Cascade**
*Deepwater Shark Basket –East**	*Oreo Smooth, other**
*Deepwater Shark Basket –West **	*Oreo Basket, other**
*Elephant Fish**	*Pink Ling – East*
Flathead	*Pink Ling – West*
Gemfish – East	*Redfish*
Gemfish – West	*Ribaldo*
*Gummy Shark**	*Royal Red Prawn*
Jackass Morwong –East	*Saw Shark**
Jackass Morwong –West	*School Shark**
John Dory	*School Whiting*
Mirror Dory	*Silver Trevally*
Ocean Perch –Inshore	*Silver Warehou*

Table 20.9 Continued Non-quota bycatch species – (i) List of CAAB codes used to assign species to the groups Hagfish, Whiptails, Dogfish, Sawsharks, and Stingarees; (ii) List of species that were removed from all analyses or were grouped as Unknown.

(i)

CAAB	Common Name	Animal-type	Group	CAAB	Common Name	Animal-type	Group
37004000	Hagfishes	AGNATHA	HAGFISH	37038009	Brown stingaree	RAY	STINGAREES
37004001	Hagfishes	AGNATHA	HAGFISH	37038006	Common stingaree	RAY	STINGAREES
37004002	Hagfishes	AGNATHA	HAGFISH	37038002	Crossback stingaree	RAY	STINGAREES
37020002	Black Shark	SHARK	DOGFISH	37038007	Greenback stingaree	RAY	STINGAREES
37020003	Brier Shark	SHARK	DOGFISH	37038011	Mitotic stingaree	RAY	STINGAREES
37020005	Blackbelly lanternshark	SHARK	DOGFISH	37038001	Sandyback stingaree	RAY	STINGAREES
37020906	Deepwater dogfish unspecified	SHARK	DOGFISH	37038004	Sparsely-spotted stingaree	RAY	STINGAREES
37020000	Dogfishes	SHARK	DOGFISH	37038003	Spotted stingaree	RAY	STINGAREES
37020041	Eastern Longnose Spurdog	SHARK	DOGFISH	37038000	Stingarees & giant stingarees	RAY	STINGAREES
37020001	Endeavour dogfish	SHARK	DOGFISH	37038016	Striped stingaree	RAY	STINGAREES
37020902	Endeavour dogfish (mixed)	SHARK	DOGFISH	37038014	Trygonoptera sp B	RAY	STINGAREES
37020007	Greeneye dogfish (discontinued)	SHARK	DOGFISH	37038018	Urolophus kapalensis	RAY	STINGAREES
37020901	Greeneye dogfish (mixed)	SHARK	DOGFISH	37038015	Western shovelnose stingaree	RAY	STINGAREES
37020048	Greeneye Spurdog	SHARK	DOGFISH	37038008	Wide stingaree	RAY	STINGAREES
37020010	Dumb gulper shark	SHARK	DOGFISH	37038005	Yellowback stingaree	RAY	STINGAREES
37020023	Gulper shark	SHARK	DOGFISH	37232067	Aloha whiptail	FISH	WHIPTAILS
37020907	Lantern shark (mixed)	SHARK	DOGFISH	37232002	Banded whiptail	FISH	WHIPTAILS
37020043	Largetooth Cookiecutter Shark	SHARK	DOGFISH	37232005	Blackspot whiptail	FISH	WHIPTAILS
37020009	Leafscale gulper shark	SHARK	DOGFISH	37232031	Campbell whiptail	FISH	WHIPTAILS
37020011	Little gulper shark	SHARK	DOGFISH	37232121	Duckbill Whiptail	FISH	WHIPTAILS
37020012	Longnose velvet dogfish	SHARK	DOGFISH	37232045	Falseband Whiptail	FISH	WHIPTAILS
37020004	Longsnout Dogfish	SHARK	DOGFISH	37232039	Humpback whiptail	FISH	WHIPTAILS
37020033	Mollers lantern shark	SHARK	DOGFISH	37232063	Inflated Whiptail	FISH	WHIPTAILS
37020036	Pacific Sleeper Shark	SHARK	DOGFISH	37232047	Little whiptail	FISH	WHIPTAILS
37020006	Piked Spurdog	SHARK	DOGFISH	37232016	Longrayed whiptail	FISH	WHIPTAILS
37020905	Platypus shark (mixed)	SHARK	DOGFISH	37232017	Mahia whiptail	FISH	WHIPTAILS
37020013	Plunket's Dogfish	SHARK	DOGFISH	37232014	Notable whiptail	FISH	WHIPTAILS
37020025	Portuguese dogfish	SHARK	DOGFISH	37232015	Serrulate whiptail	FISH	WHIPTAILS
37021001	Prickly dogfish	SHARK	DOGFISH	37232021	Silver Whiptail	FISH	WHIPTAILS
37020019	Roughskin dogfish	SHARK	DOGFISH	37232062	Snubnose Whiptail	FISH	WHIPTAILS
37020014	Smalltooth Cookiecutter Shark	SHARK	DOGFISH	37232001	Southern Whiptail	FISH	WHIPTAILS
37020015	Smooth lanternshark	SHARK	DOGFISH	37232010	Spearnose whiptail	FISH	WHIPTAILS
37020027	Smooth lanternshark	SHARK	DOGFISH	37232074	Spinnaker whiptail	FISH	WHIPTAILS
37020021	Southern lanternshark	SHARK	DOGFISH	37232042	Spottyface whiptail	FISH	WHIPTAILS
37020042	Velvet dogfish	SHARK	DOGFISH	37232004	Toothed Whiptail	FISH	WHIPTAILS
37020018	Western Highfin Spurdog	SHARK	DOGFISH	37232028	Unicorn whiptail	FISH	WHIPTAILS
37020008	Whitespotted Spurdog	SHARK	DOGFISH	37232038	Victory whiptail	FISH	WHIPTAILS
37023002	Common Sawshark	SHARK	SAWSHARK	37232000	Whiptails	FISH	WHIPTAILS
37023900	Sawshark (mixed)	SHARK	SAWSHARK	37232900	Whiptails - Coelorinchid	FISH	WHIPTAILS
37023000	Sawsharks	SHARK	SAWSHARK	37232902	Whiptails - Coryphaenoid	FISH	WHIPTAILS
37023001	Southern Sawshark	SHARK	SAWSHARK	37232901	Whiptails - Macrourid	FISH	WHIPTAILS

(ii) Species were removed from all analyses or grouped as “Unknown”, as follows:

- Five general groups (671 observations) were omitted from all analyses: Benthos, Substrate or rocks, Human attributed objects, Trees or driftwood, Unk or other (CAABs 99000001, 99000002, 99000003, 99000004, and 99999999 respectively);
- Observations of TEP species in the on-board catch composition data were assigned to the group “Omit” (279 observations). A separate (linked) observer database exists for TEPS, thus the former data were considered anomalous;
- Species with missing CAAB codes and unresolved AFMA codes were grouped as “Unknown” and included in analyses, where appropriate (Across the SESSF and for the period 1993 to 2011, there were 12,146 “unknown” observations out of the 364,577, excluding the observations for general groups and TEPs mentioned above).

Table 20.10 List of 98 species/species groups (including high risk species) that were used for analysing non-quota species catch composition for the SESSF. See Table 20.9 for species codes (CAAB) for Stingarees and Whiptails. Note CRUSTACEANS 28850000 is a group identified from the SIMPER analysis and is distinct from CRUSTACEANS[G], which comprises all crustaceans apart from those with CAAB 28850000. Similarly for ECHINODERMS.

	Species (Project Key) and CAAB		Species (Project Key) and CAAB
1	AUSTRALIAN ANGELSHARK 37024001	51	ORNATE ANGELSHARK 37024002
2	BANDED BELLOWSFISH 37279001	52	OTHER (CNIDARIANS, SPONGES, TUNICS)[G]
3	BARRACOUTA 37439001	53	PIKED SPURDOG 37020006
4	BARRACUDAS 37382901	54	PORCUPINE FISH 37469000
5	BASS GROPER 37311170	55	PORT JACKSON SHARK 37007001
6	BIGEYE OCEAN PERCH 37287093	56	RAY'S BREAM 37342001
7	BIGHT SKATE 37031010	57	RED GURNARD 37288001
8	BIGSCALE RUBYFISH 37345002	58	REDBAIT 37345001
9	BLACK SHARK 37020002	59	ROUGHSKIN DOGFISH 37020019
10	BLACKTIP CUCUMBERFISH 37120001	60	ROUNDSNOUT GURNARD 37288008
11	BLUE MORWONG 37377004	61	SEAROBINS ARMOUR GURNARDS 37288000
12	BLUE SHARK 37018004	62	SHARK[G]
13	BLUESTRIPED GOATFISH 37355001	63	SILVER DORY 37264002
14	BUTTERFLY GURNARD 37288003	64	SKATES/ RAYS[G]
15	CALAMARI 23617000	65	SNAPPER 37353001
16	CHIMAERAS (GHOSTSHARK)[G]	66	SOUTHERN LANTERNSHARK 37020021
17	COCKY GURNARD 37288007	67	SPECKLED STARGAZER 37400018
18	COMMON GURNARD PERCH 37287005	68	SQUID (GENERAL) 23615000
19	COMMON JACK MACKEREL 37337002	69	STARGAZERS 37400000
20	COMMON STINKFISH 37427001	70	STINGAREES[A2]
21	CRUSTACEANS 28850000	71	STRIPED TRUMPETER 37378001
22	CRUSTACEANS[G]	72	SWALLOWTAIL 37258005
23	CUCUMBERFISHES GREENEYES LIZARDFISHES 37120000	73	SWIMMER CRAB 28911020
24	DEEPWATER BURRFISH 37469002	74	TASMANIAN NUMBFISH 37028002
25	DOGFISH 37020000, 37020008, 37020014, 37020018, 37020023,	75	THREE-SPINED CARDINALFISH 37311053
25	37020036, 37020041, 37020042, 37020043, 37020048, 37021001	76	TRIGGERFISHES LEATHERJACKETS 37465000
26	DRAUGHTBOARD SHARK 37015001	77	VELVET LEATHERJACKET 37465005
27	EASTERN ORANGE PERCH 37311001	78	WHIPTAILS[A2]
28	ECHINODERMS 25102000	79	WHITEFIN SWELL SHARK 37015013
29	ECHINODERMS[G]	80	YELLOWSPOTTED BOARFISH 37367001
30	FISH[G]	81	YELLOWTAIL KINGFISH 37337006
31	FLYING SQUIDS 23636000	82	HIGH RISK BROADNOSE SHARK 37005002
32	FROSTFISH 37440002	83	HIGH RISK BRONZE WHALER 37018001
33	GARGOYLE FISH 37232003	84	HIGH RISK CUTTLEFISH (UNSPECIFIED) 23607000
34	GIANT GUITARFISH 37026001	85	HIGH RISK GREENEYE DOGFISH 37020007, 37020901
35	GLOBEFISH 37469001	86	HIGH RISK HAPUKU 37311006
36	GOULD'S SQUID 23636004	87	HIGH RISK DOGFISH OTHER 37020005
37	GREY MORWONG 37377002	88	HIGH RISK HAGFISH 37004001
38	GUITARFISHES UNSPECIFIED 37026000	89	HIGH RISK MOLLUSCS 23607001, 23607901, 23608003,
39	HAGFISH 37004000, 37004002	89	23659003, 23659004, 23659013
40	HAPUKU AND BASS GROPER 37311902	90	HIGH RISK SHARKS 37010001, 37018003
41	IMPERADOR 37258001	91	HIGH RISK SKATES / RAYS 37031028, 37031035
42	KING DORY 37264001	92	HIGH RISK TELEOSTS 37327001, 37327010, 37327018
43	KNIFEJAWS 37369002, 37369000	93	HIGH RISK UPPER SLOPE DOGFISH 37020001,
44	LATCHET 37288006	93	37020009, 37020010, 37020011, 37020902
45	LEATHERJACKETS 37465903	94	HIGH RISK OCTOPUS 23650000, 23659000
46	LONGNOSE VELVET DOGFISH 37020012	95	HIGH RISK PLATYPUS SHARK (MIXED) 37020905
47	LONGSNOUT BOARFISH 37367003	96	HIGH RISK SKATE SP A 37031005
48	MOLLUSCS[G]	97	HIGH RISK SMOOTH HAMMERHEAD 37019004
49	NEW ZEALAND DORY 37264005	98	HIGH RSIK WHISKERY SHARK 37017003
50	OGILBY'S GHOSTSHARK 37042001		

[G] Species group

Table 20.11 SET fishery observed total catch (t) for non-quota species groups 61 to 86 (continued from Table 20.2). TOTAL observations (shots) at the top indicate sampling effort. Dis: D=mostly discarded; R=mostly retained. High risk (Hrisk) species indicated by "HR".

Ord	Species (Project Key)	Dis	Hrisk	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
	TOTAL Observations (shots)			518	838	594	595	745	692	946	824	977	848	935	829	949	855	317	452	633	706	679
61	GIANT GUITARFISH	D		-	<1	-	-	-	<1	-	-	-	-	-	<1	-	-	-	-	-	-	-
62	SMOOTH HAMMERHEAD_HRISK	R	HR	<1	<1	<1	<1	<1	-	<1	-	<1	<1	<1	<1	<1	<1	-	-	-	<1	<1
63	BASS GROPER	R		<1	-	-	-	-	-	-	-	-	<1	-	<1	-	-	<1	-	-	-	-
64	DOGFISH	D		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
65	HIGH RISK SHARKS	R	HR	-	<1	-	<1	<1	-	<1	<1	-	-	<1	-	<1	<1	-	<1	-	<1	<1
66	YELLOWTAIL KINGFISH	R		<1	<1	-	<1	-	-	-	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1	<1
67	IMPERADOR	R		<1	-	-	<1	-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.2	<1	<1	<1
68	PORCUPINE FISH	D		<1	-	-	-	-	-	<1	-	-	-	-	-	<1	-	<1	<1	<1	<1	1.8
69	BUTTERFLY GURNARD	R		<1	-	-	-	<1	-	<1	<1	<1	<1	-	<1	<1	-	<1	1.3	<1	<1	-
70	BARRACUDAS	D		-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.8	<1	2.6	1.7	-
71	BLUE MORWONG	R		-	-	-	-	-	-	-	-	<1	-	<1	<1	-	-	-	-	<1	-	<1
72	BROADNOSE SHARK_HRISK	R	HR	-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	<1
73	CUCUMBERFISHES GREENEYES[L]	D		-	-	-	-	-	<1	<1	-	-	<1	<1	<1	-	<1	2.6	1.2	2.0	1.3	<1
74	FLYING SQUIDS	R		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.4	3.2	1.5	-
75	HAGFISH	D		-	-	-	-	-	<1	-	<1	-	<1	<1	-	<1	-	<1	<1	<1	-	<1
76	HAPUKU AND BASS GROPER	R		-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<1	<1	<1	<1
77	HIGH RISK HAGFISH	D	HR	-	-	-	-	-	<1	<1	<1	<1	<1	<1	-	<1	<1	-	-	-	-	-
78	HIGH RISK MOLLUSCS	R	HR	-	-	0.0	-	-	-	-	-	<1	-	<1	<1	<1	-	<1	<1	1.0	<1	1.4
79	HIGH RISK SKATES / RAYS	D	HR	-	-	<1	-	-	-	-	<1	1.4	1.4	<1	<1	<1	<1	-	-	-	<1	<1
80	LEATHERJACKETS	R		-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	1.4	2.1	1.2	<1
81	ORNATE ANGELSHARK	R		-	-	-	-	-	-	-	<1	-	<1	-	-	-	-	<1	<1	<1	<1	<1
82	RAY'S BREAM	R		-	-	-	-	-	<1	<1	<1	<1	<1	-	<1	<1	<1	-	-	<1	-	<1
83	SEAROBINS ARMOUR GURNARDS	D		-	-	-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.8	<1	1.4	<1	<1
84	SQUID (GENERAL)	R		-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.4	8.9	1.2	8.6	15.8
85	SWALLOWTAIL	D		-	-	-	-	-	<1	-	-	<1	-	-	-	-	<1	<1	-	<1	<1	<1
86	YELLOWSPOTTED BOARFISH	R		-	-	-	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	<1	<1

[L] Includes Lizardfishes

Table 20.12 GABT fishery observed tonnes (discarded and retained) for non-quota species groups 63 to 75 (continued from Table 20.3).TOTAL observations (shots) indicate sampling effort (limited sampling for 2007, 2008). Yearly discard tonnage was not estimated on a SPECIES-BY-SPECIES basis, since the ISMP design was limited in this regard. Dis: D=mostly discarded; R=mostly retained. High risk (Hrisk) species indicated by "HR".

				2000	2000	2001	2001	2002	2002	2003	2003	2004	2004	2005	2005	2006	2006	2007	2007	2008	2008	2010	2010
Ord	**Species (Project Key)**	**Dis**	**Hrisk**	**D**	**T**	**D**	**T**	**D**	**T**	**D**	**T**	**D**	**T**	**D**	**T**	**D**	**T**	**D**	**T**	**D**	**T**	**D**	**T**
	Number of unique CAABs				146		117		133		182		170		148		166		155		158		135
	TOTAL Observations (shots)				122		164		142		132		173		215		173		143		151		139
63	IMPERADOR	R		-	-	-	-	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	-	-
64	LEATHERJACKETS	R		-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<1	-	-	-	-
65	PORCUPINE FISH	R		-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.1	2.1	1.9	1.9	<1	<1
66	RAY'S BREAM	R		-	-	-	-	-	-	-	-	<1	<1	-	-	-	-	-	-	-	-	-	-
67	ROUNDSNOUT GURNARD	R		-	-	-	-	-	-	-	-	-	-	<1	<1	-	-	-	-	-	-	-	-
68	SEAROBINS ARMOUR GURNARDS	R		-	-	-	-	-	-	-	-	<1	<1	-	-	-	-	-	-	-	-	-	-
69	SKATE SP A_HRISK	R		-	-	-	-	-	-	<1	<1	-	-	-	-	-	-	-	-	-	-	-	-
70	SMOOTH HAMMERHEAD_HRISK	R		-	-	-	-	-	<1	-	<1	-	<1	-	<1	-	-	-	-	-	-	-	-
71	SQUID (GENERAL)	R		-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	3.5	1.2	8.0	<1	1.2
72	STARGAZERS	R		-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<1	1.6	1.6	<1	<1
73	TASMANIAN NUMBFISH	R		-	-	-	-	<1	<1	<1	<1	-	-	-	-	-	-	-	-	-	-	-	-
74	THREE-SPINED CARDINALFISH	R		-	-	-	-	<1	<1	-	-	-	-	<1	<1	<1	<1	-	-	-	-	<1	<1
75	YELLOWTAIL KINGFISH	R		-	-	-	-	-	-	<1	<1	-	<1	-	-	-	-	-	-	-	-	-	-

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