

**Development of an On-site Recreational Fishery Survey for
mulloway *Argyrosomus japonicus* (Sciaenidae) in the Yalata
Indigenous Protected Area**

Final Report to the Alinytjara Wilurara Natural Resource Management (AWNRM) Board



P. J. Rogers, A. Loisier and G. Ferguson

**SARDI Publication No. F2010/000640-1
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Summary

1. This report provides the first summary of fishery, biological and fisher demographic information for the recreational mulloway *Argyrosomus japonicus* (Scleropterygiidae) fishery in the Yalata Indigenous Protected Area (IPA) and Great Australian Bight Marine Park on the far-west coast of South Australia (SA);
2. We conducted 29 interviews during nine on-site surveys of fishers that were targeting mulloway in the IPA. Interviews provided information on numbers of retained and released fish, catch composition, bycatch and fishing effort during Nov–March 2009/10. Biological data on mulloway were collected to estimate length and age composition of catches. Voluntary survey forms and information brochures were distributed to fishers;
3. 114 fishers were interviewed, comprising 35% of the visitors that paid to camp in the IPA over the survey period;
4. 71 voluntary survey forms were distributed and six (8%) were returned. 148 information brochures were distributed on-site or left at petrol stations and fishing tackle outlets in Ceduna (SA).
5. Most visiting fishers were from SA with five (24%) from interstate (WA and Vic).
6. 273 bony fish, sharks and rays were landed during the on-site survey. This comprised 83 mulloway, 40 southern eagle rays, 23 gummy sharks, and 12 snapper, as well as other less common by-catch and ‘bait’ species;
7. The catch rate of mulloway during the on-site survey was estimated at one per 7.5 hours fished. 63% of mulloway landed were released and 37% were retained;
8. All rays and Port Jackson sharks were reported to be released. A total of 88% of the gummy sharks and bronze whalers were retained;
9. Combination of the on-site and volunteer survey data indicated that 118 mulloway were landed over 111 fisher days. Of these, 65% were released and the remaining 35% (n = 41 fish) were retained;
10. Using the on-site survey data we estimated that the mulloway catch inside the IPA was ~354 fish landed (all sizes) and ~123 retained during the spring-summer period in 2009–10. In the IPA, mulloway are mostly taken along 25 km of coastline.
11. Size distributions of mulloway ranged between 400–1600 mm, total length, TL with three strong modal sizes present. Preliminary estimates of the age composition of mulloway indicated there were 11 age classes present and fish were 4–20 years of age. The mean estimated age was 10 years.
12. The Discussion provides options for the future management and monitoring of the recreational fishery for mulloway in the IPA.

Background

Need

For several years, representatives from the Yalata Aboriginal Land management group have expressed concerns regarding: 1) the sustainability of the recreational mulloway fishery in the Yalata Indigenous Protected Area (IPA); 2) allocation and sharing of the mulloway resource; 3) the ecological impacts of camping on flora and fauna in the IPA; and 4) the management of camping refuse, mulloway and bait carcasses. In response to these community concerns, the AW NRM Board approached SARDI Aquatic Sciences to assist the development and implementation of an on-site survey of the recreational fishery for mulloway in the Yalata IPA (hereafter referred to in this report as IPA). Prior to this study, there have been no detailed on-site recreational fishing surveys in the IPA.

The GAB region

The Great Australian Bight (GAB) on the far-west coast of SA is a remote area of coastline characterised by steep high-energy ocean beaches, fringing limestone reefs and small rocky headlands. It is the location of the Great Australian Bight Marine Park (GAB MP) that is jointly managed by the State and Commonwealth governments (Fig. 1). The State Park boundary runs from the Western Australian border ($129^{\circ} 00'E$) to just west of Cape Adieu ($132^{\circ} 00'E$), and consists of a Whale Sanctuary that is a zone of the GAB MP. Lands on the terrestrial boundary of this park, from the mean high water mark comprise the IPA and the Wahgunyah Conservation Park.

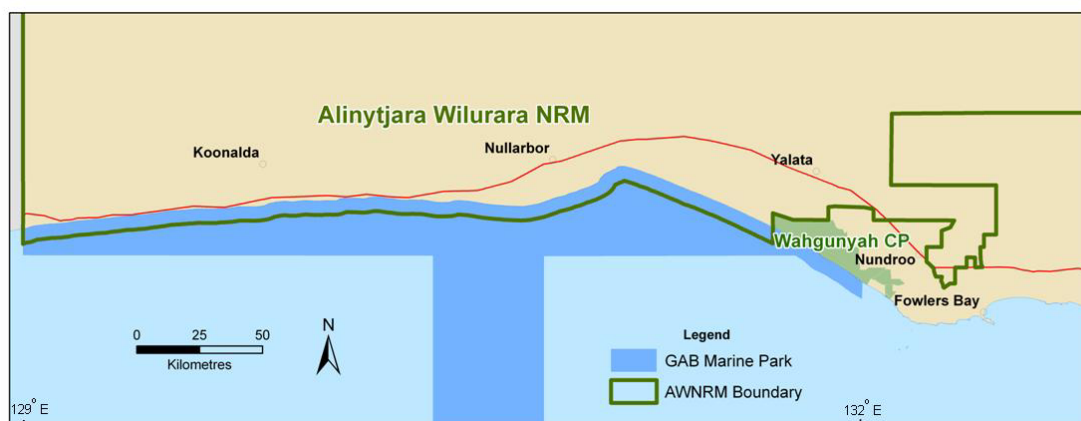


Figure 1. Map showing the GAB MP and Alinytjara Wilurara NRM Board managed boundaries.

Mulloway

Mulloway *Argyrosomus japonicus* (Sciaenidae) is a prized recreational species throughout temperate and subtropical Australia. They are long-lived, exhibit slow growth rates and mature at a large size, which makes them potentially vulnerable to over-fishing (Griffiths and Hecht 1995; Griffiths 1996; Ferguson *et al.* 2008). In South Africa and SE SA, juvenile mulloway are dependent on protected habitats in estuaries. In contrast, on the far west coast of SA the juveniles and adults occupy the same exposed, high energy surf beach habitats.

Yalata IPA and mulloway

Recreational fishing has occurred from the beaches in the IPA and GAB MP since the 1970's (Jones 1991). During this period, fishers that lived and worked in the Yalata Community would often share their catch and they rarely fished the area to the west of Coombra (Fig. 2). In the 1980's and 1990's, the exceptional fishing on the far-west coast attracted the attention of state and national fishing media. In the 2000's, video footage of mulloway fishing at Yalata was featured on the web, giving the IPA an international profile (e.g. <http://www.youtube.com>). The combination of 'word of mouth' among fishers and exposure by these media led to increased demand by visitors to target mulloway within the IPA.

Shore-based recreational mulloway fishing is the main attraction to this region, and visitors fish at several locations that are a mix of beach and reef habitats. Generally, no recreational mulloway fishing occurs from boats in this region as there are no launching facilities nearby. Visitors contribute to the management of the park through the purchase of camping permits, and to the Ceduna-Nullarbor regional economy via the purchase of fuel and supplies. Recreational fishers from SA and interstate visit the area to camp in purpose-built sites during spring and summer (Fig. 2). This period coincides with when mulloway of both sexes have been observed in spawning condition, i.e. females have developing and hydrated eggs present in ovaries (Appendix 1), and males have milt present or running in testes (P.J. Rogers, unpublished data)



Figure 2. Location of the six main campgrounds and tracks in the IPA within the AW NRM region. Map also shows the location of the Yalata Community beach.

Use of all terrain vehicles (ATV) is popular as they allow access to the entire coastline, and allow fishers to target isolated 'gutters' that are not easily fished using standard four-wheel drive vehicles. While ATVs can be used responsibly, they can also contribute to the creation of large eroded holes or 'blow-outs' in the dunes. Steps have been taken by the AW NRM Board to reduce these impacts during the 2009/10 season, including demarcation and restriction of ATV tracks. Other potential impacts of using ATVs that have been highlighted previously by the AW NRM include disturbance of protected endemic shorebirds that inhabit this coastline, including the Hooded Plover (*Charadrius thinornis robriollis*).

Previous Australian recreational fishing surveys

The National Recreational and Indigenous Fishing Survey (NRIFS) estimated that the annual harvest of mulloway in SA waters was 27,004 \pm 5156, or 90.2 tonnes, with a release rate of 71% (Jones and Doonan, 2005). The NRIFS did not include detailed data on indigenous or recreational fisheries on indigenous land in SA.

The recent recreational fishing survey in SA estimated that the recreational mulloway harvest was 10,171 \pm 6219 fish, or 62 tonnes with a release rate of 85% (Jones, 2009), and that there was an almost equal proportion of mulloway taken by boat and from shore. This survey suggested that the far-west coast component of the recreational mulloway catch comprised only 2% of the catch, and 3% of the numbers released. Most of the reported mulloway catch was taken from the Coorong and the ocean beaches in SE SA.

Previous research

Previous published research on mulloway populations and fisheries in SA includes; a summary of the fishery and fisheries biology in the Coorong (Hall 1986); a recent SARDI fishery assessment that mostly focussed on the commercial Lakes and Coorong fishery (Ferguson and Ward 2003); and information on the age and growth of the mulloway population in the Coorong and the adjacent ocean beach (Ferguson *et al.* 2008), which has been collected as part of a current PhD study by G. Ferguson (SARDI Aquatic Sciences, The University of Adelaide).

Aims and Objectives

The objective of this project was to provide a better understanding of the recreational fishery for mulloway in the IPA, inform management of the key recreational fishery related issues in this isolated region, and provide options for further development and improvement of the on-site survey methodology.

The specific aims were to:

1. Develop cost effective on-site and voluntary surveys of the recreational fishery for mulloway in the IPA;
2. Collect information on the population demographics of mulloway to inform future management of the recreational fishery;
3. Collect information on species taken as bycatch while targeting mulloway;
4. Promote indigenous stewardship along the IPA.
5. Increase community awareness and education regarding the unique mulloway sub-stock on the far-west coast of SA;

Methods

Survey training and development

Staff of the AWNRM Board and Yalata Land Management team were provided with training over two days by a SARDI staff member in November 2009. This involved how to approach, engage and interview recreational fishers, and collect biological data for mulloway that had been captured.

Training consisted of providing advice regarding suitable methods to:

1. Access campsites and fishing holes in the IPA and approach recreational fishers to conduct on-site interviews;
2. Approach and communicate with fishers to request that they complete and return voluntary interview forms;
3. Handle and release under-sized or unwanted mulloway;
4. Measure and sex all fish, remove otoliths (ear bones) and recognize different stages of sexual maturity of gonads;
5. Record accurate and consistent biological data and collect tissue and otolith samples.

A senior representative of the Yalata Aboriginal Community attended the first on-site survey that was conducted on day one of the two day training period. It was originally thought that greater community participation would occur during the initial training days, however a significant community member passed away at the time of the survey training and this reduced the availability of other key participants. Further community participation occurred during subsequent on-site surveys, as four other community members assisted with the data collection.

The survey consisted of two main components:

1. On-site survey:

Fisher demographic data and additional information

Interviews were conducted twice monthly when possible and depending on the level of fisher activity in the survey area. Fishers were approached and interviewed on-site using the interview form in Appendix 2. Table 1 provides a summary of dates and locations surveyed between November and March, 2009/10 in the IPA.

Campsites were visited during daylight hours from east to west, based on occupancy and allowable time. Fisher demographic and additional information collected included length of stay, number in fishing group, sex of fishers, and whether an ATV was used to access fishing gutters that did not have immediate vehicular access.

Table 1. On-site survey. Summary of dates, campsites and locations surveyed in the IPA between November and March, 2009/10.

Date of survey	Campsites and locations surveyed
15/11/2009	Jaxsons Hole, Bobs Kitchen, Hilton, Geues, and Granites
19/11/2009	Geues
1/12/2009	Bobs Kitchen, Hilton, Geues and Coombra
4/12/2009	Bobs Kitchen - interview at SARDI Aquatic Sciences
30/12/2009	Yalata beach
14/01/2010	Bobs Kitchen, Geues, Jaxsons Hole and Granites
15/02/2010	Bobs Kitchen, Geues, and Granites
19/02/2010	Coombra
22/02/2010	Coombra
17/03/2010	Bobs Kitchen and Hilton

Fishery and biological data on mulloway and by-caught species

Fishery and biological data collected on mulloway and other by-catch species included the species and numbers of fish, sharks and rays captured, retained and/or released, fish size, reason for release, and if bait was transported in from outside the IPA or caught on-site.

All mulloway were measured by total length (TL, cm), sexed, and the degree of reproductive maturity was assessed macroscopically for a small proportion of fish (the reproductive data is limited and therefore not presented here). Otoliths were removed from a sub-sample of the freshly captured fish measured during the on-site surveys. Otoliths were removed by removing the gills, then using garden secateurs to make a cut in the otic bulb at the posterior end of the skull. Otoliths were removed with forceps, cleaned and placed in labelled plastic bags (location, date, total length, and sex). Supplemental otoliths were collected from desiccated heads and carcasses found on beaches and in the adjacent dunes. Samples of tissue were also collected and stored in 90% ethanol for future population genetics studies.

Laboratory and data analysis

The size data collected during the on-site and voluntary surveys were binned into 100 mm size classes and presented as percentage-based size distribution histograms. Otoliths collected during the on-site surveys were weighed on a microbalance (± 0.001 g) in the laboratory. The otolith weight-age linear regression equation for west-coast mulloway: Age = $4.103 \cdot \text{Oto wt} - 0.906$, $r^2 = 0.93$, $n = 54$ was used to estimate the age composition of the fish sampled during the surveys. Age distributions were binned by age classes and summarised as percentage-based age composition histograms.

Sustainable mulloway fishing practices

During the on-site surveys, the SARDI and AW NRM board staff discussed sustainable mulloway fishing practices, and suitable handling and release techniques with visiting recreational fishers to reinforce the importance of release of undersized or unwanted fish.

2. Voluntary survey and distribution of information brochures

Voluntary anonymous survey forms were handed directly to fishers, and left on unattended cars and campsites to collect information on catch and fishing effort, catch composition, and

fisher demographics (Appendix 3). The voluntary forms contained a similar suite of questions to those asked during the on-site survey.

AW NRM Board developed information brochures that included additional information on the fisheries biology of mullocky and release techniques (Appendix 4). These brochures were provided to fishers with the voluntary survey forms. The voluntary survey forms were provided with reply-paid envelopes addressed to AW NRM Board in Ceduna.

Results

1. On-site survey

Fisher demographic data and additional information

Yalata Land Management estimated that 324 people in 95 different groups paid for camping permits in the Yalata IPA during the 2009–10 period. Therefore, we estimate that 35% of fishers and 31% of groups that paid for permits were interviewed. For the purpose of this report, we assumed that all fishers/groups that paid for permits represented the minimum number of occupants in the Yalata IPA during the peak mulloway fishing period.

A total of 29 interviews of fishing groups were conducted over nine separate survey days in the Yalata IPA between November and March, 2009/10. One interview was also undertaken at SARDI Aquatic Sciences following the return of a fishing group from the IPA. The 29 fishing groups comprised 114 individual fishers (108 men and 6 women).

Of 21 groups interviewed, five (24%) that provided postcodes were visiting from interstate (WA and Vic). Of the fishers interviewed, two (3.9%) were aged 5–14, 17 (33.3%) were aged 15–29, 16 (31.4%) were aged 30–44, 13 were aged 45–59, and three (5.9%) were in the 60+ age group. A total of 16 (55%) of the fishing groups interviewed used ATVs to access fishing gutters that were not adjacent to their designated campsites.

Catch composition

The capture of 273 bony fishes, sharks and rays was recorded during the on-site surveys. Table 2 provides a summary of catch composition, numbers/total catch by species, and the percentage of each species retained and released between November and March, 2009/10 in the Yalata IPA.

Mulloway was the most commonly captured species ($n = 83$), and comprised 30% of the total catch, 22% of the retained catch, and 40% of the released catch (all bony fishes, sharks and rays). A total of 31 (37%) mulloway were retained and 52 (63%) were released. Bony fish comprised 65% of the catch, and sharks and rays comprised the remaining 35%. Southern eagle rays (*Myliobatis australis*), gummy shark (*Mustelus antarcticus*) and Port Jackson shark

(Heterodontus portusjackson) were the most common by-catch species. All southern eagle rays and Port Jackson sharks were reported to be released and approximately half of the gummy sharks were reported to be released. Despite the high reported release rates reported for by-caught species, there was evidence that some fishers killed and dumped some species of sharks and rays in the IPA (Appendix 5). This may occur when fishers are attempting to retrieve hooks from these species. Two bait species, salmon and mullet were all retained and they comprised 16 and 11% of the total catch, respectively. The data showed that 70% of the bronze whalers (*Carcharhinus brachyurus*) were retained.

Fishing effort

Most fishing effort was targeted at mulloway. A total of 626 hours of targeted fishing effort for mulloway were reported over 80 days or 7.8 hours per day (NB – the number of days fished was not reported in three interviews). The total catch rate for (including retained and released fish) mulloway was estimated to be one per ~7.5 hours fished.

Table 2. On-site survey. Summary of catch composition, total catch numbers by species, and percentages of each species retained and released in the IPA between November and March, 2009/10.

Common Name	Scientific name	Total Catch N	% of catch	% retained by species	% released by species
Ray(unidentified)	<i>Dasyatidae</i>	1	0.4	0	100
Fiddler Ray	<i>Trygonorrhina fasciata</i>	4	1.5	0	100
Sweep	<i>Scorpiis spp.</i>	6	2.2	100	0
Bronze whaler	<i>Carcharhinus brachyurus</i>	10	3.7	70	30
Snapper	<i>Chrysophrys auratus</i>	12	4.4	83	17
Port Jackson shark	<i>H. portusjacksoni</i>	17	6.2	0	100
Gummy Shark	<i>M. antarcticus</i>	23	8.4	48	52
Yelloweye mullet	<i>Aldrichetta forsteri</i>	32	11.7	100	0
S. Eagle Ray	<i>M. australis</i>	40	14.7	0	100
Aust. Salmon	<i>Arripis truttaceus</i>	45	16.5	100	0
Mulloway	<i>A. japonicus</i>	83	30.4	37	63
Total		273	100		

Size distribution of mulloway retained or released during the on-site survey

A total of 45 mulloway (retained or released) were measured during the on-site surveys. Mulloway that were released were under the minimum legal size of 750 mm (Fig. 3). The size distribution of mulloway shows three modes (Fig. 3). The largest mode comprised 'sub-legal' fish (400–500 mm). The remaining fish comprised 'legal' size modes at 800 and 1200 mm. There was also some evidence of the presence of a larger size class at 1600 mm.

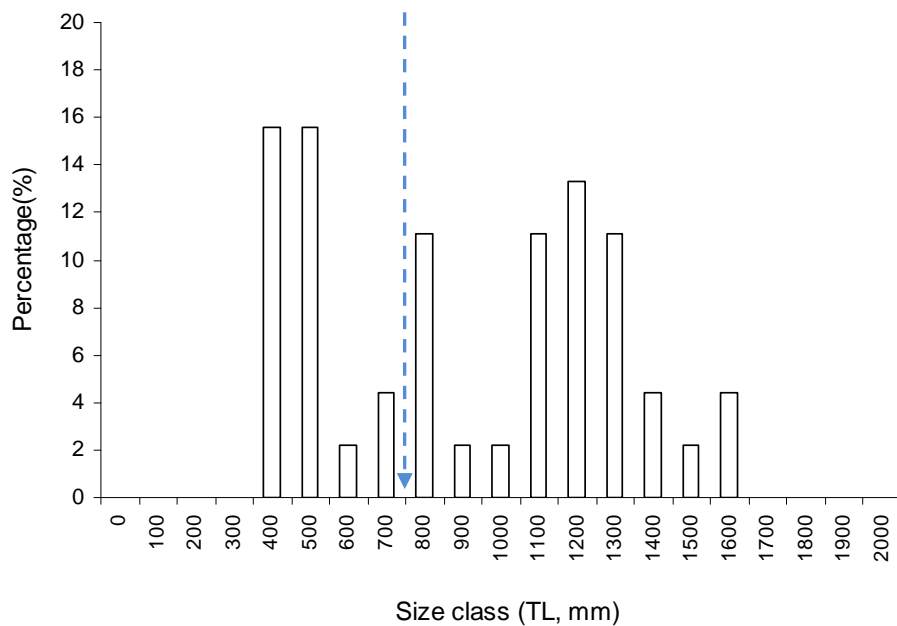


Figure. 3. Size distribution of mulloway (n = 45) retained or released during the on-site survey in the Yalata IPA between November and March, 2009/10. Blue line indicates minimum legal size.

Estimates of age composition of mulloway retained

Only 16 otoliths were collected for assessment of the age composition of mulloway in the IPA. Therefore our preliminary age compositions must be interpreted with caution.

Preliminary estimates of age composition of mulloway catches showed that there were eleven different age classes present, the fished portion of the population comprised age classes between 4 and 20 years, and >50% were between 9 and 14 years of age. The mean estimated age of mulloway taken in the IPA was 10 years.

2. Voluntary survey

A total of 71 voluntary survey forms were distributed and only six (8%) forms were completed and returned by fishing parties comprising 19 fishers. Five of the six parties were camping and fishing inside the IPA over the peak period in November and December. A total of 148 mulloway information brochures were distributed during the on-site surveys and/or were left at petrol stations and fishing tackle shops in Ceduna.

Catch composition

The catch composition reported by fishers that filled out voluntary survey forms was similar to that found during the on-site interviews (Table. 3). The capture of only 45 bony and cartilaginous fishes was reported from the voluntary survey forms. As found during the on-site survey, mulloway was the most commonly captured species (n = 35) and comprised 77% of the total catch, of which 29% was retained, and 71% was released (*c.f.* on-site survey, 37% retained, 63% released). In all cases, it was stated that mulloway were released because they were under the legal minimum size. Sharks and rays comprised ~11% of the catch and included bronze whalers, gummy sharks and unidentified rays.

Table 3. Voluntary survey. Summary of catch composition and numbers by species captured in the Yalata IPA between November and March, 2009/10.

Common Name	Scientific name	N	% of total catch	% retained	% released
Australian salmon	<i>A. truttaceus</i>	1	2	100	0
Tailor	<i>Pomatomus saltatrix</i>	1	2	100	0
Gummy shark	<i>M. antarcticus</i>	1	2	100	0
Ray (unidentified)	<i>Dasyatidae</i>	2	4	0	100
Bronze whaler	<i>C. brachyurus</i>	2	4	100	0
Snapper	<i>P. auratus</i>	3	7	100	0
Mulloway	<i>A. japonicus</i>	35	78	29	71
Total		45			

Fishing effort

Of the six fishing groups comprising 19 fishers who completed and returned the voluntary survey forms, a total of 31 days of fishing effort were reported. We used the average number of hours fished per day (7.8 hours) from the on-site survey to estimate that these 19 fishers fished for ~242 hours to catch 35 mulloway. The catch rate was estimated to be one mulloway (all sizes) per ~7 hours fished (*c.f.* on-site survey, one per ~7.5 hours fished).

Size distribution of mulloway retained and released during the voluntary survey

Size data collected for mulloway from the volunteer survey were less robust than the on-site survey in terms of sample size, and some lengths for retained fish had to be estimated from weights using the length-weight relationship (G. Ferguson, unpublished data). Mulloway from a wide range of size classes from 600 to 1500 mm were captured, and the most common size modes were 600 and 1400 mm (Fig. 4).

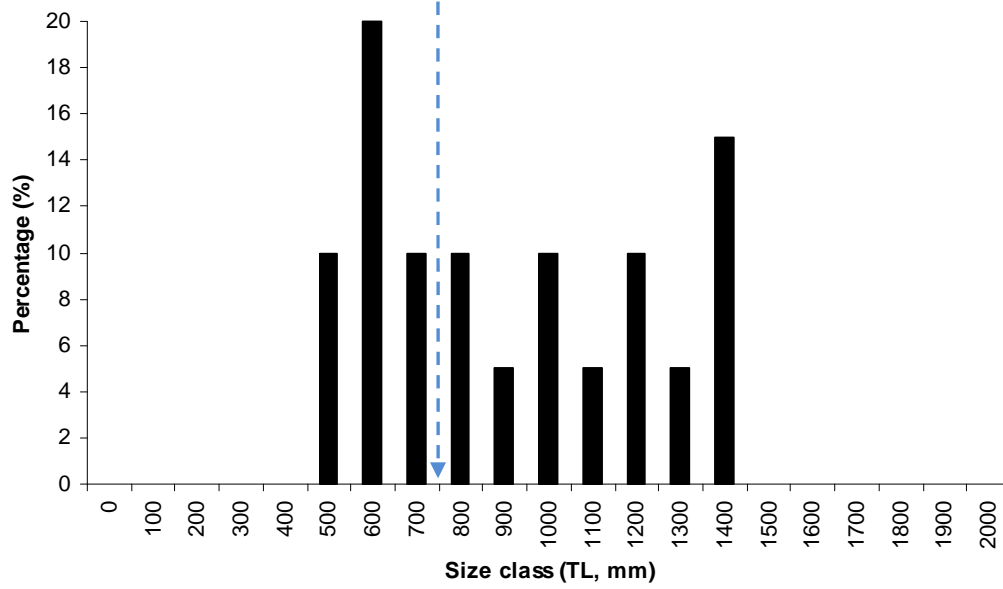


Figure. 4. Size distribution of mulloway (n = 20) reported to be retained or released by fishers that completed the voluntary survey in the IPA. Blue line indicates the minimum legal size.

Discussion

On-site and voluntary surveys

Overall, we found that the responses of the fishers that were interviewed were positive and conducive to the implementation of an on-site recreational survey program in the IPA. This survey methodology was cost-effective and provided robust data on critical aspects of the recreational fishery for mulloway. By comparison, the on-site survey method provided coverage of 35% of fishing activities, as opposed to 8% coverage provided by the voluntary method. On this basis, we recommend that the on-site survey be continued as a fishery monitoring tool in future years, and that the voluntary survey in its present form is discontinued, but provided with entry permits. We also identified a need to extend the on-site survey to indigenous fishers at the Yalata Community beach, which has separate road access, is not part of the managed visitor camping area, and was only surveyed once.

The on-site and voluntary surveys showed that visiting fishers were highly effective at targeting mulloway in the IPA. Many fishers had made considerable investments in equipment and vehicles in order to camp and fish for mulloway in this isolated region and several groups comprised repeat visitors. The on-site survey showed mulloway comprised 30% of the total catch, of which 37% were retained and 63% were released. By comparison, the voluntary survey for which there were less data, indicated that mulloway comprised 77% of the total catch, of which 29% were retained, and 71% were released. Participants who filled out the voluntary survey forms indicated that all fish released were under the minimum legal size.

There is no estimate of the post-release survival rate of mulloway released from high energy surf beaches, such as those in the IPA, and therefore it is difficult to estimate fishing mortality using our preliminary data. Factors that may affect the survival of line-caught released fish include hooking location, fight time, handling related stress, and predation of released fish by sharks. The species composition and proportions of mulloway released and retained reported in the voluntary survey were similar to those of the on-site survey. On this basis, we have summed the data from both surveys to provide an estimate of the total number of mulloway captured during the survey period (Table 4).

Table 4. Summary of number of mulloway landed, percentages retained and released from the combined on-site and volunteer survey data.

Survey	Fishing days (effort)	Mulloway landed	N retained	% retained	N released	% released
On-site	80	83	31		52	
Volunteer	31	35	10		25	
Combined	111	118	41	35	77	65

Based on the combined on-site and voluntary survey data, and the assumption that the catch and release rates were representative of the remainder of the fishing season, we estimated that the total (conservative) mulloway catch would have been in the order of ~354 mulloway of all sizes, with ~123 legal-sized fish retained. Given that this species is long-lived and reaches sexual maturity at a large size, this may be significant considering that most mulloway caught in the IPA are taken along only 25 km of coastline that is characterized by a unique combination of habitats.

Mulloway size distribution and age composition

Our combined size distribution data from both surveys ($n = 65$) suggest that the region inside the IPA currently supports juvenile and adult mulloway. Evidence that a strong size class of sub-legal sized juveniles were present in the same habitats as where adults occur (Appendix 1) contrasts the situation in the SA SE, where juveniles mostly occupy the protected waters inside the Coorong estuary, and adults mostly inhabit the deep gutters along the ocean beaches outside this critical nursery area. A recent stock discrimination study also indicated that the SE SA and west coast mulloway comprise different sub-populations. This could be resolved further in the future via a comparative study of the population genetics of these two geographically isolated regions. Our age composition data should only be viewed as preliminary due to the low sample size ($n = 16$); however, it provides initial evidence that the recreational mulloway fishery in the IPA was supported by a broad range of juvenile and adult age and year classes in 2009/10. Following these lines of evidence, this recreational fishery may be managed at a region-specific scale, and further monitoring and research focusing on this important mulloway sub-stock is required in the future.

Bycatch

Bycatch in this fishery comprised several species of sharks and rays, which are susceptible to the gear and bait types used by beach fishers that target mulloway. All of the rays were reported to be released, yet two shark species that are considered to be of higher eating quality (gummy shark and bronze whaler) were often retained. Despite these findings during the on-site surveys, there was evidence that some sharks and rays were discarded on the beach (Appendix 5). This may occur when fishers are attempting to retrieve hooks from these species. In addition to the mortality of the sharks and rays this could have other potentially negative impacts, such as attracting feral species (cats and wild dogs) to the tide lines, which are inhabited by protected endemic shorebirds, including the Hooded Plover. This issue will be part of the focus of community and visitor information material in the future.

Other fishery related issues and observations

Fishing related waste was observed at campsites during the on-site surveys, including discarded line, plastic, glass, rotting bait and mulloway carcasses. Unfortunately, given the feedback that we got from fishers during the survey, it is likely that only a small proportion of visitors to the IPA were responsible for the negative impacts that were observed. One of the main issues highlighted as requiring attention during this survey was the management of mulloway carcasses after they have been gutted or filleted. Carcasses are often buried by fishers, yet dingos and wild-dogs often unearth them and drag them into the sand dunes near the campsites. Development of a cost-effective composting waste management system at each of the main campsites, would reduce the frequency of this occurring, and facilitate the collection of mulloway otoliths (ear-bones) that could be utilised to monitor annual changes in the age composition of catches in the future. This could simply be a large bottomless black plastic tank with a lid that could be partly buried at a suitable location well behind the campsites.

Implementation of an annual or bi-annual consultation process would also be a constructive means of improving feedback between the Yalata Aboriginal community and government departments involved in the management of indigenous lands, regional tourism and the recreational fishery for mulloway. This would support the maintenance of a sustainable recreational fishery on the far-west coast, and help to encourage sustainable and culturally respectful practices by visitors to the IPA. This on-site survey highlighted some of the

complex cultural, ecological and socio-economic issues that are involved when managing a recreational fishery for a high profile species on indigenous lands where there are multiple management boundaries and land-use issues. Similar situations have rarely been explored in any detail for Australian recreational fisheries. There is also potential for this survey to be used as a case study for other 'niche fisheries' that target iconic recreational and game fishing species.

Future Options for Monitoring, Research, Visitor Education and Management

1. The on-site survey represents a cost-effective monitoring methodology for collecting a broad range of demographic, biological and fishery data, and should be supported and continued on an annual basis. In the future this information will be required to monitor the status of this regionally important recreational fishery. The survey should be extended to interview indigenous fishers that live in the Yalata, Kooniba and Ceduna communities and fish at the Yalata Community Beach in the IPA.
2. Information booklets that outline *Codes of Conduct* for capture, handling and release of mulloway and by-caught species, carcass disposal and camping ethics could be distributed with camping permits.
3. We consider mulloway to be among the 'high risk' species in terms of susceptibility to fishing, due to its life history traits and popularity as an iconic recreational species. Hence, we suggest that trip possession limits are considered as a precautionary management option for the recreational mulloway fishery in the IPA. Similar strategies have been adopted to maintain the sustainability of other successful recreational fisheries that target iconic species. For example, barramundi have bag and possession limits of one fish in some regions in the Northern Territory, and similar restrictions exist for Salmonid species in Alaska, where some of the most strictly managed, spatially discrete and high profile recreational fisheries exist.
4. There is a need for: 1) on-going monitoring of the size and age structure of the recreational mulloway catch in the IPA. Development of dry composting waste management systems at each of the main campsites would assist in the disposal of

mulloway carcasses, and facilitate a means for annual collection of otoliths for monitoring changes in the age composition of mulloway over subsequent years; 2) investigation of the size and age at sexual maturity; and 3) further resolution of the population/stock structure of mulloway populations in SA, as available information suggests the SE and far-west coast populations may have separate management requirements.

5. Innovative electronic tagging programs could be implemented to investigate the movement patterns, residence times and post-release survival of juvenile and spawning mulloway and key bycatch species (sharks and rays) in the Yalata IPA and GAB MP.

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References

- Ferguson, G. J. and Ward, T. (2003). Mulloway (*Argyrosomus japonicus*) Fishery. Adelaide, South Australian Research and Development Institute (Aquatic Sciences): 1-55.
- Ferguson G. J., Ward, T. M, Geddes, M.C. (2008). Do recent age structures and historical catches of mulloway, *Argyrosomus japonicus* (Temminck & Schlegel, 1843), reflect freshwater inflows in the remnant estuary of the Murray River, South Australia? *Aquatic Living Resources* 21, 145-152.
- Griffiths, M. H. (1996). Life history of the Dusky kob *Argyrosomus japonicus* (Sciaenidae) of the east coast of South Africa. *South African Journal of Marine Science* 17, 135-154.
- Griffiths, M. H., Hecht, T. (1995). Age and growth of South African dusky kob *Argyrosomus japonicus* (Sciaenidae) based on otoliths. *South African Journal of Marine Science* 16, 119-128.
- Hall, D. A. (1986). 'An assessment of the mulloway (*Argyrosomus hololepidotus*) fishery in South Australia with particular reference to the Coorong Lagoon.' Department of Fisheries, South Australia, South Australia.
- Jones, K. (1991) Fin fish considerations in the management of the proposed Great Australian Bight marine park. *SAFISH* 15 (4), 11 – 12, 15.
- Jones, K., and Doonan, A. (2005). 2000-2001 National Recreational and Indigenous Fishing Survey. South Australian Regional Information. Report No. 46. 99 pp.
- Jones, K. (2009) South Australian Recreational Fishing Survey. PIRSA Fisheries, Adelaide, 84 pp. South Australian Fisheries Management Series. Paper No 54.

Appendices

Appendix 1. Spawning seasonality - Visits to the IPA led to the collection of anecdotal information on the spawning seasonality of mulloway in 2003 and 2008. Males and females were assessed to be in pre-spawning condition (Fig. a) in late November 2008 (n = 4). Males and females were spawning during mid December 2003 as indicated by the presence of milt in testes, and yolked and hydrated oocytes (see insert - developing eggs) in ovaries (N = 5) (Fig. b).



Figure. a. Mulloway in pre-spawning condition with mature ovary containing yolked oocytes in the IPA on 27/11/08.



Figure. b. Mulloway in spawning (hydrated oocytes present) condition in the IPA on 13/12/03.

Appendix 2. On-site interview form.

Alinytjara Wilurara NRM Board
Yalata Lands Recreational Fishing Interview Form

Date..... Time of interview..... Location Camped at.....								
Time of High Tide..... Swell (direction and strength).....								
Wind (direction and strength)..... Cloud cover..... Temperature.....								
Moon (e.g. Full + 2days).....								
No. in Fishing Party..... Total No. of Fishers..... Males..... Females.....								
Age group: 5 – 14 <input type="checkbox"/> 15 – 29 <input type="checkbox"/> 20 – 44 <input type="checkbox"/> 45 – 59 <input type="checkbox"/> 60 or more <input type="checkbox"/> Postcode.....								
No. of days fished..... Total no. of hours fished (approx)..... Total no. of fishing lines.....								
Use of ATV: Yes No Shore Type: Beach Reef Combo Other								
Target Species.....								
Bait caught at Yalata (CY) or brought in (BI).....								
<u>Catch Data</u>								
Fish No.	Species	Location	Retained Y/N	Released Y/N <i>If yes, give reason</i>	Size of Retained Fish (mm)	Sex (M/F) Stage of Maturity <i>Refer to table</i>	Please label the sample with fish no., date, size and sex	
							Ear Bones Collected Y/N	Tissue Sample Collected Y/N

Appendix 3. Voluntary interview form.



Far West Coast Recreational Mulloway Fishing Survey 2009–2010



Thanks for helping to gather information about recreational fishing of mulloway on the Far West Coast. Please take a few minutes to fill out this anonymous survey. For further information please contact the Alinytjara Wilurara NRM Board on (08) 8625 3706.

Fisher's Information

No. in Fishing Party: _____ Total no. of Fishers: _____ Males: _____ Females: _____ Postcode(s): _____

Age group: 5 – 14 15 – 29 30 – 44 45 – 59 60 or more

No. of days fished: _____ Total no. of hours fished (approx): _____ Total no. of fishing lines: _____

Have you come fishing for Mulloway at the Yalata Coast before? Please circle Y / N, if yes please indicate When and How often: _____

If you have been fishing here for more than 5 years, have you noticed any difference in numbers and sizes of Mulloway?

Please circle Y / N, if yes please explain: _____

Use of ATV: Please circle Y / N Bait caught at Yalata (CY) or brought in (BI): _____

Mulloway Information

Date	Location <small>Refer to map on back for location codes</small>	Time <small>M-Morning No-Noon E-Evening NI-Night</small>	Size of kept Mulloway (s) - fill in at least one measurement for each fish kept <small>Please indicate the presence of eggs inside fish (E)</small>			Did you release any fish and Why? <small>Please list number released</small>	
			cm	lbs	kg	Too small	Bag Limit reached
*14/11/09	H	No	80, 110 (E)			2	-

* Example Only

Please provide information on other species caught, or any other comments:

Appendix 4. Mulloway Information Brochure developed by AW NRM.



Above Left to right examples of a mature mulloway and an undersized catch. Please note the undersized fish was successfully released back to the ocean. Photos: Kai Smith and Andrew Sleep ©

Tackle Choices

Circle hooks – are appropriate for many styles of fishing, including mulloway. These hooks greatly reduce the occurrence of deep hooking and injury in some species. This increases the survival rate of fish that are released and reduces the chance of you losing your tackle.

Hook size – research indicates that it's best to use the maximum hook size possible for the target species, which decreases the chances of catching smaller or undersized fish and of a fish swallowing the hook.

Barbless hooks – research also indicates that barbless hooks don't significantly affect catch or landing rate. Barbs on hooks can be flattened using pliers or by filing them down.

Use a knotless net for larger fish - knots can damage the scales, eyes and fins. Never hold a large fish up by the line only.

Never use a gaff on a fish you plan to release - this is especially the case if you catch a larger female fish that produces many more eggs.

For further information please contact our Coast and Marine Officer

Alinytjara Wilurara Natural Resources Management Board
Ceduna Office
Shop 3, 35 Poynton Street Ceduna SA 5690
(08) 8625 3706



CARING FOR OUR COUNTRY



Government of South Australia
Alinytjara Wilurara Natural Resources Management Board

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This brochure was produced by the Alinytjara Wilurara NRM Board for educational purposes only and the Board acknowledges that fisheries management and planning is the responsibility of PIRSA Fisheries.

Recreational Mulloway Fishing Far West Coast of South Australia



Photo: Troy Chandler ©

The Far West Coast Mulloway

population is fragile

Find out how to fish for the future

Flyer Mulloway - for Auke.indd 1

10/11/2009 12:48:57 PM

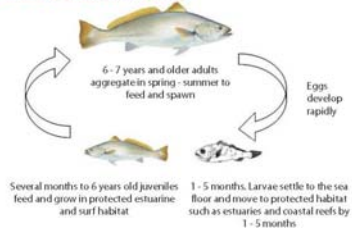
Mulloway life history

The life history of mulloway (*Argyrosomus japonicus*) is not very well known. Mature mulloway aggregate from November to February to feed and spawn.

The two aggregation sites for mulloway in South Australia



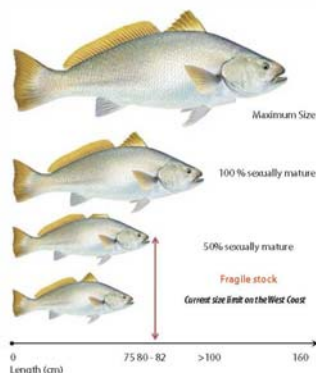
Life cycle of mulloway



A fragile population

Mulloway on the Far West Coast of South Australia appear to be a different population as they grow faster than those from east of Eyre Peninsula.

Population structure



Catching sexually immature mulloway **WILL REDUCE** mulloway stocks.

Further work is underway to better understand the Far West Coast mulloway population.

Please consider your fishing **NOW** to help keep the mulloway safe for generations to come.

Safe fishing

Decide quickly if you plan to release the fish to reduce the fish's time out of the water. Remove hook while the fish is still in the water if possible.

Never hold a fish with dry hands as the protective mucous layer and scales can be rubbed off. Wet your hands, use a wet towel or rag or use a fish grip device.

Measure your catch quickly using a mat or ruler, on a wet towel, wet foam or vinyl.

Quickly, but gently, remove the hook with needle pliers.

If the hook is deeper in the throat then simply cut the line as close to the hook as possible.

Keep fish out of direct sunlight if possible as this can damage their eyes and dry out their gills.

Survival of large fish to be released can sometimes be enhanced by holding them in the water by the mouth and moving them to force water past their gills.



Above an example of a juvenile mulloway. Photo: Andrew Sleep ©

Flyer Mulloway - for Auke.indd 2

10/11/2009 12:49:08 PM



Appendix 5. Image of Southern Eagle Ray (*Myliobatis australis*) dumped on the beach in the Yalata IPA. Courtesy of P. Schmucker.