

Lakes and Coorong Yellow-eye Mullet (*Aldrichetta forsteri*) Fishery

Fishery Assessment Report to PIRSA Fisheries

January 2005

Jason Higham, Greg Ferguson & Qifeng Ye

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EXECUTIVE SUMMARY

- 1 This is the first stock assessment on yellow-eye mullet, *Aldrichetta forsteri*, for South Australia. The report synthesises information on the fishery from 1984/85 to 2002/03, assesses the current status of the resource, and identifies future research needs.
- 2 The fishery comprises two main sectors: the Lakes and Coorong Fishery (LCF) and the Marine Scale Fishery (MSF). This report focuses on the LCF.
- 3 The South Australian total catch was 215 t in 2002/03, which is 1.6% above the 5-year average of 212 t. The LCF and MSF contributed 69% and 29%, respectively, to the total catch (most recent 5-year average).
- 4 The LCF harvested 166 t in 2002/03. Small mesh gill nets were the dominant gear and CPUE (kg/fisher day) has increased in recent years. CPUE (kg/net day) also increased but at a lesser rate. This difference may be due to changes in the numbers of nets used each day.
- 5 Assessment of the fishery performance indicators (PI) identified in the Draft Management Plan for the Lakes and Coorong Fishery showed that all PI's were within, or positively outside, the defined reference points (RP). Notably;
 - Total annual catch was 166 t, and 23% above the lower RP,
 - CPUE was 109 kg/fisher day, and 12% above the upper RP,
 - 4-year total annual catch trend was 10 t and within the RP range,
 - 4-year targeted CPUE trend was 4.5 kg/fisher day and within the RP range.
- 6 The MSF harvested 44 t in 2002/03, mostly from Spencer Gulf and Gulf St. Vincent. The dominant gears were haul and gill nets which caught 34 and 11 t respectively.
- 7 There are no data to suggest that current levels of fishing effort for yellow-eye mullet in the LCF are unsustainable. However, more detailed information on fishing effort is required, performance indicators for the fishery (particularly CPUE) need further refinement and basic biological information on patterns of age, growth and reproduction are needed to assess current management arrangements (e.g. minimum legal size) and to formally assess the sustainability of current exploitation levels. In combination, these data will substantially improve future assessment of this fishery.

1 GENERAL INTRODUCTION

1.1 Overview

This is the first stock assessment on Yellow-eye mullet, *Aldrichetta forsteri*, taken from South Australian waters. It is a living document that will be updated in response to future management needs of the fishery. The focus of this report is on the LCF fishery for yellow-eye mullet. However, because the stock is managed on a State-wide basis preliminary assessment of the MSF has also been included.

The aims of the report are (i) to provide a comprehensive synopsis of information available for this species; (ii) assess the current state of the resource, and (iii) to identify future research needs for the fishery.

The first section is the General Introduction, which (i) describes the fisheries for yellow-eye mullet in South Australia, (ii) outlines the existing management arrangements, and (iii) provides a synopsis of existing biological information and previous documentation of stock status.

Section two describes inter-annual patterns in catch, effort and catch-per-unit-effort (CPUE) in the Lakes and Coorong Fishery (LCF) and Marine Scalefish Fishery (MSF).

Section three assesses the fishery against the biological performance indicators outlined in the Draft Management Plan for the Lakes and Coorong Fishery.

Section four is the General Discussion. Assessment of the status of the fishery, comments on the suitability of the current biological performance indicators and future research needs are provided in this section.

1.2 Description of the Fishery

1.2.1 Location

Yellow-eye mullet (*Aldrichetta forsteri*) is caught throughout South Australia, but the main commercial catch is taken from the Coorong lagoons (Figure 1-1).

1.2.2 Environmental Characteristics

Yellow-eye mullet are found in brackish and inshore coastal waters and estuaries with a preference for shallow estuaries (Kailola et al. 1993; Yearsley et al. 1999; Webb 1973a). Their association with estuaries has been categorised as “estuarine opportunist” i.e. they regularly utilise estuaries during part of their life cycle, but do not need access to low salinity water to complete their life cycle (Potter and Hyndes 1994; Wakefield 1999).

The Coorong

The Coorong is the largest area of estuarine habitat in South Australia (Figure 1-1). It comprises two shallow, hyper-saline lagoons that are 100 km long and 2-3 km wide with a depth of approximately 2-3m (Noye, 1974). The original estuary of the Murray River also included Lakes Alexandrina and Albert (Figure 1-1). In 1941, a system of barrages was constructed separating the lakes from the Coorong lagoons. This altered the system reduced the estuary to 11% of its previous size.

The Coorong lagoons may be separated into three sections based on geomorphology and salinity patterns (Olsen and Evans, 1991; Higham et al. 2002, Geddes and Hall 1990):

1. Murray estuary (extending from Goolwa Barrage to Mark Point),
2. northern lagoon (extending from Mark Point to the Narrows), and
3. southern lagoon (extending beyond The Narrows).

Estuarine conditions occur between Goolwa and Pelican Point when freshwater is discharged from the barrages. The majority of the freshwater then flows out to sea via the Murray Mouth, or is available for mixing in the Coorong, resulting in an increase in salinity southwards along the northern lagoon (Geddes and Hall 1990).

Salinities in the northern lagoon may range from freshwater in the north to estuarine in the south during periods of freshwater inflow. During periods with no freshwater inflow, conditions may range from seawater in the north and hyper-marine in the south (Geddes and Hall 1990).

High evaporation during summer may cause salinities in the southern lagoon to reach 3-5 times that of seawater while in winter and spring, rainfall and groundwater inflow may result in hypo-saline conditions.

Water exchange between the northern and southern lagoons is limited by a narrowing of the lagoons at “The Narrows” southeast of the Murray Mouth. Consequently, the hydrology of the two lagoons differs.

The Murray mouth closed completely in 1981 and almost closed completely in 2001/02 presenting several potential impacts on populations of fish within the Coorong. These include; (i) formation of a physical barrier preventing movement of adults and juveniles between the lagoons and the open ocean, (ii) lowered dissolved oxygen levels and (iii) elevated salinity. These changes may have the potential to severely impact the yellow-eye mullet fishery, especially if they occur over a long period or during the warmer months i.e. autumn or summer (Higham et al. 2002).

1.2.3 Commercial Fishery

Yellow-eye mullet are caught throughout South Australia but most commercial fishing occurs in the Coorong lagoons (Figure 1-1). The commercial fishery comprises four sectors. These are the (i) Lakes and Coorong Fishery (LCF), (ii) Marine Scale Fishery (MSF), (iii) Northern Zone Rock Lobster Fishery (NZRLF) and, (iv) Southern Zone Rock Lobster Fishery (SZRLF).

The LCF operates throughout the Coorong including Lakes Alexandrina and Albert and the associated ocean beaches between Goolwa Beach Road and the Kingston Jetty.

The MSF operates along the entire coast of South Australia (Figure 1-2).

The NZRLF and SZRLF have access to yellow-eye mullet north and south of the Murray Mouth respectively. Catches of yellow-eye mullet from the NZRLF and SZRLF are very low and they are not considered further in this assessment.

1.2.4 Recreational Fishery

Yellow-eye mullet are also targeted by recreational fishers and in 1985 the dominant gear was the monofilament nylon net, most of which were set between Goolwa and the Tauwitchere barrages (Hall, 1984). In 2001 the National Recreational and Indigenous Fisheries Survey (NRIFS) reported line fishing (estimated from catches) as the main method (Henry and Lyle 2003). However, it is possible that recreational net fishers may have been underrepresented in the NRIFS.

In 1995 there were 1527 recreational nets registered for fishing in the Lower Lakes and Coorong with the majority used for targeting yellow-eye mullet (Pierce 1995). Currently, there are 2,258 recreational nets registered with PIRSA Fisheries, although no ongoing information is collected on catches or target fish species. Additionally, some of these net registrations allow fishing in the Lakes Alexandrina, Albert and George, under specific conditions.

1.2.5 Traditional Fishery

The presence of otoliths from mullet, black bream, and yellow-eye mullet in middens in the Coorong area indicate that fish formed a major component of the diet of the Ngarrindjeri (Luebbbers, 1981). The first white settlers were known to have also bartered with resident tribes for fresh fish.

The Ngarrindjeri used traps, nets, spears and specially modified boomerangs to kill schooling fish (Olsen and Evans, 1991). Additionally they built pounds and/or enclosures to hold live fish that were in excess of their immediate needs (Olsen and Evans 1991).



Figure 1-1 Map of the Coorong and Lower Lakes region, South Australia illustrating lakes Alexandrina and Albert and the Coorong lagoons. (Orange = Murray River estuary, Red = North lagoon, Green = South lagoon. Red dots are major ports).

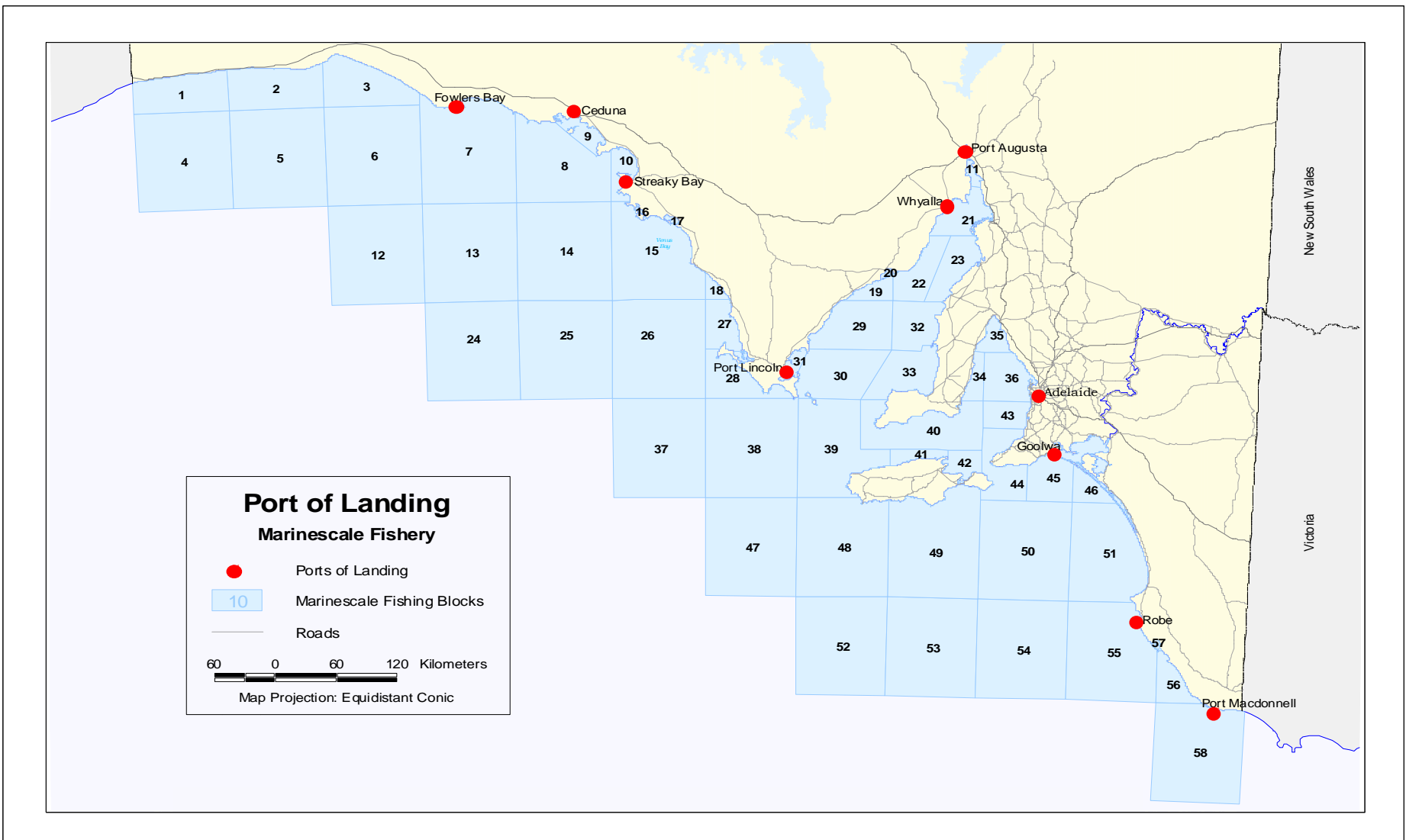


Figure 1-2. Map of South Australia showing Marine Scale Fishery reporting blocks for catch and effort.

1.3 Management of the Fishery

Total commercial catches of Yellow-eye mullet in South Australia have been recorded since 1951 (Hall 1986). Estimates of effort have been collected from the MSF since 1983 and the LCF since 1984, with fishers reporting effort in terms of target species and days fished (Knight et al. 2001).

The broad statutory framework for ecologically sustainable management of this resource is provided by the Fisheries Act 1982 (currently under review). The specific regulations that govern the LCF and MSF are described in the *Fisheries (General) Regulations 2000* and the *Fisheries (Scheme of Management-Lakes and Coorong Fishery) Regulations 1991* and *Fisheries (Scheme of Management-Marine Scalefish Fisheries) Regulations 1991* respectively.

Specific Performance Indicators (PI's) and Biological Reference Points (BRP's) for yellow-eye mullet are explained in the Draft Management Plan for the South Australian Lakes and Coorong Fishery (Sloan 2004). The Draft Management Plan for the South Australian Marine Scalefish Fishery is currently in preparation.

1.3.1 Management Milestones

Management arrangements for the LCF have evolved since the inception of the fishery and the Management Plan for the South Australian Lakes and Coorong Fishery will be finalised during 2005 (Sloan, 2004).

The MSF was reviewed in 1986 when a number of measures, including restrictions on netting were established. The Draft Management Plan for the South Australian Marine Scale Fishery is currently being prepared.

A review of the recreational fishery was completed in 1997 and a management strategy was developed that identified environmental health and sustainability of fish stocks as key objectives (Anon. 1995). Major management milestones are listed in Table 1-1.

Table 1-1. Management milestones for marine scale-fish species in South Australia (Jones et al 1990; Rohan et al. 1991; Anon, 1988, 1995, 2003; Sloan, 2004).

Date	Milestone
1971	Introduction of fishing licences for all commercial fishing in South Australia
1972	Licensed commercial fishers required to provide monthly catch data
1977	Freeze on commercial marine scalefish licences to stabilise fishing effort
1980	“Owner/ operator” policy introduced. Class A net endorsement limited to 1 net with a maximum length of 600m.
1982	Non-transferability of net endorsements to reduce fishing effort.
1984	<i>Scheme of Management (Lakes and Coorong Fishery) Regulations</i> <i>Scheme of Management (Marine Scalefish Fisheries) Regulations</i> <i>Scheme of Management (Restricted Marine Scale Fishery) Regulations</i>
1986	Restrictions on commercial net type, mesh size, net depth and net length. Prohibition of net use adjacent to the Murray Mouth from November 1 to March 31. Limit of one registered recreational net per person, with 70m total length and maximum of 1m drop. Total prohibition on recreational netting in coastal marine waters from Goolwa Beach Road to Kingston Jetty. Recreational bag limit of 60 yellow-eye mullet per person per day in Coorong waters (boat limit 180 per person per day). Prohibition of all forms of netting in the Coorong, adjacent to the Murray Mouth from December 25 to January 7.
1991	<i>Fisheries (Scheme of Management—Lakes and Coorong Fishery) Regulations</i> <i>Fisheries (Scheme of Management—Marine Scalefish Fisheries) Regulations</i>
1994	Licence amalgamation scheme introduced to reduce number of licensed participants in the commercial MSF fishery
1995	Changes to coastal marine net fishing regulations result in ban on recreational net fishing in coastal marine waters.
1997	Review of the Recreational Fishery
1997-98	Port Germein, and Port River and Franklin Harbour and southern Adelaide metropolitan waters closed to net fishing by MSF.
2000	Port Lincoln bays closed to netting by MSF.
2004	Draft Management Plan for the South Australian Lakes and Coorong Fishery Draft Management Plan for the South Australian Marine Scale Fishery

1.3.2 Current Management Arrangements

Commercial Fishery

The Lakes and Coorong Fishery is limited entry, with 37 owner-operators (Knight et al. 2000). Licence holders have non-exclusive access to resources within the Lakes and Coorong system and effort is limited through gear entitlements and owner-operator provisions as designated under the Lakes and Coorong Fishery Scheme of Management (Pierce and Doonan 1999; Knight et al. 2000). To monitor catches, fishers must complete monthly records of catch, effort (days) and fishing location. The level of detail and nature of effort reporting in these returns is currently under review.

Size limits are in place with a Legal Minimum Limit (LML) of 21 cm Total Length (TL) for all mullet species in all waters. In addition to size limits the commercial fishery is managed by restrictions to gear type, and area/time closures.

Each licence holder is limited by maximum gear entitlements, with relevant yellow-eye mullet fishing gear listed in Table 1-2.

Table 1-2. Maximum gear entitlements that may be endorsed on a licence following licence transfer or amalgamation for the Lakes and Coorong Fishery in South Australia.

Type of device	Gear Entitlement
Mesh nets (inland waters)	Maximum of 25 per licence upon transfer; or a maximum of 100 per licence on amalgamation, subject to approval by the Director of Fisheries
Hauling net	1
Bait net	1
Set line (long line)	The number endorsed on the original licence, subject to a 400 hook limit when use in coastal waters

The restrictions on gear type include restrictions to length, drop and mesh size of mesh nets. Restrictions to gear include:

- Total length of small mesh gill nets (>50 mm and ≤64 mm mesh)
- Large mesh gill nets (> 115 mm mesh) not to exceed a depth of 2m, or 33 meshes, and a total length must not exceed 500m,
- Total length of large mesh monofilament hauling net (>95 mm) set at 240m.

The waters of the Coorong lagoons are divided into 2 sections for management of the area and time closures (Figure 1-3).

Area 1 is defined as; the waters of the Coorong separated from the Lower Murray and Lake Alexandrina by the Murray Barrages and by a straight line drawn westerly from Pelican Point to Gnurlung Point and separated from the ocean by the Murray mouth.

Area 2 is defined as; the waters of the Coorong commencing from a straight line drawn westerly from Pelican Point to Gnurlung Point, then extending south easterly to the most southerly limit of the lagoon proper.

Specific regulations from the *Fisheries (General) Regulations 2000*, relevant to fishing activities in the LCF are shown below.

Closures to netting in the Coorong:

- net fishing in Area 1 is prohibited from 1 November to 31 March inclusive,
- nets are prohibited within 150 m of all barrages,
- nets are prohibited within a 500 metre radius of the Murray Mouth throughout the year,
- Netting is prohibited in the waters within the Goolwa channel between midnight Friday and midnight Sunday,
- No small mesh monofilament set nets, or small mesh haul nets may be used from 1 November to 31 March,
- There is no seasonal prohibition on the use of a mesh net in Coorong Area 2.

Members of the MSF do not have access to the Coorong Lagoons and the LML of 21 cm applies.

Recreational Fishery

The recreational fishery is open access and the LML of 21 cm TL applies in addition to specific bag and boat limits. Netting by recreational fishers is permitted and there are currently 2,258 registrations for nets with access to the Coorong. Under the *Fisheries (General) Regulations 2000* these are subject to restrictions on net numbers and mesh size as well as area and time closures. The daily bag and boat limit is a total of 60 mullet per day for each fisher, or a maximum of 180 mullet per vessel where three or more fishers are on board. Area 1 is closed to recreational netting between 1st

November and 31st March inclusive. Restrictions to the recreational mesh nets used in Coorong (Area 1) or Coorong (Area 2) are:

- Maximum length 75 metres
- Minimum mesh size of 50mm, and a maximum mesh size of 64mm
- Mesh panel no more than one metre in depth
- Must be marked with 2 black buoys at one end and one yellow buoy at the other. If the net exceeds 50m in length, it must be marked with a floating red buoy at intervals not exceeding 50m
- must float when set, and the operator must be in attendance i.e. within 50 metres of the net at all times. In addition, a mesh net must not be set within 200 metres of any other net.

A person can only use at one time no more than;

- one mesh net (registered with PIRSA Fisheries) or
- one hand net or
- 10 hoop nets or
- 3 hoop nets and one mesh net or
- 3 hoop nets and one hand net.

In addition to a mesh net, recreational fishers are also permitted to use:

- up to two rods, or
- two handlines, or
- one of each.

With each line having

- up to three hooks attached or up to five hooks joined eye to shank or threaded together.

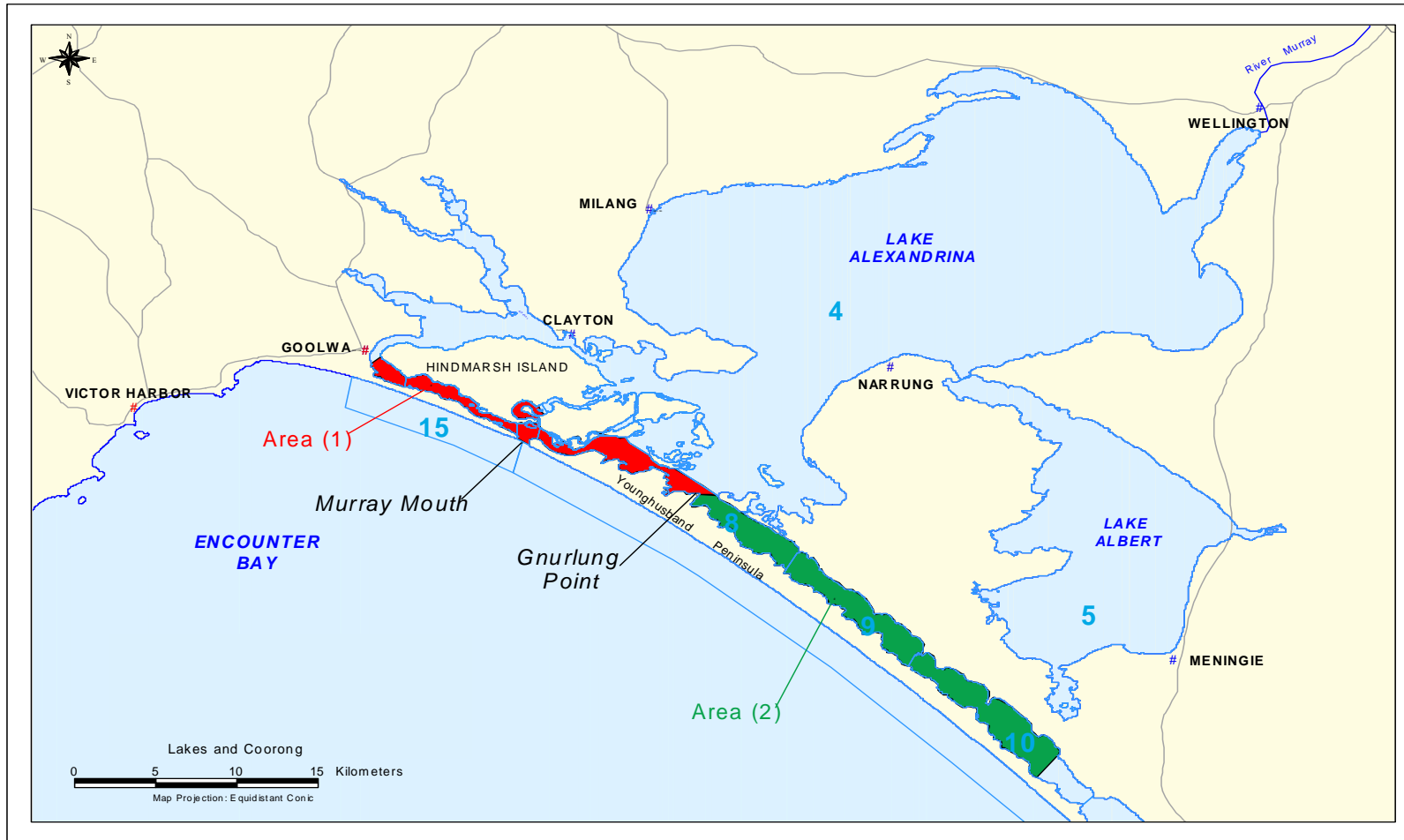


Figure 1-3. Map of the Coorong region in South Australia, showing Lakes and Coorong Fishery management Areas 1 (red) and 2 (green)

1.3.3 Management Objectives and Strategies

Management objectives for the LCF and MSF are outlined in the Draft management Plan for The South Australian Lakes and Coorong Fishery and the Draft Management Plan for the South Australian Marine Scale Fishery respectively. However, there are few management objectives and strategies identified for yellow-eye mullet in particular.

1.4 Fisheries Biology of Yellow-eye Mullet

1.4.1 Taxonomy and Distribution

Mulletts (Family Mugilidae) are found around the world in warm to cool seas and consists of about 13 genera and 95 species. Eight genera and 20 species are recognised in Australian waters with four genera represented on the south coast; *Mugil*, *Aldrichetta*, *Liza* and *Myxus*. The only representative of *Aldrichetta* in Australian waters is the yellow-eye mullet (*Aldrichetta forsteri*, Cuvier & Valenciennes, 1836).

Yellow-eye mullet is fished by commercial and recreational fishers throughout most of its distribution around southern Australia, from Kalbarri (WA) to Newcastle (NSW) including the northern coast of Tasmania. It is also found in New Zealand waters (Thomson 1957; Kailola et al. 1993; Gommon et al. 1994; Yearsley et al., 1999).

1.4.2 Stock Structure

There are two distinct populations of yellow-eye mullet based on differences in counts of lateral scales and gill rakers and in the timing of the breeding season i.e. eastern and western populations (Thomson, 1957a; Thomson, 1957b; Pellizzari, 2001).

Yellow-eye mullet in South Australia is considered to be closely related to the western population, based on similarities in lateral scale counts. Yellow-eye mullet from Western Australia and South Australia have 54-59 scale rows while those from eastern Australia have 59-64. (Thomson 1957). This interpretation is supported by similarities between other morphological characters for the two populations (Pellizzari 2001) (Table 1-3).

The spawning season may vary between eastern and western Australia although this may be partly due to regional differences in estuarine habitat (Thomson, 1957a). For example, in Western Australia there is a marked tendency for sandbars to form at the entrances to estuaries during summer that effectively prevents fish in spawning condition from moving into coastal waters for spawning (Chubb et al. 1981).

Table 1-3. Counts (means) of selected morphological characters of yellow-eye mullet from SA, WA and Victoria (Pellizzari, 2001).

Morphological character	POPULATION		
	WA	SA	VIC
Gill rakers	45	45	49
Lateral line Scales	55	56	62

1.4.3 Habitat and life-history

Schools of yellow-eye mullet occur in brackish and inshore coastal waters and tidally inundated saltmarsh although the preferred habitats are shallow estuaries (Webb 1973a; Kailola et al. 1993; Yearsley et al. 1999; Connolly et al. 1997). Larger yellow-eye mullet show a preference for deeper habitats such as channels or ‘gutters’ on beaches, whereas juveniles remain in the shallow bank sections of estuaries and beaches.

Yellow-eye mullet have been described as “estuarine opportunists” because they regularly utilise estuaries but can also complete their lifecycle when they do not have access to this environment (Wakefield 1991; Potter and Hyndes 1994).

Yellow-eye mullet from the Coorong lagoons spawn from summer to early autumn (January to March) (Harris, 1968). The spawning season for the eastern and western populations was December-March and May-October respectively (Thomson 1957a; Chubb et al. 1981; Lenanton et al. 1984). Thus the spawning period for Yellow-eye mullet from the Coorong lagoons appears closely aligned with that of the eastern population.

Annual spawning frequency may be regionally variable. Several authors have reported that they spawn one set of moderately large (0.5 mm diameter) pelagic eggs

each season (Harris 1968; Crossland 1981; Kingsford and Choat 1986; Kingsford 1988, Manikiam 1963). However, in New Zealand the presence of two distinct 0+ cohorts within one year, supported by results from macroscopic ovary staging, led Webb (1973b) to conclude that they may spawn twice per year. However, it is not unusual for variations in timing and duration of spawning to occur in a species with a distribution across a broad range of latitudes e.g. *Mugil cephalus* (Kesteven 1942; Thomson 1954).

The pre-settlement duration for the larvae in the Coorong lagoons was determined to be 19 to 25 days from otolith microstructures and newly settled larvae were observed during both winter and summer (Pellizzari 2002). Consequently, either (i) spawning occurred twice or (ii) spawning was protracted throughout the year or (iii) larvae spawned outside the lagoons may have taken several months to move inside to the sampling sites.

Yellow-eye mullet have been reported to spawn both in estuaries and in the open ocean waters. Harris (1968) and Webb (1973a), describe yellow-eye mullet as spawning within estuaries in South Australia and New Zealand. Also, newly hatched yellow-eye mullet were observed in estuaries closed off from the sea by a sand bar for 3 years which may indicate spawning within the estuary (Lenanton, 1974).

Alternatively, spawning may have occurred outside the estuary and new recruits may have crossed the isolating sand bar during periods of exceptionally high water (Chubb et al. 1981). That spawning occurs outside the estuary is further supported by the presence of large numbers of juveniles in large marine embayments (Chubb et al. 1981; Dybdal 1979).

1.4.4 Diet

Yellow-eye mullet are considered to be omnivorous and eat detritus, seagrass, micro and macro-algae as well as small animals and epiphytes (Kailola et al. 1993; McDowall 1996).

Thomson (1957c) examined and identified the gut content of yellow-eye mullet from fourteen estuaries and semi-enclosed bays around south-western Australia. Gut content was dominated by algae (22%), amphipods (14%), univalve molluscs (14%), bivalve molluscs (11%) as well as chironomids (9%), with the remainder

unidentifiable (30%) Figure 1-4). Generally, food items were in direct proportion to their relative abundance within the estuary sampled.

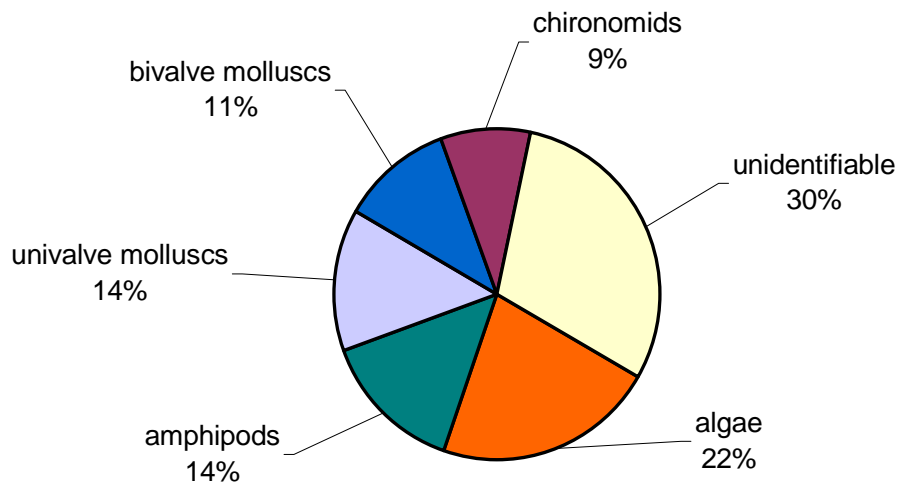


Figure 1-4: Gut contents for yellow-eye mullet from south-western Australia (Thomson, 1957c)

Webb (1973c) presented a list of food items from two different size classes of yellow-eye mullet; less than 150mm caudal Fork length (CFL) and greater than 150mm CFL. Webb (1973c) examined 496 individuals < 150mm, and 1868 individuals > 150mm with approximately 1/3 of the fish examined having an empty gut (Figure 1-5).

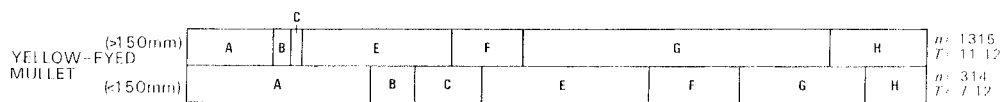


Figure 1-5: Relative occurrence of food types in gut contents of yellow-eye mullet from the Avon-Heathcote Estuary, April 1965-April 1966. Food types: A crustaceans, B molluscs, C polychaetes, D coelenterates, E algae, F detritus, G mud, H other (mostly fish). Each food type expressed as a rounded % contribution to total dietary occurrences in n (total sub-sample with gut contents) and T (number of months out of twelve in which sub-sample was obtained). (Webb, 1973c)

During summer, significant amounts of fish material were present in gut samples. These were from *Galaxias maculatus*, *G. attenuatus* and *Anguilla australis*. During winter, guts were found to contain mud, possibly due to feeding on high density populations of micro-organisms contained within the mud (Webb 1973c). The algae *Ulva sp.* and *Enteromorpha sp.* were also eaten in greater amounts during summer when they were freely available (Webb 1973c).

Diets of individuals from two size classes i.e. <150mm CFL, and > 150mm CFL were found to differ (Webb, 1973c). Food for the smaller individuals came from freshwater or brackish water origins (mysids, copepods and insect larvae), probably due to habitat preference for freshwater stream outlets. As they grew larger they gradually moved from shallow to deeper water and the food preference switched to an ‘adult’ diet (Webb 1973c).

1.4.5 Growth

In the Coorong lagoons, South Australia, yellow-eye mullet grow rapidly during the first two years of their life, with growth declining after this although females continue to grow more rapidly than males (Table 1-4, 1-5) (Harris 1968). This is supported by growth data from both eastern and western populations (Thomson 1957b).

Yellow-eye mullet from the western population attain a greater length at an earlier age than those from the eastern population because they spawn earlier in the year and experience a longer growth period in their first year (Harris 1968).

Table 1-4 Comparison of growth (caudal fork length, cm CFL) of yellow-eye mullet from 3 populations in Australia (Harris, 1968, Thomson, 1957b).

Year Class	Western & Eastern populations	I	II	III	IV	V
	“Coorong Mullet”	0+	1+	2+	3+	4+
Western Fish		11	18-19	24-25	29-32	32-35
Eastern Fish		5	12-13	19-21	24-27	30
“Coorong mullet”		7	14	21	26	31

Table 1-5. Average caudal fork length (cm CFL) attained by male and female yellow-eye mullet from the Coorong Lagoon (Harris, 1968)

Year Class	I	II	III	IV
Males	14.2	21.7	26.1	30.9
Females	13.7	21.1	24.5	-

The maximum total length achieved by yellow-eye mullet in South Australia was at least 40 cm (total length) (Hall 1986). This was supported the maximum length of 39.3 cm reported by Thomson (1957a).

1.4.6 Size at maturity

The size of maturity (SOM) for yellow-eye mullet from the Coorong lagoons was approximately 23 and 22 cm CFL (Caudal Fork Length) for females and males respectively (Harris 1968). This is supported by estimates of SOM from other Australian states and from New Zealand (Thomson 1957a; Thomson 1957d; Harris 1968; Webb 1973b).

Table 1-6. Size at first maturity for yellow-eye mullet, *Aldrichetta forsteri* from four regions (Thomson 1957a, Harris 1968 & Webb, 1973b)

Population	Male size (CFL cm)	Female size (CFL cm)
SA (Coorong)	22.0	23.0
Eastern fish	22.0	24.5
Western fish	22.0	24.5
NZ fish	22.0-24.0	22.0-24.0

1.4.7 Discussion of Fisheries Biology

Some uncertainty exists around the size at maturity for yellow eye-mullet in South Australia because previous studies did not use formal size at maturity ogives (i.e. LD₅₀). This should be done for both males and females and would provide more accurate estimates of size at maturity . Formal growth curves estimated from otolith based age estimates would also provide more precise estimates of growth rates.

The length of the spawning period varies throughout the geographical range and it is also possible that regional differences in the timing and duration of spawning may occur across the state. Protracted spawning may also occur in the part of the population that utilises the Coorong lagoons (Pellizarri 2001). Uncertainty related to the timing and duration of the spawning period could be reduced by constructing gonadosomatic indices for the key South Australian fishing regions for yellow-eye mullet i.e. Spencer Gulf, Gulf St. Vincent and Coorong lagoons.

The population structure of yellow-eye mullet in southern Australia has been based on morphological characteristics. Eastern and western populations have been identified and those from South Australia are more closely aligned with the western population. Given the current level of information on the population structure of yellow-eye mullet within South Australia the species should be managed as a single stock. However, it seems likely that some sub-structuring of the population may occur between regions in South Australia i.e. west coast, Spencer Gulf, Gulf St. Vincent, Coorong lagoons and the south-east. Further information on the regional sub-structure of the stock may be obtained by sampling yellow-eye mullet from each geographic region and comparing otolith microstructure or microchemistry, or comparing growth curves and size at maturity ogives.

1.5 Stock Assessment

1.5.1 Commercial Fishery

There has been no formal stock assessment of either the LCF or MSF fisheries for yellow-eye mullet in South Australia. Pierce and Doonan (1999) described the yellow-eye mullet resource in the Coorong lagoons as under-exploited although they did not explain how they reached this conclusion.

1.5.2 Recreational Fishery

Catch and effort from the recreational sector has been estimated for 1982/83 and May 2000 to April 2001 (Philipson et al. 1986; Henry and Lyle 2003).

In 1982/83, recreational effort (all species combined) was seasonal with a peak in summer (Table 1-7). During the 1982/83 summer, fishers were most active from December to February with approximately 40% of the annual effort reported for this period. (Philipson et al. 1986). June to August was the least active period. Although low participation rates may have affected these results the Lakes and Coorong region appeared to be most popular area for boat based fishing (Philipson et al. 1986).

Table 1-7. Recreational fishing effort in the region from Caper Jervis to Kingston South Australia in 1982/83 (Philipson et al. 1986).

Period	Effort (fishing days)
December - February	99,143
March – May	66,967
June - August	40,508
September - November	41,372

More recently, the National Recreational and Indigenous Fisheries Survey (NRIFS) collected catch data from 1900 recreational fishers in South Australia, between May 2000 and April 2001 (Henry and Lyle, 2003). Information recorded included catch, fishing method and fishing platform in spatial units as shown in Figure 1-6.

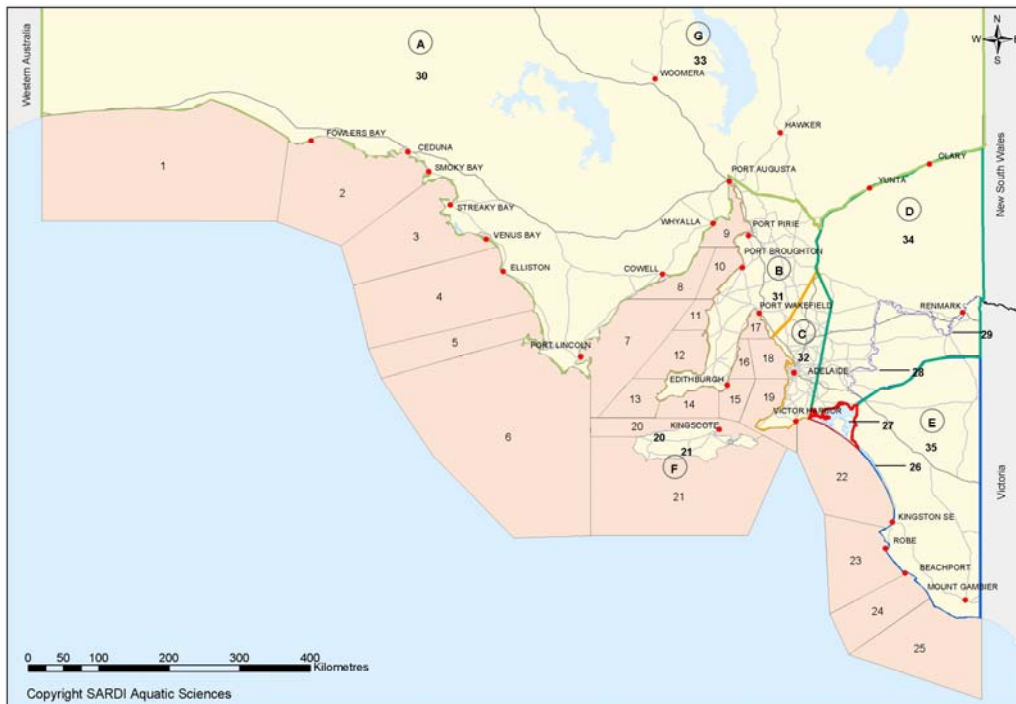


Figure 1-6. Map of South Australia, indicating National Recreational and Indigenous Fishing Survey reporting units. (Lakes and Coorong region applies to NRIFS regions 22, 26 & 27).

The South Australian recreational catch of yellow-eye mullet between May 2000 and April 2001 was 46,926 kg (estimated as 438,560 fish with an average weight of 0.107kg) (Henry and Lyle 2003). In addition to this 220,810 yellow-eye mullet were released. Most of the catch was taken from the shore with 55 and 15 percent caught from beach/rock and jetties respectively. Catches from boats contributed 22 per cent. These estimates may include some data from species other than *A. forsteri* recorded as “unspecified mullet” (Keith Jones pers. comm. 2004). The data from the NRIFS were further analysed with increased spatial resolution and are presented in Section 2.1.2.

1.5.3 Net Selectivity

The size structure of yellow-eye mullet from South Australian commercial catches was investigated between November 1982 and May 1983 (Hall 1986). The length range was 21 to 28 cm CFL with a mode at 28 cm CFL. Mesh selectivity’s for a range of mesh nets sizes (range from 1 ¼ to 3 ¼ inches, 31 to 82 mm) were also constructed by Thomson (1957a) (Table 1-8).

Table 1-8. Length frequencies of fish caught in mesh nets of various sizes from Thomson (1957a). (CFL = Caudal fork length).

CFL (cm)	Mesh size (in)					
	1.25	1.5	2	2.25	2.5	3.25
	Mesh size (mm)					
	31	38	50	56	63	82
13		1				
14	5			1		
15	93	2		1		
16	218	8	2			
17	65	39	1	2	1	
18	5	65	3	1	1	
19	1	4	5	3	2	
20		2	2	18	4	
21			55	92	8	
22			19	184	6	2
23			10	90	6	2
24			7	31	18	3
25			3	9	4	9
26			2	5	1	14
27				4		7
28						6
29						5
30				2		1
31			1	1	1	
32				1		
n	387	121	110	445	52	49
No. of tests	8	8	8	8	2	2

2 FISHERY STATISTICS

2.1 Introduction

Fisheries statistics were available from 1983/84 to 2002/03. This section describes the inter-annual patterns in reported catch, effort and CPUE for yellow-eye mullet on a State-wide basis and then for the LCF and MSF sectors. Some analysis of catch data collected from the National Recreational and Indigenous Fishing Survey was also done.

2.1.1 Overview of State-wide Catches

The total reported South Australian commercial catch (total catch) of yellow-eye mullet was characterised by high inter-annual variability between 1984/85 and 1990/91 (Figure 2-1). From 1991/92 to 2002/03 inter-annual variability in total catch was less marked. Total catch rose from an initial 223 tonnes in 1984/85 to 488 tonnes in 1986/87 to the highest recorded catch of 522 tonnes in 1989/90. Total catch then declined to 207 tonnes in 1998/99. From 1998/99 to 2002/03 catches were relatively constant and the catch was 215 tonnes in 2002-03. The average catch for 1999/00 to 2002/03 was 213 tonnes.

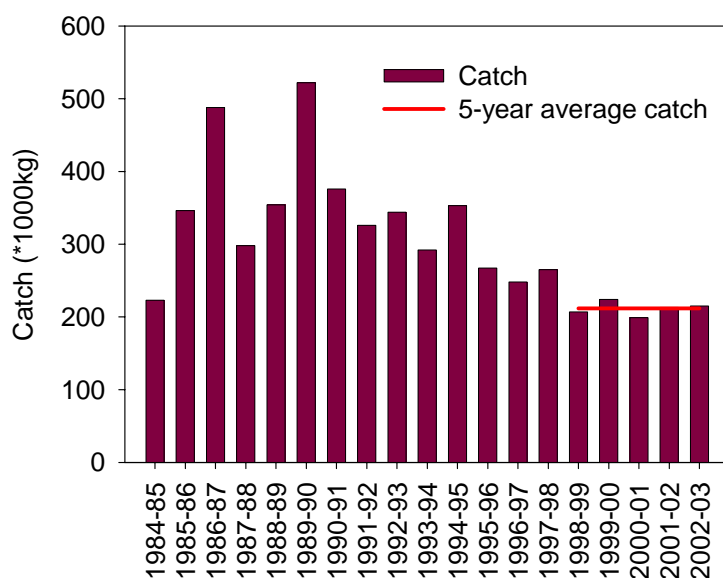


Figure 2-1. Total South Australian annual commercial catch of yellow-eye mullet from 1984-85 to 2002-03 with most recent 5-year average catch.

2.1.2 Catch by Sector

The LCF was the dominant sector and the catch of 166 t contributed 69% (most recent 5-year average) of the South-Australian total catch of yellow-eye mullet (Figure 2-2). The MSF catch was 44 t which was 29 per cent (most recent 5-year average) of the catch.

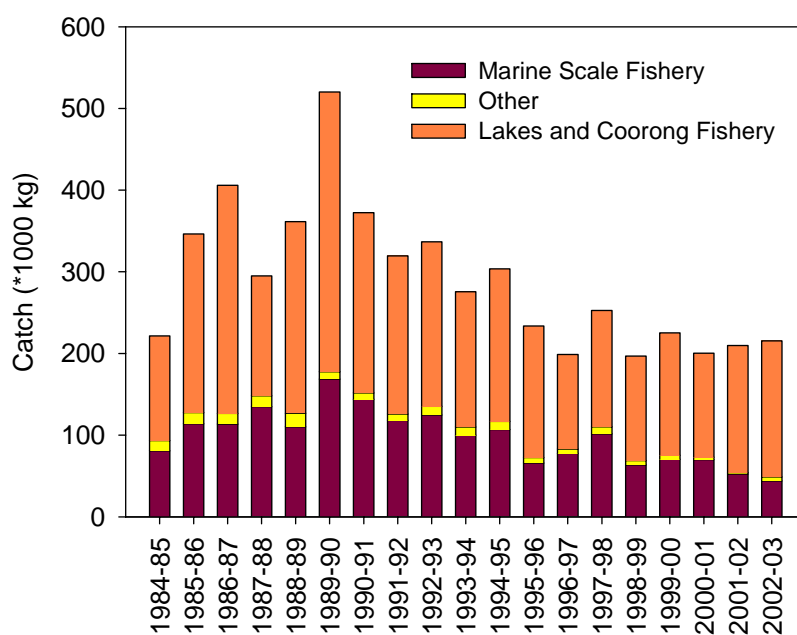


Figure 2-2 Total South Australian annual commercial catch of yellow-eye mullet, by sector.

Lakes and Coorong Fishery

The catch from the LCF was 128 tonnes in 1984/85. This increased to a maximum of 342.4 tonnes in 1989/90 (Figure 2-3). After 1989/90 catches declined to 142 tonnes in 1997/98 and remained stable for the next 5 years when 166 tonnes were caught in 2002/03. The most recent 5-year average catch for the LCF was 145 tonnes.

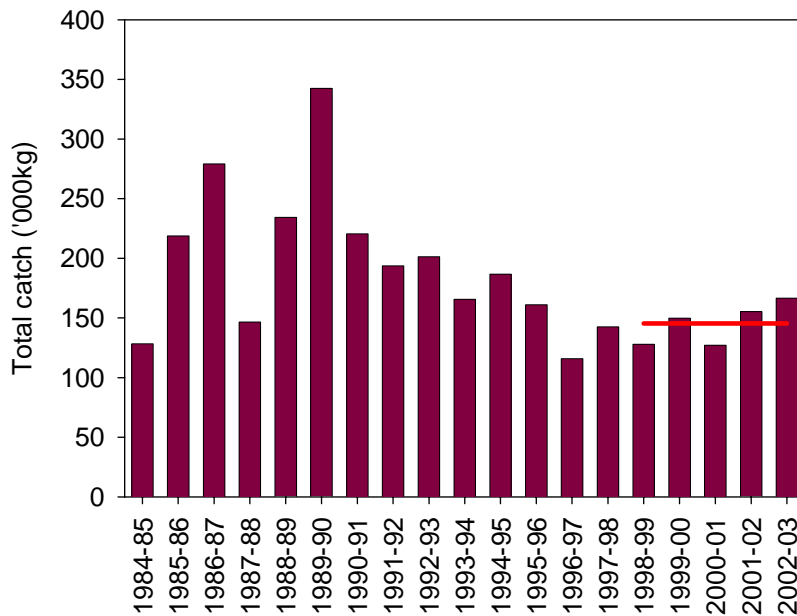


Figure 2-3. Total catch of yellow-eye mullet by the Lakes and Coorong Fishery, South Australia. (red line = 5-year average).

The dominant gear type was the small mesh gill net, which accounted for approximately 92% (most recent 5-year average) of the total catch of yellow-eye mullet (Figure 2-4a). Large mesh gillnets were the next most important gear although they accounted for only 5% (most recent 5-year average) of the catch.

Catches from small mesh gill nets rose from 98 to 338 tonnes from 1984/85 to 1989/90 (Figure 2-4b). Catches then declined to 129 tonnes in 1996/97. After this the overall trend was for increasing catches until 2002/03 when 159 tonnes were caught. Annual effort for small mesh gill nets increased from 1773 fisher days in 1984/85 to peak at 3266 in 1988/89. The level of effort in 2002/03 was 1225 fisher days. From 1990/91 to 1993/94 effort remained high while catches declined. After 1996/97 the trend in annual effort was similar that of the annual catch.

Catches from large mesh gill nets were small and after a peak of 42.5 tonnes in 1986/87 to less than 1 tonne/year in the mid 1990's (Figure 2-4c). Large mesh gill net catches were less than 14.5 tonnes from 1998-99 to 2002/03 and the most recent 5-year average was 4 tonnes/year. The trend in effort was very similar to that of catch.

The clearest trend in the catch and effort data for yellow-eye mullet was provided by targeted CPUE (kg/fisher day) for small mesh gill nets. CPUE (kg/fisher day) appeared to show an increasing trend from 1991/92 to 2002/03 but it is not possible to determine if this was due to an increase in relative abundance or an increase in

effective effort. Trends for effort (fisher days) and effort (net days) were similar from 1984/85 to 1992/93. After this effort (fisher day) declined steadily until 2002/03 while effort (net days) stabilised between 17,000 to 20,000 net days from 1996/97 to 2001/02 i.e. average of 17,600 net days but increased to 22,000 net days in 2002/03 (Figure 2.5a).

CPUE for large mesh gill nets was variable between years and rose from 27.8kg per fisher day on 1984/85 to 48.6 kg/fisher day 1986/87 (Figure 2-4e). CPUE remained below 50 kg per fisher day until a peak of 134 in 1989/90. With the exception of 1994/95 and 1995/96 CPUE then remained under 50 kg per fisher day until 1999/00 when a peak of 112.2 kg per fisher day occurred. The CPUE in 2002/03 was 58.3 kg per fisher day.

Trends in both CPUE (kg/ fisher day) and CPUE (kg/net day) were similar with peaks in 1985/86 and 1989/90, 1994/95 and 1997/98 (Figure 2.6b). However, CPUE (fisher days) increased steadily from 1991/92 while CPUE (net days) increased at a lower rate for the same period.

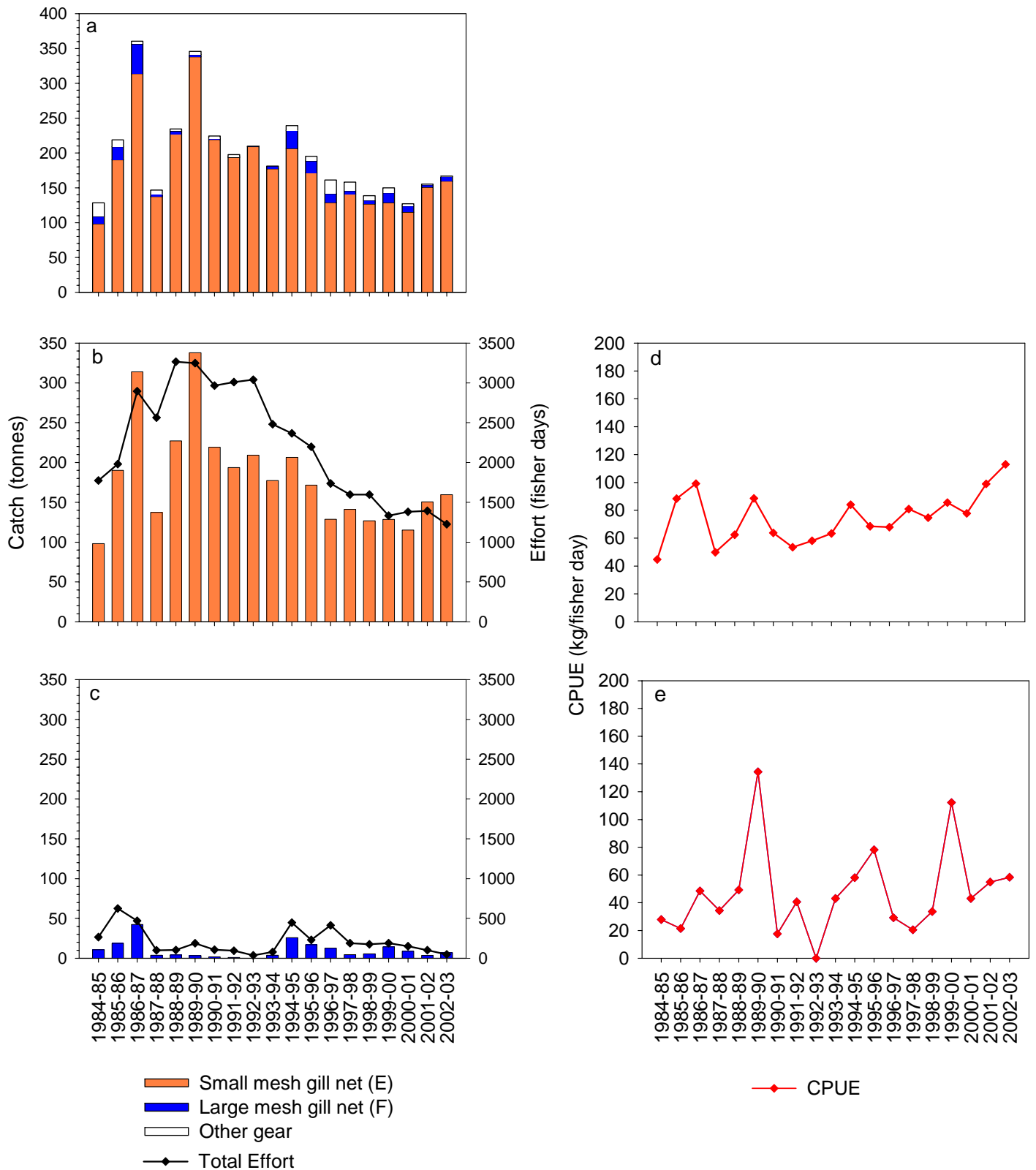


Figure 2-4. Catch, effort and CPUE for yellow-eye mullet from the Lakes and Coorong Fishery in South Australia: (a) Catch by gear type, (b) small mesh gill net catch and effort, (c) large mesh gill net catch and effort, (d) CPUE for small mesh gill net and (e) CPUE for large mesh gill net.

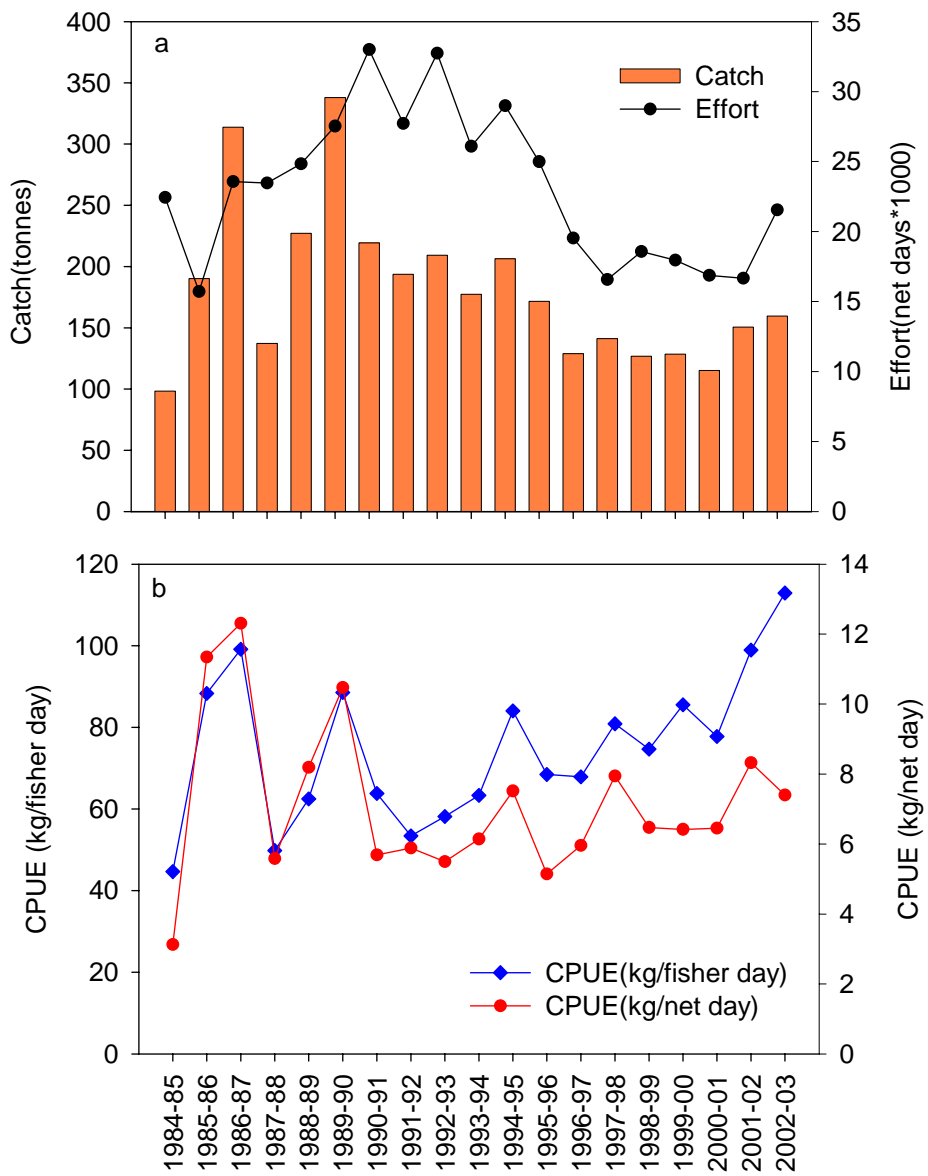


Figure 2-5. Catch and effort for yellow-eye mullet taken by small mesh gill net in the Lakes and Coorong Fishery, South Australia. (a) catch and effort (net days) and, (b) CPUE (kg/fisher day) and CPUE (kg/net day).

Marine Scale Fishery

The Marine Scale Fishery was divided into 4 regions: (i) West Coast (MFA's 5,7, 8, 9, 10, 15, 16, 17, 24, 25, 26, 27, 28, 38), (ii) Spencer Gulf (MFA's 11, 19, 20, 21, 22, 23, 29, 30, 31, 32, 33, 39); (iii) Gulf St. Vincent (MFA's 34, 35, 36, 40, 41, 42, 43, 44); (iv) Coorong (MFA's 45, 46, 51) and; (v) South-east (MFA's 53, 55, 56, 57, 58).

Catches of yellow-eye mullet from the MSF were dominated by Spencer Gulf and Gulf St. Vincent (Figure 2-6). In 2002/3 the catch from each of the Gulfs was 22 t. Most of the MSF catch came from Spencer Gulf (55 %, most recent 5-year average) while 42% was taken from Gulf St. Vincent. The MSF catch (most recent 5-year average) of yellow-eye mullet from the Coorong region, made up less than 0.5% of the MSF catch.

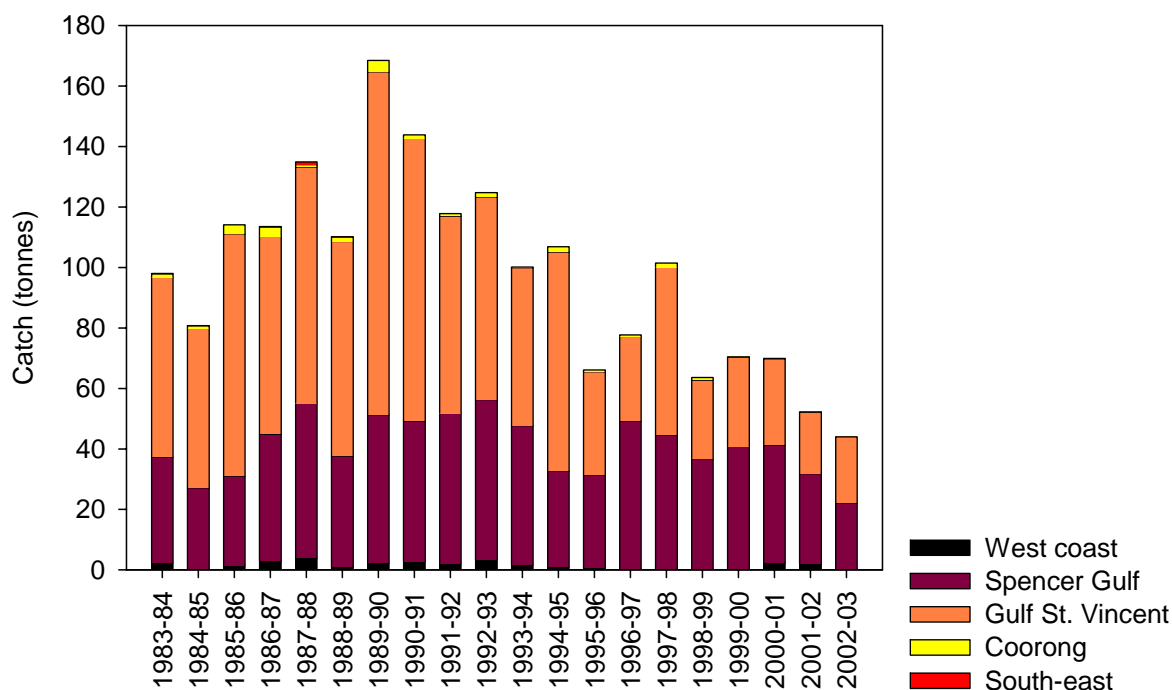


Figure 2-6. Catches, by region, for the South Australian marine Scale Fishery for yellow-eye mullet.

The dominant gear used to target yellow-eye mullet was the haul net, which accounted for 77 per cent of the State-wide catch. Gill nets accounted for 22 per cent

of the catch while catches from all other gear types combined were negligible (1.5%) (Figure 2.7a).

Catch and effort statistics for yellow-eye mullet were not analysed in detail for each region due to small numbers of licence holders and confidentiality obligations. Instead state-wide trends in catch and effort are shown in Figure 2-7, (b to e).

Overall, catches from the Marine Scale Fishery increased from 98 tonnes in 1983-84 to a peak of 168 t in 1989-90 (Figure 2-7a). Catches then declined to 44 t in 2002-03. Haul nets were the dominant gear and catches ranged from a peak of 130 t in 1989-90 down to 33.5 t on 2002-03 (Figure 2-7b).

Inter-annual trends in gill net catches were similar to those for haul nets and ranged from 38.1 to 10.2 t between 1989-90 and 2002-03 respectively (Figure 2-7c).

Targeted CPUE for haul nets was 46.6 kg/fisher day in 1983-84 and rose to a peak of 175.2 in 1989-90, then declined steadily to 61.6 kg/fisher day in 2002-03 (Figure 2-7d).

The inter-annual trend for targeted CPUE for gill nets rose from 23.7 to 104.2 kg per fisher day between 1983-84 and 1998-99. CPUE then declined to 37.2 kg per fisher day in 2001-02 before increasing slightly to 45.5 kg per fisher day in the following year.

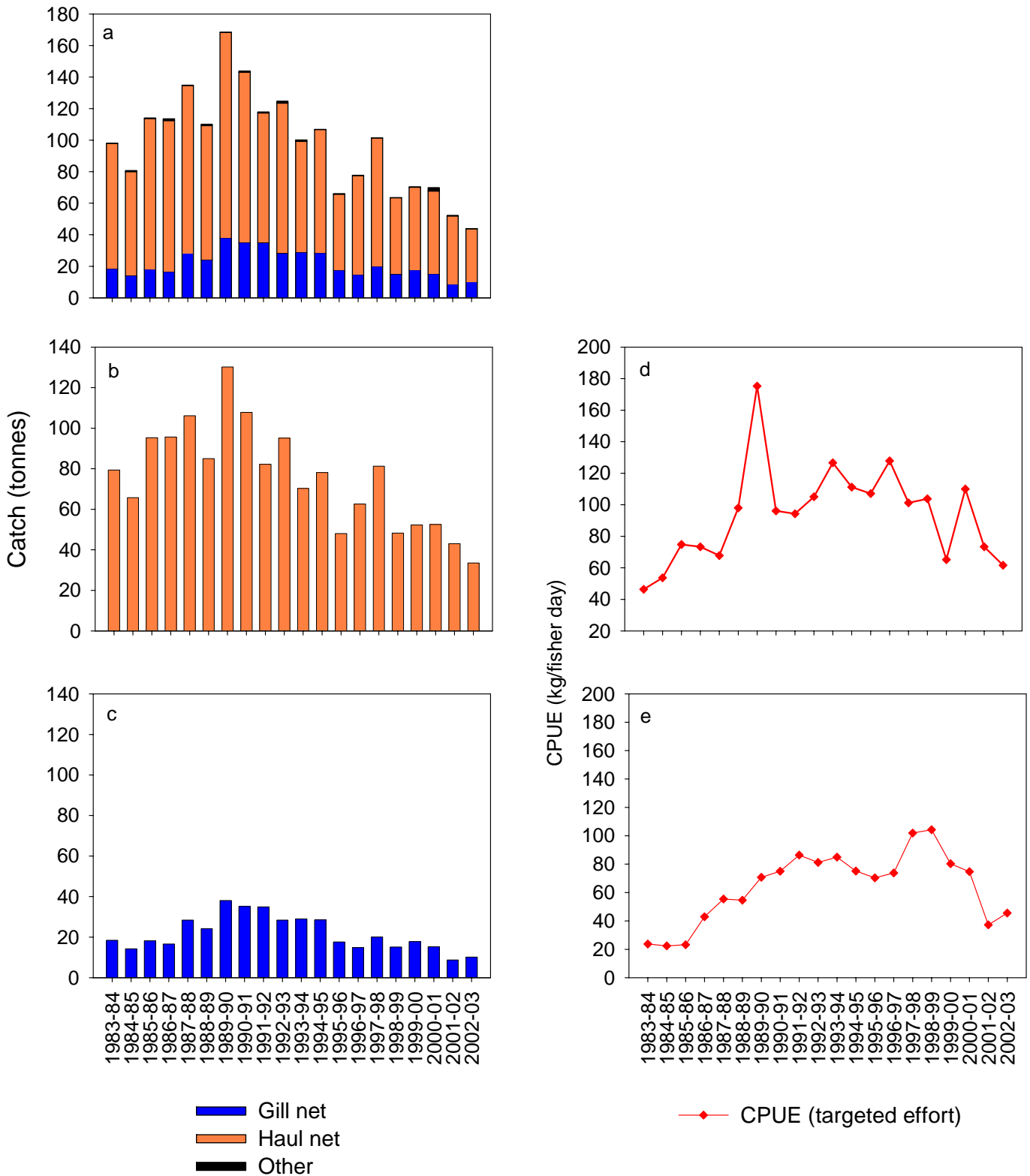


Figure 2-7. Catch and CPUE for yellow-eye mullet from the Marine Scale Fishery in South Australia: (a) Catch by gear type, (b) haul net catch, (c) gill net catch, (d) CPUE for haul net and (e) CPUE for gill net.

Recreational Fishery

Data were obtained from the National Recreational and Indigenous Fishing Survey (May 2000 to April 2001) and a regional breakdown of recreational catches conducted (Table 2-1). The majority of yellow-eye mullet were caught in the Gulf St Vincent/Kangaroo Island region, with the second highest catch taken from the South East region (including the Lakes and Coorong region). State-wide, 66% (numbers of fish) of the catch was harvested with the rest released. For the south-east region 71% of the catch was retained. Catches were seasonal and highest during January (8 t), and lowest during October (0.2 t) (Table 2-2). These estimates may include some data from species other than *A. forsteri* recorded as “unspecified mullet” (Keith Jones pers. comm. 2004).

Table 2-1. Summary of recreational catch data for each major region in South Australia from May 2000 to April 2001.

Region	Harvested catch		Released catch
	(No's)	(kg)	(No's)
West Coast	20,653	2,210	10,429
Spencer Gulf	73,304	7,844	16,708
GSV/KI	245,782	26,299	153,437
South East	98,821	12,516	40,237
State Total	438,560	46,926	220,811

Table 2-2. Seasonal recreational catches of yellow-eye mullet for South Australia from May 2000 to April 2001

Month	Harvested catch		Released catch
	(No's)	(kg)	(No's)
January	74,987	8,024	45,139
February	51,965	5,560	9,615
March	56,817	6,079	23,477
April	61,552	6,586	26,462
May	33,635	3,599	10,627
June	28,884	3,091	36,155
July	60,668	6,491	27,577
August	35,789	3,829	7,740
September	16,400	1,755	5,578
October	1,859	199	3,235
November	8,557	916	15,504
December	7,447	797	9,703
Annual Total	438,560	46,926	220,811

Within the Lakes and Coorong (See Figure 1-6) the recreational harvest of yellow-eye mullet was estimated at 82,519 fish with a further 31,763 released. The total estimated harvest of yellow-eye mullet from the Lakes and Coorong was 8,830 kg. Of this catch, the majority (95%) was caught from private boats, while approximately 4% were caught from beach/rocks and less than one percent was caught from other platforms (Table 2-3).

Table 2-3. Recreational catches of yellow-eye mullet for each fishing platform from the Lakes and Coorong region, South Australia from May 2000 to April 2001.

Fishing Platform	Harvested catch		Released catch
	(No's)	(kg)	(No's)
Boat	78,227	8,370	28,762
Beach/rocks	4,212	451	876
Other	80	9	2,124
Total	82,519	8,830	31,763

The catch of yellow-eye mullet from the Lakes and Coorong was mostly taken on line (96%) with 4% caught using gill nets (Table 2-4).

Table 2-4. Recreational catches of Yellow-eye mullet for each fishing method used in the Lakes and Coorong region, South Australia from May 2000 to April 2001.

Fishing Method	Retained catch		Released catch
	(No's)	(kg)	(No's)
Line	79,602	8,517	31,763
Net	2,916	312	0
Total	82,519	8,830	31,763

The highest regional catches of yellow-eye mullet were made during February when approximately 3.4 tonnes were harvested. The largest number of fish caught was in January when almost 54,000 fish were caught, over 24,000 of which were released, compared to nearly 33,500 fish in February, when only 1,694 fish were released. Minimum catches were made during June, July, August, October and November when no fish were harvested (Table 2-5).

Table 2-5. Seasonal recreational yellow-eye mullet catches for all platforms and methods from the Lakes and Coorong region, South Australia from May 2000 to April 2001.

Month	Harvested catch		Released catch
	(No's)	(kg)	(No's)
January	29,568	3,164	24,234
February	31,746	3,397	1,694
March	14,513	1,553	0
April	3,140	336	4,710
May	318	34	636
June	0	0	0
July	0	0	0
August	0	0	0
September	2,985	319	0
October	0	0	0
November	0	0	0
December	249	27	489
Total	82,519	8,830	31,763

2.1.3 Discussion

In the commercial fishery total State-wide annual catches showed high inter-annual variability prior to the early 1990's with this becoming less marked in later years. This was possibly the result of high inter-annual variability in the catches from the LCF, which was the dominant sector.

Catches from the LCF were dominated by small mesh gill net catches and were stable over the past 5 years. Targeted CPUE (kg/fisher day) from small mesh gill nets increased from 1991/92 to 2002/03. CPUE (net days) however, was stable and did not increase over this period. Estimating relative abundance on the basis of trends in CPUE assumes that there is no change in effective effort and these data should be treated with caution. Additional effort data, particularly net soak time, and net length could be used to address this.

Approximately 5% of the LCF catch was taken by large mesh gill nets and there were no strong trends in targeted CPUE. It is unlikely that targeted CPUE for this gear can be used to estimate relative abundance of yellow-eye mullet in the LCF.

Catches from the MSF were dominated by Spencer Gulf and Gulf St. Vincent whilst negligible catches were obtained from the Coorong region. Haul nets were the main gear. Catches from both haul nets and gill nets declined steadily from 1989/90 to the present. CPUE (fisher days) declined strongly from 1997/98 to the present. Estimates of annual targeted effort were the only effort data available for this sector. Consequently total effort could not be related to total catch.

Data from the National Recreational and Indigenous Fishing Survey suggested that only 4% of the recreational catch of yellow-eye mullet caught from the Lakes and Coorong region could be attributed to gill nets licensed to recreational fishers. Although line fishing is the dominant method used by recreational fishers in the Coorong lagoons in recent years there are also 2258 current recreational net registrations. Gill net fishers may have been under-represented in the National Recreational and Indigenous Fishing Survey and the recreational catch for the Coorong lagoons may have been underestimated.

3 PERFORMANCE INDICATORS

3.1 Introduction

This section provides a report on the performance of the LCF for yellow-eye mullet against the reference points defined in the Draft Management Plan for the South Australian Lakes and Coorong Fishery. Reference points were established for the key performance indicators using historical data from 1984/85 to 2001/02. Additional reference points are the 4-year rate of change for total catch and CPUE.

3.2 Summary of Performance indicators

3.2.1 Key performance indicators

The values of the performance indicators for 2002/03 are shown in Table 3-1.

Table 3-1. Performance indicators for yellow-eye mullet caught by the lakes and Coorong Fishery, South Australia.

Performance Indicator	Upper reference point	Lower reference point	2002/03
Total catch (tonnes)	315	134	166
CPUE (kg/fisher day)	93	47	109
Most recent 4-year total catch trend (tonnes/year)	+35	-35	+10
Most recent 4-year CPUE trend (kg/fisher day)	+10	-10	+4.5

Catch in 2002/03 was 166.5 t and was within the range for the reference points specified in the management plan.

Targeted CPUE was 109 kg/fisher day. This was 12 % above the upper reference point specified in the management plan.

The most recent 4-year total catch trend was +10 tonnes per year. This was within the specified range for the reference points.

The most recent 4-year CPUE trend was +4.5 kg/fisher day. This was within the specified range for the reference points.

3.2.2 Other performance indicators

Number of licences reporting yellow-eye mullet as target

The number of fishers targeting yellow-eye mullet ranged from 18 to 26 (Table 3-2). In 2002-03, yellow-eye mullet were targeted by 21 fishers representing 57 % of fishers.

Table 3-2. The number of Lakes and Coorong Fishery commercial licences against which yellow-eye mullet were taken.

Year	No. licences in fishery	No licences reporting yellow-eye mullet as target	% licences reporting yellow-eye mullet as target
1998-99	39	18	46
1999-00	39	22	56
2000-01	38	23	61
2001-02	38	26	68
2002-03	37	21	57

Pre-recruit abundance

There are currently no data on pre-recruit abundance for this species.

Baseline biological information

There is limited information available on size of maturity and patterns of reproduction and growth for yellow-eye mullet in South Australia. Age and size structures are also not available at this time.

Impacts of fishing on non-target species

There is currently no information on the nature and extent of by-catch taken by small mesh gill nets when yellow-eye mullet are targeted. There exists the potential for 0 to and 1 year old mulloway (*Argyrosomus japonicus*) to be taken in this gear. An FRDC funded project has been proposed to address this and other by-catch issues in the 2005-07 period.

4 GENERAL DISCUSSION

4.1 Synopsis of Information

Few data are available on the biology and ecology of yellow-eye mullet in South Australia. Currently, yellow-eye mullet in South Australia are managed as a single stock and the stock sub-structure is poorly understood. Uncertainty also exists around growth rates, size at maturity or size and age structures; and nothing is known about regional differences.

Approximately 69% (most recent 5-year average) of the total South Australian annual commercial catch of yellow-eye mullet was taken by the LCF. The dominant gear used to target yellow-eye mullet is the small mesh gill net. Uncertainty exists around changes in the level of effective effort over time with this gear. Annual small mesh gill net catches were relatively stable from 1996/67 to 2002/03, while effort (fisher days) declined. Consequently, over this period CPUE (kg/fisher days) increased steadily. CPUE (kg/net days) however, increased at a lower rate. The implication is that the increase in CPUE (kg/fisher days) does not reflect an increase in relative abundance but that more nets were employed to take approximately the same annual catch.

4.2 Status of the Fishery

Information available for assessing the status of yellow-eye mullet in South Australia is presented in Section 2 of this report. Like most fisheries assessments, the data and estimates presented have high associated levels of uncertainty. This uncertainty originates from several sources.

One of the most significant potential sources of uncertainty in this assessment is its reliance on fishery-dependent data. Changes in effective effort may not be detected when estimates are based on either of the two available measures of effort i.e. fisher days and net days. Most of the catch of yellow-eye mullet is taken by the LCF in the Coorong region with almost all the rest being taken by the MSF in Spencer Gulf and Gulf St. Vincent. The accuracy of log book data has not been examined empirically for either of these sectors.

The mixed nature of the LCF means that non-biological factors, such as availability of and prices paid for, other LCF species, not just yellow-eye mullet abundance, can affect catches of yellow-eye mullet.

Despite the limitations identified above, catch and CPUE from the LCF do appear to provide a useful indicator of the abundance of yellow-eye mullet. Catches were stable over recent years and the trend in CPUE (kg/net days) from small mesh gill nets is consistent with stable abundance. However, small mesh gill net effort will remain subject to a level of uncertainty until changes in fishing patterns, related to net setting practices, are better understood.

Performance indicators for the yellow-eye mullet fishery currently exist only for the Lakes and Coorong Fishery although this will be addressed by the Management Plan for the South Australian Marine Scalefish fishery in 2005. Of the four indicators all but CPUE were within the range specified in the Management Plan for the Lakes and Coorong. CPUE (fisher days) increased steeply during 2001-02 and 2002-03. This may be due to (i) an increase in relative abundance of yellow-eye mullet and/or (ii) problems measuring effort resulting from increases in the number of nets used per fisher day.

Twenty nine percent (most recent 5-year average) of the South Australian catch of yellow-eye mullet was taken in the MSF and this consisted mostly of catches from haul nets. Catches using this method declined steadily after a peak in 1989/90 and CPUE (fisher days) declined after the mid 1990's. Trends in both catch and CPUE (fisher days) were similar for gill net catches from this sector. This could reflect a decline in abundance of yellow-eye mullet in both of the South Australian Gulfs. However, targeting practices and fishing effort in this sector are poorly understood.

4.3 Current Management Arrangements

The management plan for the LCF will be finalised in 2005. Analyses conducted in this report suggest that for the yellow-eye mullet fishery the performance indicator CPUE should be based on (i) data from small mesh gillnets only (which take over 90% of the catch), and (ii) effort measures should be based on net days rather than fisher days, as the numbers of nets used per day has changed over time and biases CPUE data based on fisher days.

4.4 Future Research Needs

Limited information is currently available for assessing the status of South Australia's fisheries for yellow-eye mullet.

Improved effort reporting, particularly for the small mesh gill nets, e.g. length of net and length of set, are needed to address uncertainties in CPUE for the LCF. Improved effort estimates are also required for the MSF.

Basic biological data are also required for this species. For example, estimates of size at maturity are needed to assess the suitability of the current minimum size limit.

These data are needed for the Coorong region, Gulf St Vincent and Spencer Gulf as regional variations in size at maturity can be significant.

Information on the age and growth of this species are also needed. Age structure data are required to assess the level of exploitation of the stock. Information from otoliths could also be used to provide information on the levels of stock structure.

REFERENCES

- Anon. (1988). New restrictions for mulloway fishery. *Australian Fisheries* 47(8): 9-10.
- Anon. (1995) Proceedings of the Murray Mouth Biological Resource Assessment Workshop South Australian Research and Development Institute, Ocean 2000, Adelaide, 1-103.
- Anon. (2003) Marine Scale Fisheries Management Committee Annual Report.
- Chubb, C. F., Potter, I. C, Grant, Lenanton R.C.J. and Wallace J. (1981). Age Structure, Growth Rates and Movements off Sea Mullet, *Mugil cephalus* L., and Yellow-eye Mullet, *Aldrichetta forsteri* (Valenciennes), in the Swan-Avon River System, Western Australia. *Australian Journal of Marine and Freshwater Research* 32: 605-628.
- Crossland, J. (1981). Fish Eggs and Larvae of the Hauraki Gulf, New Zealand. Wellington, New Zealand, New Zealand Ministry of Agriculture and Fisheries, Fisheries Research Division: 59.
- Geddes, M. C. and D. Hall (1990). The Murray Mouth and Coorong. The Murray. N. MacKay and D. Eastburn. Canberra, Murray-Darling Basin Commission: 200-213
- Gommon, M. F., J. C. M. Glover, et al., Eds. (1994). The Fishes of Australia's South Coast. Adelaide, State Print.
- Hall, D. (1984) The Coorong: Biology of the major fish species and fluctuations in catch rates. 1976-1983. *SAFRIC* 8(1): 3-15
- Hall, D. A. (1986). An assessment of the mulloway (*Argyrosomus hololepidotus*) fishery in South Australia with particular reference to the Coorong Lagoon. South Australia, Department of Fisheries, South Australia: 1-41
- Harris, J. A. (1968). Age structure, growth rate and spawning cycle of a population of Yellow-eye mullet *Aldrichetta forsteri* (Cuv. and Val.) from the Coorong Lagoon, South Australia. *Transactions of the Royal Society of South Australia* 92: 37-50.
- Henry, G. W. and J. M. Lyle (2003) The National Recreational and Indigenous Fishing Survey 99/158 NSW Fisheries, Cronulla
- Higham, J. (2002) Survey of Mawson Lakes for resident fish populations and recommendations for future stocking. Consultants report to Mr. Paul Manning - ECO Tech Services. June 2002.
- Higham, J., Hammer, M. & Geddes, M. (2002). Fish and Invertebrates, pp 53-64 in: The Murray Mouth; exploring implications of closure or restricted flow (Goodwin, N. & Bennet, S. Eds). Murray Darling Basin Commission, Canberra. pp95.
- Jones, G.K., (1986) A review of the recreational and commercial marine scale fish resource in Pt Lincoln waters. South Australian Department of Fisheries Discussion Paper, March 1986: 29 pp

- Jones, G. K., D. A. Hall, et al. (1990). The South Australian Marine Scale Fishery: Stock Assessment, Economics and Management. Green Paper. Adelaide, South Australian Department of Fisheries: 186.
- Kailola, P. J., M. J. Williams, et al., Eds. (1993). Australian Fisheries Resources. Canberra, Bureau of Resource Sciences, Department of Primary Industries and Energy and the Fisheries Research and Development Corporation.
- Kingsford, M. J. (1988). The early life history of fish in coastal waters of northern New Zealand: a review. *New Zealand Journal of Marine and Freshwater Research* 22: 463-479.
- Kingsford, M. J. and J. H. Choat (1986). Influence of surface slicks on the distribution and onshore movements of small fish. *Marine Biology* 91: 161-171.
- Knight, M. A., A. Tsolos and A. M. Doonan (2000) South Australian Fisheries and Aquaculture information and statistics report 49 South Australian Research and Development Institute, Adelaide, 1-67.
- Lenanton, R. C. J. (1974). Fish and Crustacea of the Western Australian South Coast Rivers and Estuaries. Perth, Marine Research Laboratories, Department of Fisheries and Fauna: 17.
- Lenanton, R. C. J. (1984). "The commercial fisheries of temperate Western Australian estuaries: early settlement to 1975." *Fish. Wildl. West. Aust. Rep.* 62: 1-92.
- Manikiam, J.S. (1963). Studies of Yellow-eye mullet *Aldrichetta forsteri* (Cuvier and Valenciennes) (Mugilidae). Unpublished M.Sc. thesis, Department of Zoology, University of Wellington, NZ. pp 241.
- McDowall, R. M., Ed. (1996). Freshwater fishes of South-Eastern Australia. Sydney, Reed Books Australia, Chatswood, NSW.
- Noye, J., Ed. (1974). The Coorong. Adelaide, Department of Adult Education, University of Adelaide.
- Olsen, A. M. and D. Evans (1991). The Coorong. a multi-species fishery. Adelaide, SA, SA Department of Fisheries: 1-60.
- Pellizzari, M. (2001). A preliminary investigation of the biology of yellow-eye mullet in South Australian waters. Adelaide, SARDI Aquatic Sciences: 22pp.
- Pellizzari, M. (2002). The early life history of yellow-eye mullet (*Aldrichetta forsteri*), in the Coorong lagoon South Australia, determine via analysis of otolith microstructure. Unpublished Honours thesis, Department of Environmental Biology, University of Adelaide, Australia. pp 43.
- Pierce, B. E. (1995). Coorong and Murray Mouth Fisheries pages 43 - 49 in Proceedings of the Murray mouth biological resource assessment workshop. eds Edyvane, K. and Carvalho, P. (1995) South Australian Research and Development Institute (Aquatic Sciences), Adelaide. 87pp
- Pierce, B.E. and Doonan, A.M. (1999) A Summary report on the status of selected species in the River Murray and Lakes and Coorong Fisheries. South Australian Fisheries Assessment Series 99/1.

- Philipson, M., Byrne, J. and Rohan, G. (1986). Participation in recreational fishing in South Australia. Fisheries Research Paper Number 16. Department of Fisheries, Adelaide, South Australia. 33pp.
- Potter, I. C. and G. A. Hyndes (1994). Composition of the fish fauna of a permanently open estuary on the southern coast of Australia, and comparisons with a nearby seasonally closed estuary. *Marine Biology* 121: 199-209.
- Rohan, G., G. K. Jones, et al. (1991). The South Australian Marine Sclae fish Fishery: Supplementary Green Paper. Adelaide, South Australian Department of Fisheries: 1-169
- Sloan S. (2004) Management Plan for the South Australian Lakes and Coorong Fishery. South Australian Fisheries Management Series Report: Agriculture Food and Fisheries Division of Primary Industries and Resources, South Australia 128 pp, in prep.
- Thomson, J. M. (1954). The Mugilidae of Australian and adjacent seas. *Australian Journal of Marine and Freshwater Research* 5: 70-131.
- Thomson, J. M. (1957a). Biological studies of economic significance of the Yellow-eye mullet, *Aldrichetta forsteri* (Cuvier & Valenciennes) (Mugilidae). *Australian Journal of Marine and Freshwater Research* 8: 1-13.
- Thomson, J. M. (1957b). Interpretation of the scales of the Yellow-eye mullet, *Aldrichetta forsteri* (Cuvier & Valenciennes) (Mugilidae). *Australian Journal of Marine and Freshwater Research* 8: 14-28.
- Thomson, J. M. (1957c). The Food of Western Australian Estuarine Fish. Perth, Fisheries Department, Western Australia: 13pp.
- Thomson, J. M. (1957d). The size at Maturity and spawning times of some Western Australian Estuarine Fishes. Perth, Fisheries Department, Western Australia: 8pp.
- Webb, B. F. (1973a). Fish Populations of the Avon-Heathcote Estuary. 1. General ecology, distribution and Length-Frequency. *New Zealand Journal of Marine and Freshwater Research* 7(1&2): 45-66.
- Webb, B. F. (1973b). Fish Populations of the Avon-Heathcote Estuary. 2. Breeding and Gonad Maturity. *New Zealand Journal of Marine and Freshwater Research* 7(1&2): 45-66.
- Webb, B. F. (1973c). Fish Populations of the Avon-Heathcote Estuary. 3. Gut Contents. *New Zealand Journal of Marine and Freshwater Research* 7(3): 223-234.
- Yearsley, G. K., et al., Eds. (1999). Australian Seafood Handbook an identification guide to domestic species. Hobart, CSIRO Marine Research.