

**KEY FINDINGS OF THE 2013 WEST COAST
DEMERSAL SCALEFISH RESOURCE STOCK
ASSESSMENT**

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1.0 EXECUTIVE SUMMARY

In 2007, a stock assessment of the three indicator species: West Australian dhufish (WA dhufish), pink snapper and baldchin groper, for the demersal scalefish resource in the West Coast Bioregion (WCB) concluded that overfishing of the stocks was occurring and that the levels of fishing effort and catch by all sectors needed to be reduced by at least 50 per cent to allow the stocks to recover (Fisheries Research Report No 163). A 2009 stock assessment confirmed this earlier finding.

The findings of the assessment were the catalyst for management and consultation processes that led to the introduction of a suite of recreational and commercial fishing management measures that were believed capable of achieving the necessary catch reductions.

Now, six years since the first stock assessment, and with the completion of a comprehensive boat-based survey of recreational fishing, ongoing annual monitoring of commercial and charter catches and a third stock assessment completed in 2013, the effectiveness of current management measures is able to be assessed.

The key findings of the third stock assessment are:

- The management objective of maintaining catches of the overall demersal suite of species in the WCB by the commercial and recreational sectors at less than 50 per cent of 2005/06 catches has been achieved.
- The management strategies introduced have reduced the catches of WA dhufish and there are indications that the stock is starting to recover, albeit slowly.
- The management strategies introduced have reduced the catches of pink snapper in the two southern management Areas of the WCB and there are indications of some recovery in those stocks, but the current levels of catch in the two northern management Areas of the WCB are only allowing a very slow recovery.
- While baldchin groper catches have been reduced, there is no evidence of any recovery of its stocks in the Abrolhos Islands at this time (where it is used as a key indicator species), indicating overfishing is still occurring.

The recommended outcomes, based on the above key findings, are as follows:

- At a minimum, the current level of management needs to remain in place for at least five more years to continue the recovery trends that have been initiated.
- As catches of pink snapper and baldchin groper have not been reduced sufficiently in the northern half of the WCB, the recovery of stocks in this region is either limited or has not begun. Consideration should therefore be given to reviewing management measures for both commercial and recreational sectors within the two northern management Areas to further aid recovery in this region.

This paper also provides an overview of the determination in regard to the sectoral allocations of the demersal scalefish resource in the WCB.

2.0 INTRODUCTION

The West Coast Demersal Scalefish Resource is a multi-species resource that is fished throughout the WCB (which extends south from around Steep Point at the bottom of Shark Bay to Black Point east of Augusta - see Figure 1) by both recreational (including charter) fishers and commercial fishers operating in a number of separately managed fisheries. From a social perspective, this is widely considered to be the most important aquatic resource in WA and, as such, the management of the West Coast Demersal Scalefish Resource attracts significant interest within the general community.

From the late 1990s there was growing concern within Government, the fishing industry and the recreational fishing community that the escalating catches of demersal scalefish were not sustainable in the longer term. The catch increases were being caused by significant growth in both commercial and recreational fishing effort combined with ongoing increases in fishing efficiency.

Although the scientific evidence to support this concern was limited, processes and strategies aimed at tightening management for both fishing sectors were initiated during the early 2000s and funding was obtained to conduct the first stock assessment of the indicator species.

2.1 West Coast Demersal Scalefish (Interim) Managed Fishery

The current management goal is to reduce the total catches of demersal scalefish by commercial fisheries in the WCB by at least 50 per cent of the 2005/06 levels. Although there are a number of commercial fisheries that are able to retain demersal scalefish, the West Coast Demersal Scalefish (Interim) Managed Fishery (WCDSIMF) is the primary and most significant commercial fishery in the WCB that targets demersal scalefish. As such the WCDSIMF is the focus of this report.

The WCDSIMF extends south from 26° 30' south latitude (around Steep Point north of Kalbarri) to 115° 30' east longitude (at Black Point, east of Augusta) and seaward from the coastline to the 200 nautical mile boundary of the Australian Fishing Zone (Figure 1). The fishery comprises five management areas: being four Inshore Areas (Kalbarri, Mid-west, Metropolitan, South-west) and an Offshore Area.

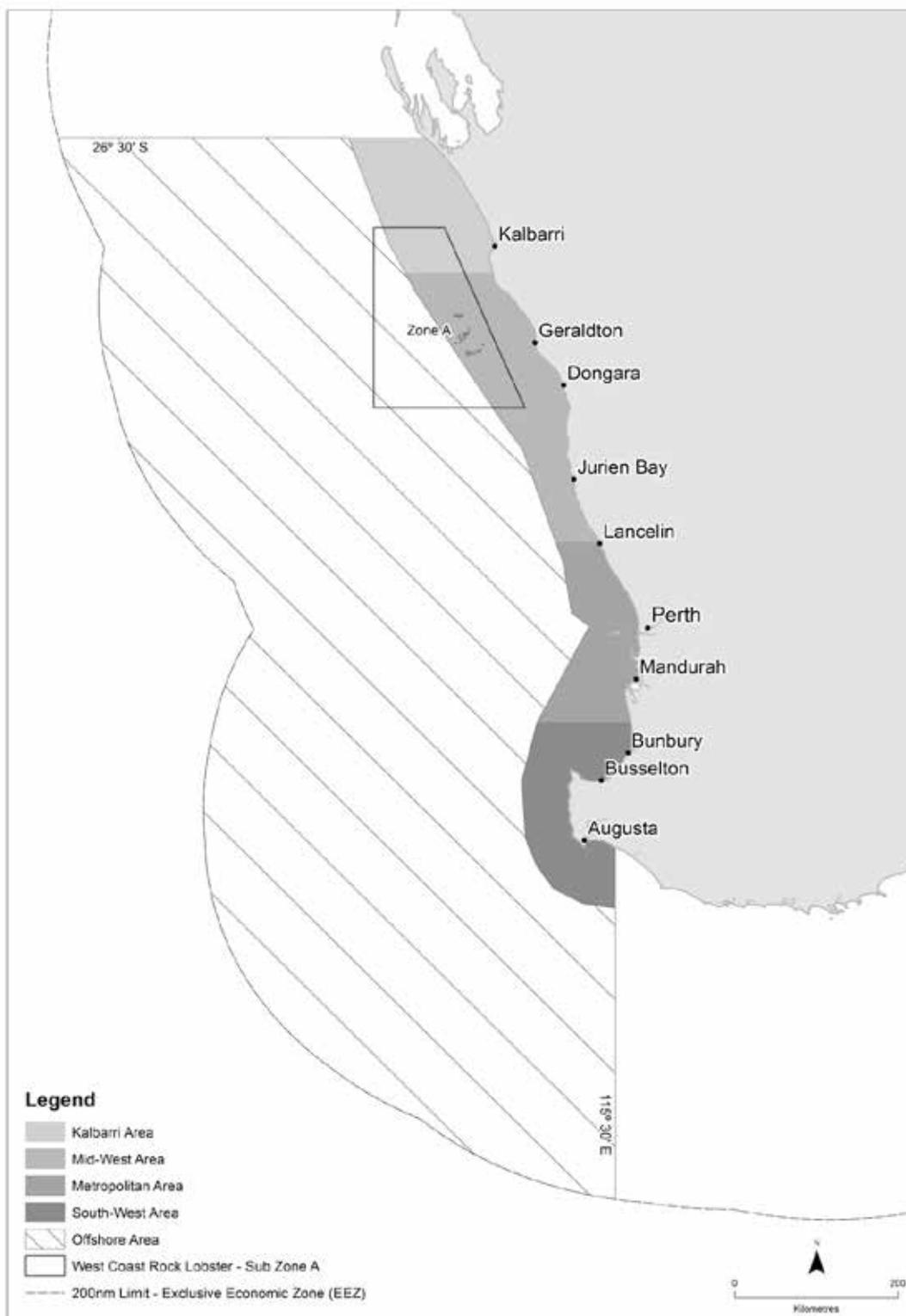


Figure 1. West Coast Demersal Scalefish (Interim) Managed Fishery

2.1.1 Management history

The WCDSIMF was an open-access fishery until January 2008. The open-access fishery, commonly known as the ‘wetline fishery’, utilized line and hooks (primarily handlines, set lines and drop lines) to catch a range of scalefish, with demersal scalefish being the most targeted species. The fishery was managed primarily through fish size limits, some gear limits and closed seasons for some species (such as a closure to fishing for Baldchin Groper at the Abrolhos Islands during their spawning period). Due to the open-access nature of the fishery (which was accessible by any person who held a current Commercial Fishing Licence and was operating from a boat attached to a current Fishing Boat Licence) there was the potential for up to 1,250 commercial fishing boats to fish by line in the WCB.

A review of ‘wetline’ fishing (the “Wetline Review”) commenced in 2003 examining the issues relating to, and development of a policy for, the future management of the wetline fishery in the West Coast and Gascoyne Bioregions. This review, which ran over four years included the establishment of two independent panels to investigate and provide recommendations on access, allocation and management matters and resulted in the publication of eight Fisheries Management Papers. The final recommendations were released as a Fisheries Management Paper for public comment in early 2006.

In May 2007, the then Minister for Fisheries announced his final “Wetline Review” decisions for the future management arrangements for the WCDSIMF. These significant changes to management arrangements were implemented in two stages:

- The first stage was implemented in late 2007 and, on commencement of the WCDSIMF management plan on 1 January 2008, access criteria were introduced that had to be satisfied in order for a holder of a Fishing Boat Licence to be eligible to be granted a Permit for the WCDSIMF. This effectively closed the wetline fishery and reduced access to line fishing for scalefish on the West Coast from a potential 1,250 boats to 63 WCDSIMF Permits.
- In the second stage, which commenced on 1 January 2009, capacities (maximum effort limits that act as a proxy for catch targets) were introduced for each of the areas of the fishery (noting that the Metropolitan area was closed to commercial fishing in late 2007). A scheme allocating entitlement to permits, and provisions to allow for transferability of entitlement (in the form of units that provide entitlement in hours of fishing) for each of the four Inshore Areas was introduced. The capacity settings (in the form of effort hours) introduced on 1 January 2009 were determined to deliver a reduction of at least 50 per cent in catch (for each area of the Fishery) based on 2005/06 catches (see Table 1).

On 15 November 2007 the Metropolitan Area commercial fishing closure was introduced. The closure, which applies to the WCDSIMF and demersal gillnet and longline fishing delivered explicit commercial catch reductions, while allowing recreational fishing to continue pending the finalisation of management objectives and the introduction of new management arrangements for the recreational sector.

2.1.2 Current management arrangements

- *Limited number of Interim Managed Fishery Permits*
There are currently 59 Permits in the WCDSIMF. To remain active, a permit must hold units of entitlement in the fishery.
- *Target Commercial Catch (TCC) for each Area*
The WCDSIMF is managed under an Individual Transferable Effort system that specifies a Target Commercial Catch (TCC) setting for each area of the Fishery. The total number of hours allocated to each area (known as the 'Capacity') was determined using the relevant TCC and Catch Per Unit Effort (CPUE) figures for each area provided by the Department of Fisheries' Research Division.

The catches from the Fishery are reviewed annually with respect to the TCC settings and adjusted as required. Entitlement for the four Inshore Areas is in "units" and unit values are determined on the basis of the relevant TCC and CPUE. The initial values of a unit of entitlement for the four Inshore Areas were determined by dividing the capacity of the area of the fishery by the respective number of units and expressed as hours. The number of hours allocated for each area (the Capacities) were set to deliver a 50 per cent reduction in catch from each area (based on 2005/06 catches).

The management arrangements for the Offshore Area of the Fishery are slightly different and operate via a "shared pool" of fishing effort (being 100 "boat fishing days" or 2,400 hours). Access to the Offshore Area is available to permit holders (who hold unexhausted inshore area entitlement) through a "first in, best dressed" arrangement. The size of the "pool" (which is in fact the Capacity set by the Minister) is set to deliver a 50 per cent reduction in catch (based on 2005/06 catches) and can be adjusted as appropriate to ensure the sustainability of offshore demersal scalefish stocks.

This approach provides a conservative means of managing the offshore area. However, it is likely that more formal arrangements will need to be developed for this area in the future.

2.2 The recreational fishery

Recreational fishing and boating has always been a popular Western Australian past-time. In the early 1990s, the first major review of recreational fishing was undertaken that set the direction of recreational fishing management in WA. In 2003, a five-year management strategy for recreational fishing in WA (West Coast Recreational Fishing Working Group 2001) was announced. This included a number of significant changes to recreational fishing rules including the introduction of possession limits for the first time in WA, and changes to bag and size limits and filleting at sea rules. It is important to note however that these changes were designed primarily for social purposes rather than to address specific sustainability concerns.

The first 12-month survey of recreational boat fishing in the WCB, including the Metropolitan Area, was conducted during 1996/97. This survey provided comprehensive data on the recreational boat-based catch for the WCB.

The recreational creel survey was repeated in 2002/03 and 2005/06. The 2005/06 survey results showed changes in the level and distribution of recreational fishing effort. People were shown to travel greater distances to fish over a far wider area. There were still peaks in fishing effort around key launching sites and considerable fishing pressure being exerted out to the 200m isobath. This trend was due to the growth in ownership of larger, faster boats and people traveling greater distances to catch fish.

When the need for a 50 per cent catch reduction (on 2005/06 levels) became known in 2007 (see Table 1), Fisheries Management Paper 225 was released, setting out future recreational fishing management scenarios for community consideration. As a result, in 2008, a number of management changes aimed at achieving the necessary recreational fishing catch reduction were introduced. These included reduced mixed bag limits for (the then) high risk “Category 1” fish (which included demersal scalefish), reduced bag limits for WA dhufish and boat possession limits for Category 1 fish.

These measures were subsequently reviewed and in 2009 a modified package of management arrangements were introduced. The key changes included:

- A two month closure (15 October-15 December) to recreational fishing for demersal scalefish (see Table 2);
- A mixed daily bag limit of two demersal scalefish per fisher;
- A daily bag limit of one WA dhufish;
- A boat limit of two WA dhufish (six on charter boats);
- An increased minimum legal length (50 cm) for pink snapper (south of Lancelin);
- The requirement to have a release weight on board when fishing for demersal scalefish; and
- Introduction of a statewide “Recreational Fishing from Boat Licence” (\$30).

In addition to the 2009 measures, the following elements of the recreational fishing arrangements announced in late 2008 remain in place:

- The closure (over the period 1 November to 31 January) to fishing for Baldchin Groper within the Abrolhos Islands Fish Habitat Protection Area during their spawning period.
- The finfish possession limit within the Abrolhos Islands Fish and Fish Habitat Protection Area of 10 kg of fillets or one day’s bag limit of whole fish or fish trunks per person.

Furthermore, the minimum legal length for pink snapper south of Lancelin was increased from 45 cm to 50 cm in December 2009.

2.2.1 Charter fishing

The WCB has the highest number of charter operators in the State with limited entry arrangements being introduced in 2001. Logbooks became compulsory in 2002/03 and these show that there has been an overall contraction in total charter effort and operational area of charter activity in the WCB since then. However, charter effort has been consistently high off Perth, Kalbarri and at the Abrolhos Islands. In 2011/12, the charter sector took about 15 per cent of the total recreational catch of WA dhufish and about 23 per cent of the pink snapper catch.

Table 1. Recreational (including charter) and commercial catch estimates

	50% of 2005/06 catches (tonnes)	Most recent catch estimate (tonnes)
COMMERCIAL		
All commercial fisheries	450	438
WA dhufish	82	80
Snapper	126	190
Baldchin groper	19	18
RECREATIONAL		
Top 15 species	252	200
WA dhufish	126	86
Snapper	37	43
Baldchin groper	33	38

Table 2. The take of these species by recreational fishers is prohibited during the recreational demersal scalefish closure in the WCB (15 October to 15 December, inclusive)

COMMON NAME	SCIENTIFIC NAME
Coral trout and coronation trout	<i>Plectropomus</i> spp. and <i>Variola</i> spp.
Cods	Family Epinephelidae/Serranidae
WA dhufish	<i>Glaucosoma hebraicum</i>
Emperors	Family Lethrinidae
Baldchin groper and tuskfish	<i>Choerodon</i> spp.
Western blue groper	<i>Achoerodus gouldii</i>
Hapuku/bass groper/blue eye trevalla and eightbar grouper	<i>Polyprion</i> spp., Family Centrolophidae and <i>Hyporthodus octofasciatus</i>
Parrot fish	Family Labridae (Sub-family Scarinae)
Pink snapper	<i>Pagrus auratus</i>
Blue morwong	<i>Nemadactylus valenciennesi</i>
Red emperor	<i>Lutjanus sebae</i>
Bight redfish, yelloweye redfish and swallowtail	<i>Centroberyx</i> spp.
Tropical snappers (mangrove jack, jobfish, stripey snapper etc.)	Family Lutjanidae
Foxfish and pigfish	<i>Bodianus</i> spp.

3.0 WEST COAST DEMERSAL SCALEFISH RESOURCE - INDICATOR SPECIES

The WCB is home to a variety of fish species that live on, or near, the sea floor. These fish, which are a subset of “scalefish” (being bony fish with scales and not including sharks, rays and other cartilaginous fish) are termed “demersal scalefish” and for management purposes comprises a ‘suite’ of over 200 inshore and offshore species. Note, there are some species of scalefish, such as King George whiting, which may fit into the general description of demersal scalefish, but are not considered demersal scalefish for management purposes. At some future date, King George whiting and some other teleost species may be included in the suite of demersal scalefish.

In the process of managing for sustainability, it is not possible to assess the status of stocks of all species in the demersal scalefish suite. Instead, key indicator species are chosen that are judged, through a process of risk assessment, to be indicative of the status of the whole suite. The criteria used in the risk assessment include inherent biological vulnerability, the importance of the species to the different fishing sectors and the wider community and the level of information required to support current management arrangements (Fisheries Occasional Publication No. 85).

The primary target demersal scalefish species within the WCB include WA dhufish (*Glaucosoma hebraicum*), pink snapper (*Pagrus auratus*), baldchin groper (*Choerodon rubescens*), redthroat emperor (*Lethrinus miniatus*), breaksea cod (*Epinephelides armatus*) and bight redfish (*Centroberyx gerrardi*). On the basis of the outcome of a risk assessment, WA dhufish, pink snapper and baldchin groper, were chosen as the key indicator species for the WCB demersal scalefish resource and are discussed in detail below.

3.1 WA dhufish

3.1.1 Distribution

WA dhufish (*Glaucosoma hebraicum*), or simply “dhufish”, are endemic (meaning they are not found anywhere else in the world) to Western Australia. They are generally found between Shark Bay and the Recherche Archipelago, but are most abundant between the Abrolhos Islands and Cape Naturaliste.

Research has indicated that dhufish are lifetime residents of their particular geographical location and movement of juveniles and adults is limited. Juveniles live in close association with habitats such as low profile reef platforms, isolated reef patches and seagrass. Adults are usually found on high profile reefs.

3.1.2 Life history

Dhufish are relatively slow-growing and long-lived, with male dhufish reaching larger lengths at any particular age than females. Dhufish reach the minimum legal length limit (MLL, 500mm) at six to seven years of age and can live for over 40 years.

The majority of dhufish spawning activity occurs between December and March. Anecdotally, aggregations of 50 to 100 dhufish have been observed at this time, but this has not been empirically substantiated. Anecdotal evidence also suggests that in recent years aggregations are rarer and/or comprise smaller numbers of individuals. The biological characteristics of dhufish indicate that they exhibit social behaviour and have a hierarchical social/mating system during

spawning. Thus, the males are relatively larger than females and they have a dorsal fin filament which may be used to distinguish them from females or to display to females. The males also have small testes relative to the size of female ovaries, indicating that they probably spawn in pairs at any one time, but that a male probably spawns with multiple females during the whole spawning season. Females produce multiple batches of eggs during a spawning season, indicating they spawn on multiple occasions.

Dhufish reach sexual maturity at between 300 and 500 mm in length and three to six years of age. Research has demonstrated that during each spawning season the smaller, younger mature female dhufish do not spawn for as long as large females and produce less eggs per batch.

As such, larger fish are likely to be very important to the reproductive dynamics of the population. This is because larger males, which may be older and more experienced, are probably more able to dominate social groups and successfully spawn with multiple females. Large dhufish are extremely vulnerable to fishing during the summer.

3.1.3 Stock structure, recruitment and release mortality

Replenishment of dhufish across their range occurs primarily through egg and larval dispersal. Adult fish are essentially sedentary with only a low percentage exhibiting significant movements along the coast, resulting in limited mixing during the adult phase. Hydrodynamic modelling has predicted that the majority of dhufish larvae would recruit from within the management area where they are spawned

Like many long-lived species, dhufish have variable levels of recruitment between years which leads to an age structure with strong and weak year classes. When fishing mortality is high, any periods of low recruitment can compound any declines that occur from exploitation and accelerate depletion.

Most dhufish live in about 20 to 90 metres of water. Thus, dhufish are susceptible to barotrauma through fishing (the effects of gas expansion in the body caused by capture at depth and subsequently being rapidly brought to the surface). This means that fish captured and released are very susceptible to post-release mortality and that this post-release mortality rate is known to increase with depth of capture.

3.2 Pink snapper

3.2.1 Distribution

Pink snapper (*Pagrus auratus*) has a continuous distribution across the southern half of Australia, from Gladstone in Queensland to Barrow Island in Western Australia, but also occurs in northern New Zealand. They inhabit coastal marine waters including shallow embayments, estuary mouths and reefs to waters deeper than 200 metres.

In Western Australia most of the pink snapper are caught from the oceanic waters off Shark Bay and in the Kalbarri and Mid-west areas. There are two known major spawning aggregation areas along the west coast of Australia. These occur off Carnarvon, in the Gascoyne Bioregion, (the largest concentration of spawning aggregations) and in Cockburn and Warnbro Sounds and Owen Anchorage, in the Metropolitan Area of the WCB. Eggs and larvae are transported in localised currents and the resulting fish recruit to these embayments, where they remain as juveniles for about the first two years.

While there is evidence of seasonal inshore-offshore migrations of adults, adult pink snapper do not typically migrate long distances along the coast. However, sub-adults are likely to intermix across waters of the WCB.

3.2.2 Life history

The life history attributes of pink snapper include a long life span (40+ years) and thus low rate of natural mortality. On average, pink snapper reach maturity at a larger length in the southern half of the WCB (close to 600 mm) than in the north (~ 426-487 mm), but at a similar age. Pink snapper thus have similar vulnerabilities to the effects of fishing as dhufish.

The timing of the pink snapper spawning period along the Western Australian coast varies with water temperature, with peak spawning typically occurring at about 19-21°C. Thus, spawning in the northern half of the WCB (Kalbarri and Mid-west areas) occurs primarily between July and September and in the Metropolitan area (including Cockburn/Warnbro Sounds and Owen Anchorage) between October and December.

The minimum legal length (MLL) for pink snapper of 410 mm was originally applied across the entire WCB. This MLL was set following biological research on pink snapper stocks off Carnarvon, which indicated that about 50 per cent of fish were mature at 410 mm. However, as more recent studies demonstrated that pink snapper in the lower west coast mature at a larger length, the MLL was increased to 500 mm (south of Lancelin).

3.2.3 Stock structure, recruitment and release mortality

Pink snapper between Carnarvon and the South Coast Bioregion are genetically a single stock, isolated only by distance. Complementary otolith microchemistry studies and tagging have demonstrated that adult pink snapper do not typically move distances greater than that of a management area. By the sub-adult stage, pink snapper are likely to have settled in a location where they will remain, with the adults in any one area likely to have been recruited from several nursery areas.

Cockburn and Warnbro Sounds and the adjacent Owen Anchorage are currently the only known locations in the WCB where pink snapper consistently aggregate annually to spawn. Eggs and larvae spawned in Cockburn Sound are retained within the Sound by a gyre and juveniles remain in the Sound until approximately 18 months of age before they migrate offshore and presumably along the coast. Recruitment strength in the WCB is highly variable over years.

Cockburn Sound is a highly industrialised area and associated environmental degradation may affect the viability of the spawning aggregations including reductions in spawning biomass and egg/larval and juvenile growth and survival, as it is an important nursery location.

While pink snapper can be successfully caught and released in shallow water, they suffer from similar levels of post-release barotrauma mortality as dhufish in deeper water (40+ m).

3.3 Baldchin groper

3.3.1 Distribution

Like WA dhufish, the baldchin groper (*Choerodon rubescens*) is endemic to Western Australia. It is found from Coral Bay to Cape Naturaliste and is most abundant in the Abrolhos Islands area. Juveniles and adults typically occur on, or in the vicinity of, benthic reef habitat. They are

common in shallow reef environments and commercial catches have been reported in depths down to 100 metres.

There is limited information on the movement of this species. Of the few adults that were recaptured (by diving) following a research tag and release study (13 of approximately 150 tagged and released) in the Abrolhos Islands, all were caught close (< 250 metres) to their release sites.

3.3.2 Life history

Baldchin groper is a slow-growing species that can reach 28 years of age. At the Abrolhos Islands they typically reach the current MLL of 400 mm at five to ten years. Baldchin groper is a protogynous hermaphrodite. Individuals commence life as females, mature and reproduce as females at about 280 mm and three to four years and then later in life (480 mm and 12 years on average) change sex to males. As males are almost always greater than 400 mm in length, they are fully exploitable. Thus, although the adult sex ratio is typically about 14 females to one male, the sex ratio in commercial catches is closer to 1:1. This makes baldchin groper highly vulnerable to fishing.

Baldchin groper spawn on multiple occasions mainly between September and December.

3.3.3 Recruitment and release mortality

Baldchin groper is a single genetic stock along its entire range. However, stock structure studies demonstrate that by the time individuals are only a few months old, they will have recruited to management areas (and island groups within the Abrolhos Islands) within which they will remain as adults. The stock structure study demonstrated that juveniles will recruit to multiple suitable locations, i.e. there are no specific nurseries along the west coast. Juveniles occupy marginal reef habitats, such as rubble, sponge and algal-covered substrate, which are typically separated from the higher-relief (limestone and coral) reef habitats where adults occur. There have been no studies on the recruitment dynamics of this species. Anecdotal reports from recreational and charter fishers concur with research studies that show that baldchin groper are highly susceptible to barotrauma-related mortality, even in very shallow water (10 metres).

4.0 STOCK ASSESSMENT

Having identified that significant overfishing of demersal scalefish indicator species was occurring within the WCB in the 2007 and 2009 stock assessments, a series of commercial and recreational fishing management changes were introduced between 2007 and 2010. The changes were specifically designed to reduce effort in the commercial and recreational fisheries taking demersal scalefish, and thus catches of demersal scalefish by at least 50 per cent of those in 2005/06 to allow stock recovery.

Ongoing monitoring of age structures of the three indicator species (WA dhufish, pink snapper and baldchin groper) has been conducted since those assessments. This third stock assessment of the indicator species has been conducted based on data collected between 2007/08 and 2010/11 and thus overlaps the time period during which management changes were implemented.

Bearing in mind that the biological characteristics of the WCB indicator species, particularly their longevity, dictate that it will require at least a decade of these management measures for stocks to recover to acceptable levels, the main objectives of the assessment were to determine:

- Whether there has been improvement in the status of stocks of each indicator species (and thus the suite of demersal species) in the period 2007/08 to 2010/11; and
- For the commercial and recreational sectors in the WCB, whether catches of the demersal suite of species and of the indicator species have been reduced by at least 50 per cent of the 2005/06 catch.

Although the formal report for the stock assessment is currently being developed for publication later in 2013, its key findings have been made available to facilitate an early reassessment of the effectiveness of the current commercial and recreational fishing management arrangements. The advice from the Executive Director of Research, setting out the key findings of the stock assessment, is included in full in Appendix 1.

Following is an overview of the methodologies used to undertake the assessment and a summary of the key findings and recommendations.

4.1 Stock assessment methodologies

When assessing the status of fish stocks, there are two basic types of analyses that are often undertaken:

1. Examination of historical catch, effort and catch rate data; and
2. Examination of age structure data and other biological information.

The first type of analysis provides information on the status of stocks by determining if there is a relationship between catches and changes in the relative abundance (catch rates) of the stocks. The second type of analysis examines what impact fishing may have had on the biology and age structure of the fished populations.

When both types of data are available, these can be used to develop an integrated model that can provide robust estimates of the current abundance of a species compared to that prior to any fishing.

However, in fisheries where the data are limited it is not possible to develop models that can accurately estimate stock abundance. In such circumstances, a “weight-of-evidence” approach is considered to be best practice to assess the status of a stock. Despite improvements in data availability, given its broad geographic range and multi-species/multi-user nature, this is the case with the West Coast Demersal Scalefish Resource.

A weight-of-evidence approach examines any quantitative measures that may be available (e.g. estimates of fishing mortality (***F***)) and considers these in conjunction with known biological characteristics, operational characteristics of the fishery and potential influences of environmental change. Although the full stock assessment uses a number of methods to estimate ***F***, this preliminary report presents the results from a ‘multi-year catch curve’ method which produced consistent estimates for each indicator species and has fewer assumptions than other methods commonly used. It is thus likely to be more robust. The assessment also produced estimates of spawning potential ratio (***SPR***), which provide an indication of the reproductive potential of the stock under the ‘current’ estimated level of fishing compared with that if there was no fishing.

Stock status was determined by comparison of ***F*** for each indicator species with internationally accepted biological reference points derived from natural mortality rates. The key reference points used in this stock assessment were as follows:

Limit Reference Point: Is an upper or lower boundary of a biological indicator. If the indicator falls outside the limit it triggers immediate significant management action.

Threshold Reference Point: Is an upper or lower boundary of an indicator, outside of which additional management actions may be required to avoid breaching the limit point.

Target Reference Point: Is the optimum value, for an indicator to deliver biological or economic objectives.

4.2 Summary of findings and key recommendations

4.2.1 Assessment results

- The current assessment was based on age composition data collected between 2008/09 and 2010/11 for WA dhufish and pink snapper and between 2007/08 and 2010/11 for baldchin groper and only includes about one year of data after management changes. Given the life history characteristics of the indicator species, only minor recovery of stocks would have been expected, if any. Recovery to better than the threshold level is not expected for at least 10 years.
- The overall assessment results for WA dhufish and pink snapper (declining ***F*** and for dhufish increasing ***SPR***) over three assessment periods indicate that some recovery has been initiated in the stocks of these indicator species within the WCB. However, for each indicator species, ***F*** has not yet reached the threshold levels.
- The recovery observed in these assessments is likely to have been influenced by the presence of three strong cohorts of recruitment (1999, 2002 and 2004) in WA dhufish stocks and by several years of protection of pink snapper spawning aggregations in the Metropolitan area.
- Declining ***F*** and increasing ***SPR*** in the southern half of the WCB for WA dhufish and pink snapper indicate adequate recovery is occurring in the Metropolitan and South-west management areas. However, the minor changes in these parameters for pink snapper in the northern half of the WCB indicate recovery is not occurring at an adequate rate (see Table 9 – Appendix 1). There was no recovery observed for baldchin groper in the Abrolhos Islands Zone A (of the Western Rock Lobster Fishery).

4.2.2 Catch data

- The total catch of the demersal suite in the WCB by the commercial sector (in 2010/11 or 2011) was < 50 per cent of 2005/06 catches. The catch of WA dhufish in the WCB by the commercial sector (in 2010/11 or 2011) was < 50 per cent of 2005/06 catches. Catches of pink snapper were greater than 50 per cent of 2005/06 catches and of baldchin groper were just below 50 per cent of 2005/06 catches.
- The total catch of the top 15 demersal species in the WCB by the recreational sector in 2011/12 was < 50 per cent of 2005/06 catches (adjusted IFAAC values). The catch of WA dhufish in the WCB by the recreational sector (2011/12) was < 50 per cent of 2005/06 catches, while catches of pink snapper and baldchin groper were greater.

4.2.3 Advice

- The combination of catch data and stock assessment results indicate that further reductions in catches in the northern management areas would be required if an adequate rate of recovery of stocks in these areas is to be achieved.
- There has been considerable unused (latent) commercial effort entitlement in each management area of the WCDSIMF since its introduction in 2009. This latent effort, if exercised, is likely to further increase commercial catches of snapper and baldchin groper in the Mid-west and Kalbarri Areas.
- Any future increases in entitlement consumption by the WCDSIMF and increased effort by the recreational sector will increase catches of demersal scalefish. This would include increased catches of:
 - the demersal scalefish suite, including WA dhufish and baldchin groper, to levels above 50 per cent of 2005/06 catches;
 - Pink snapper by both sectors to levels further above 50 per cent of 2005/06 catches; and
 - Baldchin groper by the recreational sector to a level further above 50 per cent of 2005/06 catches.
- It is expected that the high recreational catch of baldchin groper in 2011/12 would have been driven primarily by catches in the northern half of the WCB, where it is more abundant and targeted. However as pink snapper is targeted by recreational fishers across the whole WCB, and recreational catch estimates are not available for each management Area, it is not clear if catches in any particular Area were responsible for the high catches of this species in the WCB in 2011/12.
- Western Rock Lobster fishers and their families land and consume baldchin groper (and other demersal scalefish) at the Abrolhos Islands when staying there. These line-caught fish are not accounted for in the *iSurvey* or previous creel surveys and were previously demonstrated to be significant (Sumner, 2008). If such catches are still significant, this may be contributing to the lack of evidence of recovery of stocks in the Abrolhos Islands Zone A (of the Western Rock Lobster Fishery).
- Recovery of stocks of WA dhufish and baldchin groper may be affected by the high numbers of fish known to be released by the recreational sector and the associated post-release mortality. These species can suffer barotrauma, even in relatively shallow water, while pink snapper are less susceptible to barotrauma. Any level of post-release mortality will, however, be accounted for within future age structures and therefore within future assessments.

- The bag limit for WA dhufish for the recreational sector is one per person with a boat limit of two fish per boat, but the bag limit for pink snapper and baldchin groper is two per person. The higher catch allowances for pink snapper and baldchin groper may limit the effectiveness of management changes for these species and may explain why recreational catches of these species in 2011/12 were not reduced to ≤ 50 per cent of 2005/06 catches.

Overall outcome

- Although stock status results and catch data demonstrate that management changes have allowed some level of recovery of demersal stocks at the bioregion level, these stocks have not yet recovered.
- There was evidence of adequate recovery (for the period since the changes were introduced) of WA dhufish occurring in all management areas at current catch levels.
- Evidence of adequate recovery (for the period since the changes were introduced) was not present for two indicator species (pink snapper and baldchin groper) in the northern half of the WCB. Their estimated catches and fishing mortality were not reduced sufficiently in the northern management areas to allow adequate recovery of these stocks (for the period since the management changes were introduced) in this region at that time, and fishing pressure may need to be further reduced in those areas if an adequate recovery rate is to be achieved.

5.0 IFM - WEST COAST DEMERSAL SCALEFISH SECTORAL ALLOCATIONS

The Department of Fisheries (the Department) recently released the Minister for Fisheries' determination with respect to the commercial and recreational fishing sectors' catch share allocations of the West Coast Demersal Scalefish Resource.

This determination followed the receipt of advice from the Integrated Fisheries Management Allocation Advisory Committee (the Allocation Committee). The Allocation Committee undertook an exhaustive investigative and consultative process, with its findings based on a comprehensive set of guiding principles. The report of the Allocation Committee (Fisheries Management Paper No. 249) and the Minister's determination on the allocation can be found on the Department's website at <http://www.fish.wa.gov.au>.

This determination was made as part of the Department's Integrated Fisheries Management (IFM) policy. This policy is aimed at addressing the issue of how fish resources in Western Australia can be best shared between competing users within the broad context of "Ecologically Sustainable Development", or ESD, so that they can be managed on a sustainable basis.

The overall allocation of shares of the West Coast Demersal Scalefish Resource, for the total suite of species, was 64 per cent to the commercial fishing sector and 36 per cent to the recreational sector. In addition to this overall allocation, catch proportion guidelines (rather than specific fixed proportional shares) for WCB indicator species were also determined. These were as follows:

WA dhufish:	recreational sector 60 per cent, commercial sector 40 per cent
Pink snapper:	recreational sector 20 per cent, commercial sector 80 per cent
Baldchin groper:	recreational sector 65 per cent, commercial sector 35 per cent

5.1 Stock assessment review

As part of the catch share determination the Minister for Fisheries also approved that any initial management changes to enable the sectors to meet their allocation be taken at the same time as any changes to the sustainability management arrangements are made as a result of the review of the 2013 West Coast Demersal Scalefish Resource stock assessment.

It is intended that this ‘key findings’ document will be used to initiate discussions with the recreational and commercial fishing sectors regarding the effectiveness of current management measures and settings in achieving the necessary catch reductions and catch shares.

Therefore, the overall catch share and proportional catches for key indicator species, shown to have been achieved from the most recent estimates, have been included in this document as they form an important component in determining any changes to current management arrangements and settings.

The following table shows the most recent catch estimates for both sectors as percentages of the total catch (all demersal scalefish species caught) to enable comparison with the overall catch allocation and proportional guidelines.

Table 3. Commercial and recreational fishing catches and catch share allocations.

Commercial and recreational catch vs catch share allocations					
Species	Commercial catch total (tonnes)	Total recreational catch inc. charter catch (tonnes)	Commercial catch as % of total	Recreational catch (including charter) as % of total	Catch share allocations and proportional guidelines
All demersal scalefish	438	212	67.4%	32.6%	64% commercial 36% recreational
Dhufish	80	85	48.5%	51.5%	40% commercial 60% recreational
Pink snapper	190	42	81.9%	18.1%	80% commercial 20% recreational
Baldchin groper	18	38	32.1%	67.8%	35% commercial 65% recreational

APPENDIX 1. WEST COAST DEMERSAL SCALEFISH RESOURCE STOCK ASSESSMENT 2013 - KEY FINDINGS

Advice from the Executive Director of Research - 18 July 2013

Background

The 2007 and 2009 stock assessments, of key indicator species for the West Coast Demersal Scalefish Resource (WCDSR) based on data collected in the years 2002/03 - 2005/06 and 2007/08, respectively, identified that overfishing of this suite was occurring (Wise *et al.*, 2007, Fairclough *et al.*, 2009). Significant changes were made to the management of all the fisheries that exploit the WCDSR between late 2007 and early 2010. These were designed to reduce effort in the fishery and therefore the catches of the entire demersal scalefish suite by at least 50 per cent of the 2005/06 levels to allow stock recovery to commence.

The status of stocks of the three indicator species (West Australian dhufish, snapper and baldchin groper) are used to represent the status of the whole suite of demersal scalefish. The stocks of the indicator species are assessed using a weight of evidence approach based on a range of information including commercial and recreational (including charter) catch data and key fishery-dependent biological indicators (such as fishing mortality and reproductive potential). The methodology used to assess the key demersal stock status in the West Coast Bioregion (WCB) has been independently reviewed on two occasions and deemed appropriate (Wise *et al.*, 2007 FRR 163; O'Neill, 2009 FOP 66; Morison, 2012 FOP 98).

The biological characteristics of the three indicator species, especially their longevity, dictate that it will require in the order of 10 or more years with current management measures for stocks to recover such that the level of fishing mortality (F) returns to below the threshold level. For this we used the internationally accepted sustainability reference point whereby F is equivalent to the natural mortality rate (Table 1; see Wise *et al.*, 2007).

This memorandum provides a summary of results from the third assessment of indicator species for the WCDSR based on data collected between 2008/09 - 2010/11 for West Australian dhufish and snapper and 2007/08 - 2010/11 for baldchin groper. This means that this sampling period overlapped with the time when the changes were being made to management in the WCB of commercial and recreational fishing for demersal species. Therefore, combined with the expected long recovery trajectory, the current assessment was not expected to demonstrate evidence of significant recovery in the stocks of the indicator species.

The main objectives of the assessment were to determine:

1. If there was an improvement in the status of stocks for each indicator species (and therefore the entire suite of demersal species) in the period 2007/08 - 2010/11.
2. Whether catches of the demersal suite of species and each of the indicator species by both the commercial and recreational sectors in the West Coast Bioregion (WCB), have been reduced by at least 50 per cent of those levels estimated for 2005/06.

SUMMARISED ADVICE

Background

- This memorandum presents the latest stock assessment advice based on age composition data collected between 2008/09 and 2010/11 for West Australian dhufish and snapper and between 2007/08 and 2010/11 for baldchin groper.
- Changes to the management arrangements of the WCDSF were introduced between late 2007 and early 2010. As the biological characteristics of these species dictate that it will take at least 10 years for stocks to recover, the current assessment was not expected to demonstrate evidence of significant recovery in the stocks of the key indicator species.
- The weight of evidence assessment included the independently-reviewed methods used in previous stock assessments (see Wise *et al.* 2007; O'Neill, 2009), newly-developed methods and additional assessments of reproductive potential.

West Australian dhufish

- Assessment of fishing mortality (F) and spawning potential ratio (SPR) indicate that the current management arrangements have reduced the level of fishing on West Australian dhufish by both the recreational and commercial sectors, which is allowing recovery of the overall stock to begin at the bioregion level.
- However, the West Australian dhufish stock has not yet recovered to acceptable levels.
- Catches by commercial and recreational fishers are both less than 50 per cent of 2005/06 levels.

Snapper

- Assessment of F demonstrated that the current management arrangements have reduced the level of fishing of snapper, which is allowing recovery of the overall stock to begin at the bioregion level.
- However, the snapper stock has not yet recovered to acceptable levels.
- The extent of recovery in the stocks of snapper is much less than for West Australian dhufish and much lower in the northern half of the WCB.
- Importantly, total recreational catches across the WCB and commercial catches in the northern management areas are both higher than 50 per cent of 2005/06 catches.

Baldchin groper

- The F and SPR for baldchin groper in the Abrolhos Islands Zone A area have not improved since the previous assessment period.
- This indicates that overfishing is likely to be still occurring in that area with no evidence of recovery.
- Evidence of recovery may not yet be evident due to the following. (1) The overlap of this assessment period (2007/08 - 2010/11) and the introduction of changes to management. (2) While commercial catches are equivalent to 50 per cent of 2005/06 catches, recreational catches are slightly greater. (3) The complex biology of baldchin groper.

Advice

- At a minimum, the current level of management needs to remain in place for at least five more years to continue the initial trends in recovery that have been identified.
- As catches of snapper and baldchin groper have not been reduced sufficiently in the northern half of the bioregion, the recovery of stocks in this region is either limited or has not begun. Consideration should therefore be given to reviewing management measures for both commercial and recreational sectors within the northern management areas to further aid recovery in this region.

Future assessments and catch monitoring

- The next assessment is due after the collection period of 2011/12 - 2015/16; or an assessment of selected indicators could be conducted after three years data collection (i.e. based on 2011/12 - 2013/14).
- Continued monitoring of commercial and recreational catches is required, to determine the variation of catches over time around the benchmark values.

STOCK STATUS FOR CURRENT ASSESSMENT PERIOD

Stock assessment methods

- The methods used for estimating fishing mortality (F) in the first two assessments have already been independently reviewed and considered appropriate (Wise *et al.*, 2007; O'Neill, 2009).
- The current assessment used both the previous methods plus two newly-developed methods (Fisher, 2013). These new methods reduce the number of assumptions required in F -based analyses. The estimates generated by all these methods are used as part of the weight of evidence approach to determine the status of the resource.
- For the purposes of presentation in this memo, only the results for one of the methods (a multi-year catch curve) that produced consistent estimates for each indicator species over time are presented. The outputs from all methods will be presented in the formal stock assessment report.
- Estimates of spawning potential ratio (SPR), which provide an indication of the reproductive potential of the stock under the estimated level of fishing, are also presented. These analyses were based on either egg per recruit (EPR) analyses, where possible, or spawning stock biomass per recruit (SSB/R) analyses. SPR is the ratio of the estimated lifetime egg production or spawning stock biomass of an individual recruit at the current level of F , relative to that expected for an unfished stock. These analyses were used in the weight of evidence approach.
- F and SPR estimates for West Australian dhufish are presented using data from; (1) both sectors for the WCB and; (2) for each management area/sector combination for which it is used as an indicator.
- F estimates for snapper are presented using data for both sectors for the WCB and also using F and SPR estimates for each management area/sector combination for which it is used as an indicator. Assessment results are also provided for both the northern (Mid-west and Kalbarri) and southern (Metropolitan and South-west) management areas, as the trends in each half of the WCB differed. SPR could not be estimated at the bioregion level at this time as parameters such as growth and maturity that influence this estimation differ between the northern and southern parts of the WCB.
- F and SPR estimates for baldchin groper are presented for the Abrolhos Islands Zone A, where it used as an indicator for the commercial and recreational sector (see Appendix 1). Estimates are also presented for the remainder of the Mid-west area and for the Metropolitan area.
- Stock status for 2007/08 - 2010/11 was determined by comparison of F for each indicator species (Tables 2 to 4) with internationally accepted biological reference points derived from natural mortality rates (Table 1).
- Estimates of F and SPR are presented for periods prior to and during management changes.

Table 1. Natural mortality rates (M) and internationally accepted biological reference points based on fishing mortality rates (F) used in Wise *et al.* (2007).

Parameter	Reference point	West Australian dhufish	Snapper	Baldchin groper
M		0.11	0.12	0.21
	Target $F = 2/3M$	0.07	0.08	0.14
F	Threshold $F = M$	0.11	0.12	0.21
	Limit $F = 1.5M$	0.165	0.18	0.32

(1) West Australian dhufish

Summary Status: Since 2005/06 - 2007/08, the values for both F and SPR for West Australian dhufish in the WCB have improved (decreased and increased, respectively), indicating that the stock is recovering (Fig. 1).

- The multi-year catch curve estimate of F for the whole of WCB stock of West Australian dhufish in 2008/09 - 2010/11 has declined (improved) from the 2005/06 - 2007/08 level, and is now approximately equivalent to the limit reference point (Table 2; Fig. 1).
- The SPR increased from the 2005/06 - 2007/08 level (Table 2; Fig. 1).
- The F for the Mid-west and Metropolitan areas remained above the limit, while F from South-west recreational samples was now close to the threshold (Table 2).
- The trends for F and SPR in each of the management areas assessed (Mid-west, Metropolitan, South-west) were consistent with the whole of WCB estimates, indicating adequate stock recovery was occurring in each area. The lower F and higher SPR in the South-west Management area probably reflect the lower historical levels of fishing in this region compared to the Mid-west and Metropolitan areas.
- Analysis was also conducted of age composition data for West Australian dhufish from Mid-west commercial samples and Metropolitan recreational samples from an earlier period (1995/96 - 1997/98; Hesp *et al.*, 2002) using all methods of estimating F . The estimate for each area at this time was close to the threshold reference point and there was a greater proportion of older fish (> 15 y) in stocks in the 1995/96 - 1997/98 period compared with 2008/09 - 2010/11 (Fig. 2). As the 2008/09 - 2010/11 estimates of F have not yet reached the threshold, more time is required for stocks to recover to the same levels as in 1995/96 - 1997/98.

Summary Advice: Although the West Australian dhufish stock has not yet recovered to acceptable levels, the changes in F and SPR between the 2005/06 - 2007/08 and 2008/09 - 2010/2011 periods are consistent with the current management strategies, which were imposed between 2007 and 2010, having reduced the levels of fishing such that the stock is starting to recover.

Table 2. Point estimates of fishing mortality ($F \pm 2SE$) and spawning potential ratio ($SPR \pm 2SE$) for West Australian dhufish derived from data collected between 2008/09 and 2010/11 from the commercial and recreational sectors in the WCB overall and, where applicable, for each sector in each management area in the WCB separately. Note that these estimates are based on one method of estimating F and do not present the full range of uncertainty among methods.

Parameter		WCB	Management area		
			Mid-west	Metropolitan	South-west
F	Overall	0.17 (0.16-0.18)	-	-	-
	Commercial	-	0.20 (0.18-0.23)	-	-
	Recreational	-	0.20 (0.17-0.22)	0.18 (0.16-0.21)	0.11 (0.08-0.14)
SPR	Overall	0.26 (0.24-0.27)	-	-	-
	Commercial	-	0.22 (0.20-0.25)	-	-
	Recreational	-	0.23 (0.20-0.25)	0.24 (0.22-0.27)	0.36 (0.29-0.46)

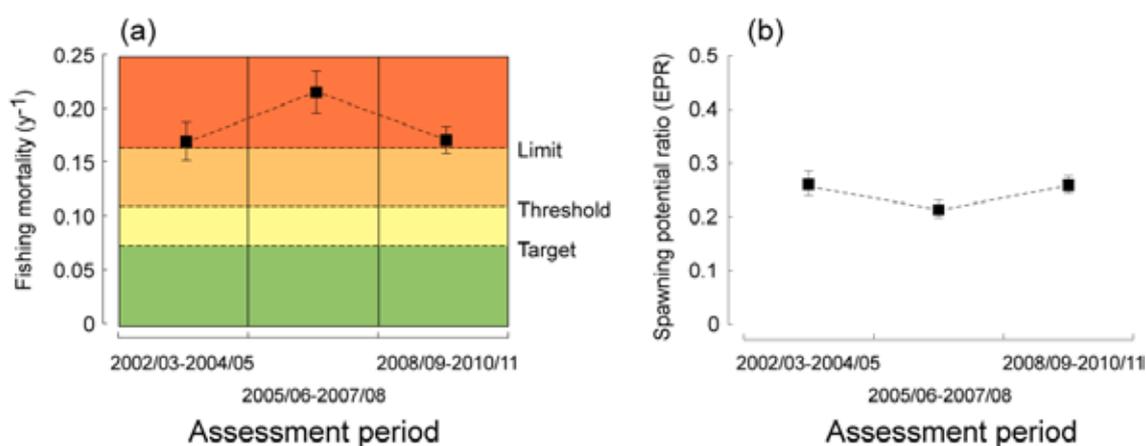


Figure 1. (a) Mean rate of fishing mortality ($\pm 2SE$) and (b) spawning potential ratio (in terms of EPR) ($\pm 2SE$) for West Australian dhufish in the West Coast Bioregion for three consecutive three-year assessment periods between 2002/03 and 2010/11. Fishing mortality reference points: $F_{\text{limit}} = 1.5M$, $F_{\text{Threshold}} = F = M$, $F_{\text{Target}} = F = 2/3M$.

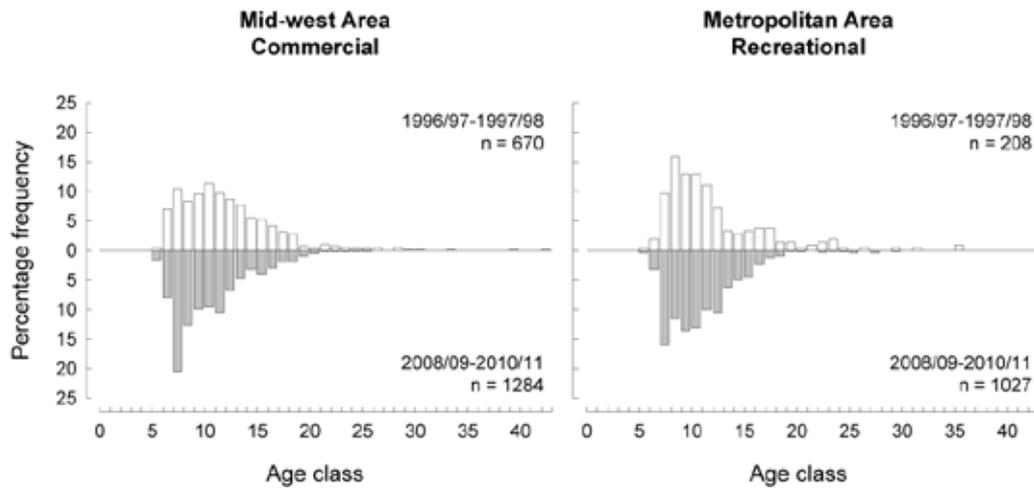


Figure 2. Age compositions of West Australian dhufish from commercial samples in the Mid-west Area and recreational samples in the Metropolitan Area in 1996/97 - 1997/98 and 2008/09 - 2010/11.

(2) Snapper

Summary Status: Since the 2005/06 - 2007/08 period, the values of F for snapper at the bioregion level have improved, indicating that the overall stock is recovering (Fig. 3).

- The multi-year catch curve estimate of F for the whole of WCB stock of snapper in 2008/09 - 2010/11 has improved, but it was still well above the limit reference level (Table 3).
- In the northern areas (Kalbarri and Mid-west) of the WCB, the F and SPR values for 2008/09 - 2010/11 indicated a slow level of stock recovery (i.e. decreased and increased, respectively), from 2005/06 - 2007/08 (Table 3; Fig. 3) with the current value of F still well above the limit level.
- The F and SPR in the southern areas (Metropolitan and South-west) of the WCB in 2008/09 - 2010/11 suggest an adequate level of stock recovery (i.e. decreased and increased, respectively), from 2005/06 - 2007/08 (Table 3; Fig. 3). The estimated F in 2008/09 - 2010/11 was much lower than in the north and was at approximately the limit reference level (Table 3; Fig. 3).

Summary Advice: Although F and SPR estimates for 2008/09 - 2010/11 indicate that the stock has not yet returned to acceptable levels, there are some signs of recovery in the stocks of snapper. The recovery is less than for West Australian dhufish, in part due to the poorer state prior to the management changes, but also because only the southern management areas show adequate levels of recovery, with the northern management areas showing only limited recovery.

Table 3. Estimates of fishing mortality ($F \pm 2SE$) and spawning potential ratio ($SPR \pm 2SE$) for snapper derived from data collected between 2008/09 and 2010/11 from the commercial and recreational sectors in the WCB overall, for both sectors in the northern (Kalbarri and Mid-west) and southern (Metropolitan and South-west) areas of the bioregion and, where applicable, for each sector in each management area in the WCB separately. Note that these estimates are based on one method of estimating F and do not present the full range of uncertainty among methods.

Parameter	WCB	North	South	Management area			
				Kalbarri	Mid-west	Metropolitan	South-west
F	Overall	0.28 (0.27-0.29)	0.43 (0.41-0.46)	0.18 (0.15-0.21)	-	-	-
	Commercial -			0.51 (0.46-0.56)	0.41 (0.37-0.44)	-	-
	Recreational -				0.40 (0.36-0.45)	0.22 (0.17-0.27)	0.18 (0.12-0.23)
	Overall		0.11 (0.11-0.12)	0.18 (0.14-0.23)	-	-	-
SPR	Commercial -			0.10 (0.09-0.11)	0.12 (0.11-0.13)	-	-
	Recreational -				0.11 (0.10-0.13)	0.12 (0.09-0.17)	0.27 (0.21-0.36)

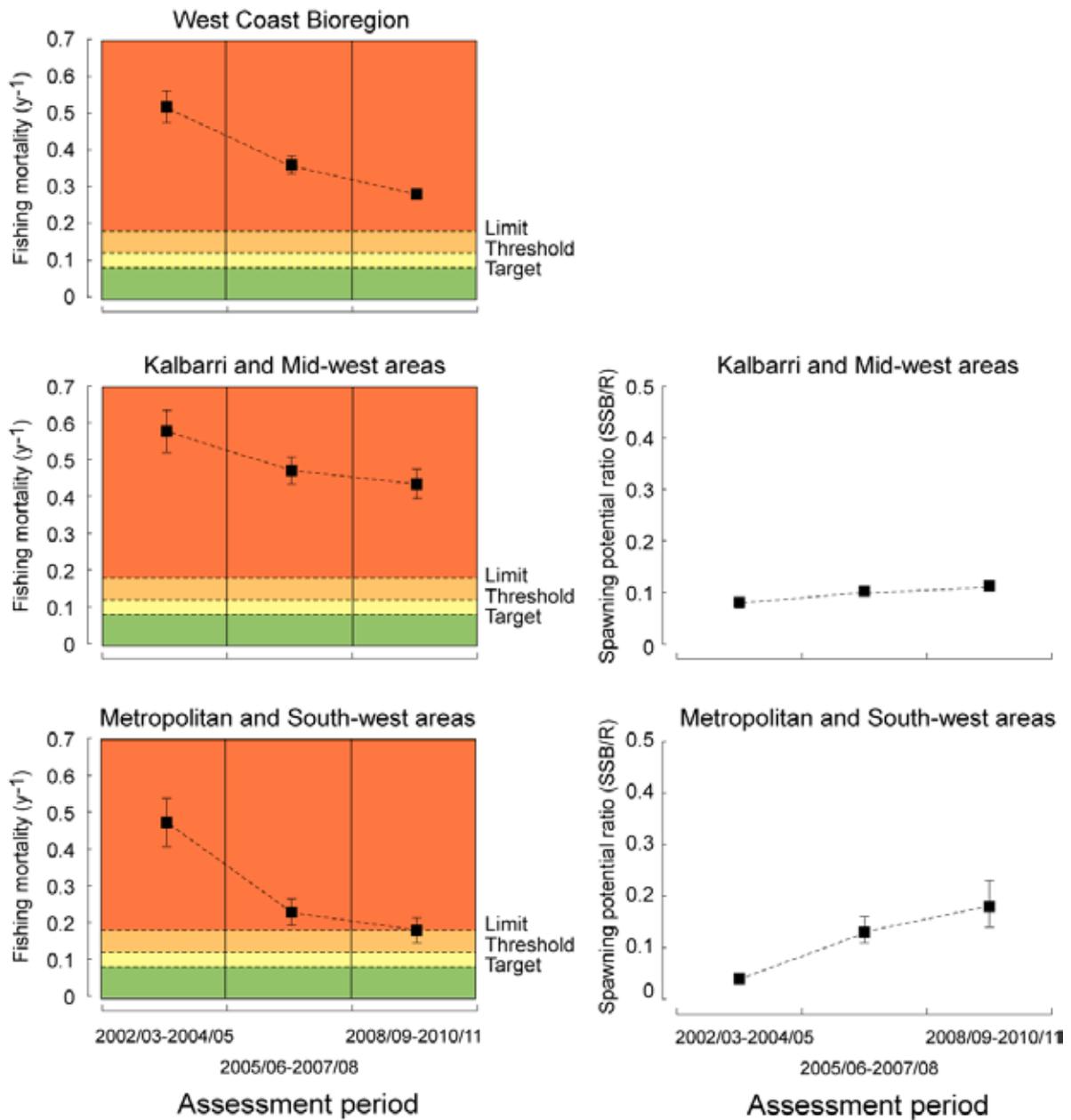


Figure 3. Mean rate of fishing mortality (± 2 SE; left column) and spawning potential ratio (SSB/R; right column) for Snapper in the West Coast Bioregion, the Kalbarri and Mid-west areas combined and the Metropolitan and South-west areas combined for three consecutive three year assessment periods between 2002/03 and 2010/11. Fishing mortality reference points: $F_{\text{limit}} = 1.5M$, $F_{\text{Threshold}} : F = M$, $F_{\text{Target}} : F = 2/3M$.

(3) *Baldchin groper*

Summary Status: Both the *F* and *SPR* estimates indicated that overfishing could still be occurring in the WCB in 2007/08 - 2010/11. This is because at the Abrolhos Islands, the mean for *F* increased and for *SPR* decreased from the previous period. This indicates no evidence of recovery in that part of the baldchin groper stock.

- The stock assessment of baldchin groper for the Abrolhos Islands Zone A is based primarily on commercial samples, which have been collected during three different time periods, allowing temporal comparison.
- The multi-year catch curve *F* estimate for the 2007/08 - 2010/11 period was over 1.5 times the limit reference level (Table 4; Fig. 4), indicating that overfishing was still occurring.
- The estimates of *F* and *SPR* comprised wide and overlapping standard errors in the three periods between 1993/94 - 1994/95 and 2007/08 - 2010/11, inferring no significant difference between each period.
- *F* estimates determined for the Abrolhos Islands, Mid-west and Metropolitan areas from recreational samples collected in 2007/08 - 2010/11 were 1.4 - 1.8 times the limit reference level (Table 4).
- The lack of recovery of stocks of baldchin groper may be complicated by it being a protogynous hermaphrodite, where females occur in the lower length and age classes and males in the upper length and age classes. In addition, post-release mortality rates are likely to be extremely high (i.e. approaching 100 per cent based on zero tag returns).
- As males are typically > the MLL of 400 mm, they are fully exploitable. Overfishing of the upper (male) part of the length/age distribution may affect reproductive success via sperm limitation and by potentially affecting the length and age at which sex change occurs.
- Although part of the female stock could be afforded protection by the MLL, this species suffers barotrauma at shallow depths (> 10 m) and thus significant post-release mortality would reduce that protection for fish caught in deeper waters.

Summary Advice: There was no evidence for recovery of the stock of baldchin groper in the Abrolhos Islands Zone A (possibly some deterioration) and *F* estimates were above the limit reference level in the remainder of the Mid-west area and in the Metropolitan area.

Evidence of recovery may be delayed due to the overlap of the assessment period and the introduction of changes to management and the biology of baldchin groper being complex.

Table 4. Estimates of fishing mortality ($F \pm 2$ SE) and spawning potential ratio ($SPR \pm 2$ SE) for baldchin groper derived from data collected between 2007/08 and 2010/11 from the commercial sector in the Abrolhos Islands sub zone A and from the recreational sector in that zone and the Mid-west and Metropolitan areas. Note that these estimates are based on one method of estimating F and do not present the full range of uncertainty among methods.

Parameter		Management area		
		Zone A	Mid-west	Metropolitan
F	Commercial	0.51 (0.39-0.62)		
	Recreational	0.55 (0.28-0.89)	0.59 (0.48-0.70)	0.45 (0.30-0.59)
SPR	Commercial	0.24 (0.20-0.28)		
	Recreational	0.22 (0.16-0.41)	0.21 (0.19-0.25)	0.26 (0.21-0.33)

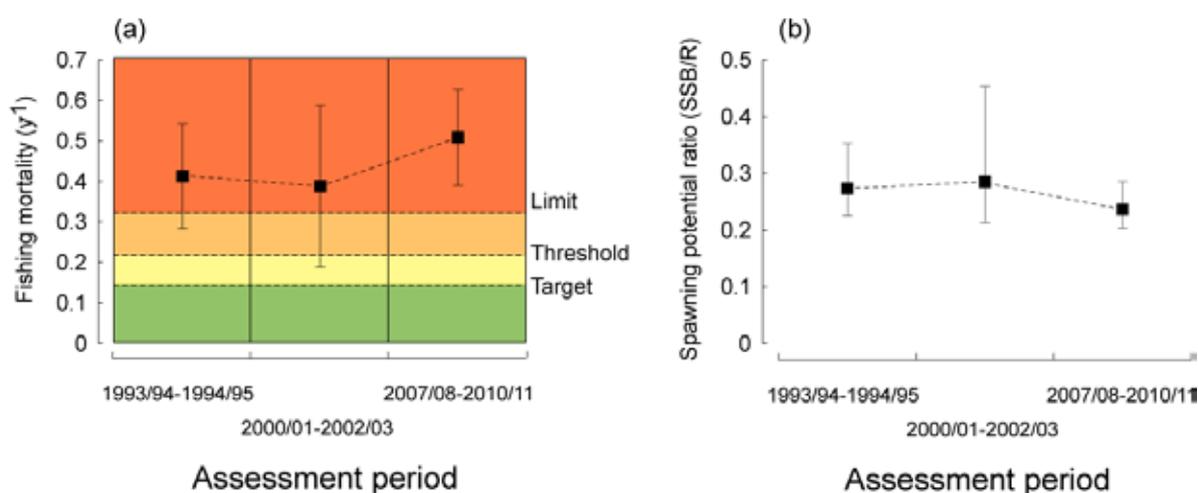


Figure 4. (a) Mean rate of fishing mortality (± 2 SE) and (b) spawning potential ratio (in terms of SSB/R ; ± 2 SE) for baldchin groper in the Abrolhos Islands Zone A for three assessment periods between 1993/94 and 2010/11. Fishing mortality reference points: $F_{\text{limit}} = 1.5M$, $F_{\text{Threshold}} = F = M$, $F_{\text{Target}} = F = 2/3M$.

CATCH DATA

COMMERCIAL CATCH DATA

- Commercial catches of demersal species in the WCB are presented for the years since commencement of the new management regime for demersal species (i.e. since 2008). The commercial fisheries that catch demersal species operate on a variety of 12-month periods, including calendar, and financial year fishing seasons. Thus, the presented total annual commercial catches of demersal species or indicator species are based on the sum of calendar year catches for the WCDSIMF, CSLPF and SWTMF and corresponding financial year catches for TDGDLF and WCRLF (see Table 5 for abbreviations).

Table 5. Fishery name abbreviations

WCDSIMF	West Coast Demersal Scalefish (Interim) Managed Fishery
WCDGDLF	West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery
JASDGDLF	Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery
TDGDLF	Temperate Demersal Gillnet and Demersal Longline Fisheries. Collective term for WCDGDLF & Zone 1 of the JASDGDLF, operating in the WCB
WCRLF	West Coast Rock Lobster Managed Fishery
CSLPF	Cockburn Sound Line and Pot Managed Fishery
SWTMF	South-West Trawl Managed Fishery

(1) Total catches of demersal species by the commercial sector

- The most recent estimated catch of all demersal species by the commercial sector (2011 or 2010/11) was 438 t, which was < 50 % of 2005/06 catches of 450 t (Table 6; Fig. 5).
- Catches of the commercial sector have been < 50 per cent of 2005/06 catches since 2009, when unit entitlements were implemented in the WCDSIMF. However, catches of the WCDSIMF have been increasing since 2009, with an increase in consumption of entitlement (Fig. 5).
- In the most recent season, the vast majority of the commercial catch of demersal species was taken by the WCDSIMF (382 t, 87 per cent), with the remainder taken by the TDGDLF (53 t, 12 per cent) and the WCRLF, CSLPF and SWTMF combined (3 t, 0.7 per cent).
- In 2011, catches of all scalefish by the WCDSIMF in the Kalbarri (155 t) and Mid-west areas (198 t) were slightly above 50 per cent of 2005/06 catches of 150 and 197 t, respectively. The catch of 52 t of scalefish in the South-west Area was less than 50 per cent of 2005/06 catches of 82 t. Of the catch in each area, 145 t (94 per cent), 180 t (91 per cent) and 50 t (96 per cent) were of inshore demersal species.
- In 2011, 7 t of offshore demersal species were caught by the WCDSIMF and none by other WA commercial fisheries. The catch of these species has ranged from 6 to 14 t between 2008 and 2011 and thus has always been below the 20 - 40 t management target range.

Summary Advice: The management objective of maintaining catches of demersal species in the WCB by the commercial sector at \leq 50 per cent of 2005/06 catches has been achieved. However, catches of all scalefish in the Kalbarri and Mid-west areas of the WCB by the WCDSIMF have reached the 50 per cent of 2005/06 benchmarks.

Table 6. Estimates of catches of all demersal species in the WCB by the commercial sector (WCDSIMF, TDGDLF, WCRLF, CSLPF and SWTMF) in the most recent period (2011 or 2010/11 financial year).

	50% of 2005/06 catches (tonnes)	Catch estimate (tonnes) (Commercial: 2010/11 or 2011)
All commercial fisheries	450	438
West Australian dhufish	82	80
Snapper	126	189
Baldchin groper	19	19
WCDSIMF	408	382
West Australian dhufish	72	67
Snapper	120	182
Baldchin groper	17	15

(2) Catches of West Australian dhufish by the commercial sector

Summary: The total estimated commercial catch of West Australian dhufish (WCDSIMF, TDGDLF, WCRLF, CSLPF and SWTMF) in their 2010/11 or 2011 seasons in the WCB was 80 t, which was below 50 per cent of the 2005/06 catch of 82 t (Table 6; Figure 5).

- Catches have increased by 14 per cent since 2010 in the WCDSIMF. Catches of West Australian dhufish by the TDGDLF decreased from 16 to 13 t from 2009/10 to 2010/11 and < 0.5 t were taken by other commercial fisheries in 2010/11.
- West Australian dhufish is an indicator species for the Mid-west, Metropolitan and South-west areas. In 2011, catches by the WCDSIMF of West Australian dhufish in the Mid-west Area (44 t) increased from 31 t in 2010. In the South-west Area, catches remained steady at about 19 t. Catches in both areas in 2011 were equal to 50 per cent of 2005/06 catches in each area.

(3) Catches of snapper by the commercial sector

Summary: The total estimated commercial catch of snapper (WCDSIMF, TDGDLF, WCRLF, CSLPF and SWTMF) in their 2010/11 or 2011 seasons in the WCB was 189 t, which was > 50 per cent of 2005/06 catches of 126 t (Table 6; Fig. 5).

- Catches of snapper by the WCDSIMF in 2011 increased by 13 per cent from 2010.
- Snapper is an indicator species for each management area of the WCB. The high commercial catch was driven by that of the WCDSIMF in the Kalbarri (88 t) and Mid-west areas (91 t), which were each greater than 50 per cent of 2005/06 catches, i.e. 65 t and 43 t, respectively.
- Catches of snapper by the TDGDLF decreased from 11 to 7 t from 2009/10 to 2010/11 and circa 1 t were taken by other commercial fisheries in 2010/11.

(4) Catches of baldchin groper by the commercial sector

Summary: Estimated commercial catch of 19 t of baldchin groper (WCDSIMF, TDGDLF, WCRLF, CSLPF and SWTMF) in their 2010/11 or 2011 seasons was just below 50 per cent of the 2005/06 catch. Catches increased from 2009/10.

- Baldchin groper is an indicator species for the Abrolhos Islands Zone A area of the WCB. Reported catch by the WCDSIMF in the Abrolhos Islands Zone A area in 2011 was 9.5 t and thus approximately equivalent to the 50 per cent of 2005/06 catch of 9 t.

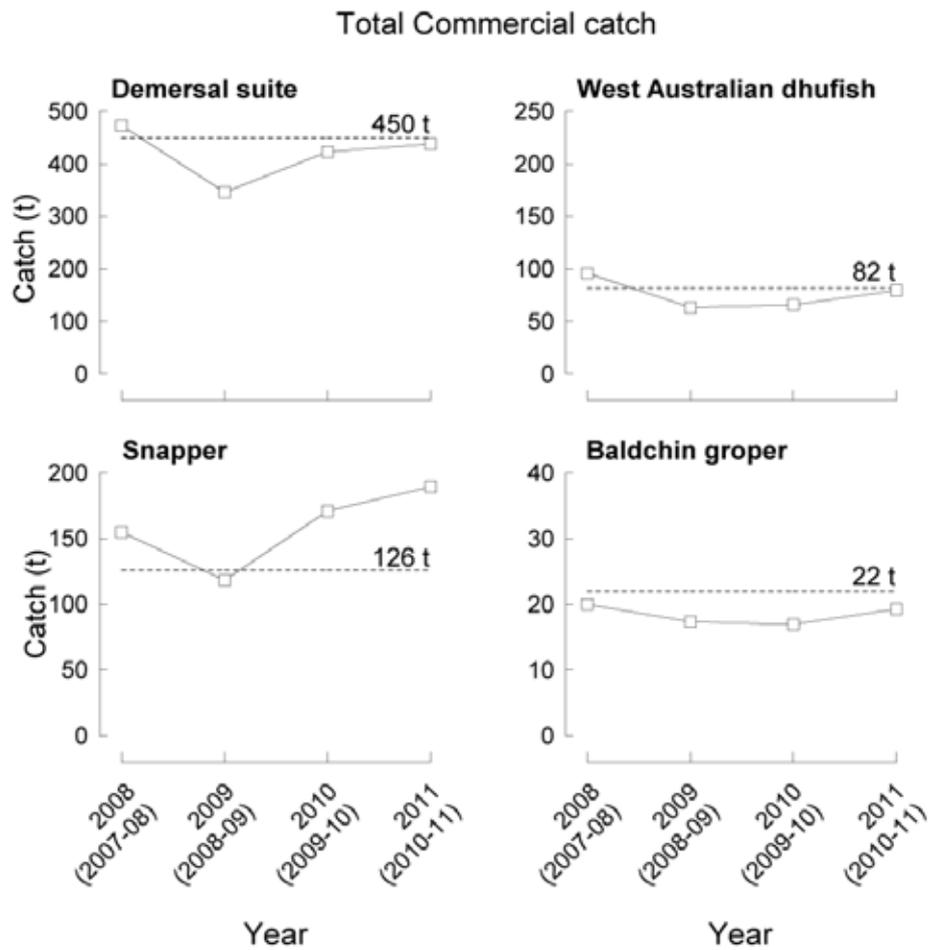


Figure 5. Catches in the West Coast Bioregion of all demersal species and of the inshore demersal indicator species by commercial fisheries.

RECREATIONAL CATCH DATA

Creel Surveys

- Historically, recreational catch and effort was estimated from onsite interviews at boat ramps. These creel surveys were not designed to estimate total catch but instead provided consistent estimates that can be compared between surveys carried out in 1996/97, 2005/06, 2008/09 and 2009/10.
- A review of the 2005/06 creel survey undertaken by Aldo Steffe in 2009 confirmed these surveys will provide underestimates of the total recreational catch and also suggested improvements to the analysis. Re-analysis of these surveys has been undertaken to account for the suggested improvements and the results presented here (and the West Coast Demersal Scalefish Allocation Report, in press) use these revised estimates. The revised estimation methods and catch estimates for 2005/06 will be published in a Fisheries Research Report (Wise and Fletcher, in review).

IFAAC adjustments

- The implementation of Integrated Fisheries Management (IFM) for the WCDSR was based on catch allocations based on total catch from all sectors (FMP 237, 247). The year 2005/06 was selected as the reference year for the allocation of the WCDSR. Given the available creel catch estimates in 2005/06 underestimate the total catch, the Integrated Fisheries Allocation Advisory Committee (IFAAC) adjusted the revised catch estimated for allocation purposes (Table 7). These included a 30 per cent adjustment to expand the creel catch estimate to include the whole day, boats launching from non-boat ramp locations and marinas, fish taken while diving and an adjustment to account for the Abrolhos Islands recreational catch.

Validation of IFAAC adjustment

- With the introduction of the Recreational Fishing from Boat Licence (RFBL) an alternative survey methodology was implemented utilising the licence frame to estimate total recreational catch. An integrated survey (*iSurvey*) using the RFBL was carried out in 2011/12. This and future *iSurveys* will provide the mechanism to monitor estimates of total recreational catch in the future.
- To compare the *iSurvey* boat-based catches with historical creel catch estimates and also provide a validation of the IFAAC adjustments it was necessary to weight the current *iSurvey* estimates. This was achieved by restricting the *iSurvey* data to similar characteristics of the 2005/06 creel survey i.e. marine line fishing between 9am to 5pm from boats launching from public boat ramps in the West Coast Bioregion (*iSurvey* lite). The initial *iSurvey* lite estimates suggest that the IFAAC adjustments generally provide reasonable adjustments to the 2005/06 creel survey to the total recreational catch. A PhD student will carry out additional analysis to investigate this further.

2011/12 vs 2005/06 recreational catch comparison

- The 2005/06 recreational catch reference level is presented in Table 7. Catches of snapper and baldchin groper in 2011/12 were greater than the respective 2005/06 reference levels, while catches of West Australian dhufish and the Top 15 demersal scalefish are below the respective 2005/06 reference levels (Table 8; Appendix). WA dhufish accounts for the largest component of the Top 15 demersal scalefish catches.

Recreational catch estimates from the *iSurvey* are the subject of current studies to investigate their direct comparability with those from previous boat-ramp surveys. Charter catches were derived from compulsory logbooks for each corresponding financial year over the same period.

Effort results for the recreational sector are not presented, as effort data from the *iSurvey* are the subject of current studies to investigate their direct comparability with those from previous boat-ramp surveys. These studies are also investigating whether estimates of catch and effort can be derived for each management area of the WCB using the current sampling frame.

Table 7. 2005/06 recreational boat-based catch estimated by IFAAC and charter catches.

	IFAAC adjusted	Charter	Total catch	50% catch reference level
WA dhufish	234.1t	18.8t	252.9t	126.45t
Snapper	55.4t	18.1t	73.5t	36.75t
Baldchin groper	55.1t	10.2t	65.3t	32.65t
Top 15 demersal scalefish	428.4t	75.5t	503.9t	251.95t

Table 8. 2011/12 recreational boat-based catch estimated from the *iSurvey* and charter catches.

	<i>iSurvey</i>	Charter	Total
WA dhufish	74t	12.7t	86.1t
Snapper	33.2t	9.8t	43.0t
Baldchin groper	28.7t	8.9t	37.6t
Top 15 demersal scalefish	159t	41.2t	200.2t

SUMMARY AND RECOMMENDATIONS

Assessment results

- The current assessment was based on age composition data collected between 2008/09 and 2010/11 for West Australian dhufish and snapper and between 2007/08 and 2010/11 for baldchin groper and only includes about one year of data after management changes. ***Given the life history characteristics of the indicator species, only minor recovery of stocks would have been expected, if any. Recovery to above threshold level is not expected for at least 10 years.***
- The overall assessment results for West Australian dhufish and snapper (declining *F* and for dhufish increasing *SPR*) over three assessment periods indicate that some recovery has been initiated in the stocks of these indicator species within the WCB subsequent to the management changes. However, ***for each indicator species, F has not yet reached the threshold level*** (Table 9).
- The recovery observed in these assessments is likely to have been influenced by the presence of three strong cohorts of recruitment (1999, 2002 and 2004) in West Australian dhufish stocks and by several years of protection of snapper spawning aggregations in the Metropolitan area.
- Declining *F* and increasing *SPR* in the southern half of the bioregion for West Australian dhufish and snapper indicate adequate recovery is occurring in the Metropolitan and South-west management areas (Table 11). However, the minor changes in these parameters for Snapper in the northern half of the bioregion indicate recovery is not occurring at an adequate rate (Table 9). There was no recovery observed for baldchin groper in the Abrolhos Islands Zone A (Table 9).

Catch data

- The total catch of the demersal suite in the WCB by the commercial sector (in 2010/11 or 2011) was < 50 per cent of 2005/06 catches (Table 9). The catch of West Australian dhufish in the WCB by the commercial sector (in 2010/11 or 2011) was < 50 per cent of 2005/06 catches. Catches of snapper were greater than 50 per cent of 2005/06 catches and of baldchin groper were just below 50 per cent of 2005/06 catches (Table 9).
- The total catch of the top 15 demersal species in the WCB by the recreational sector in 2011/12 was < 50 per cent of 2005/06 catches (adjusted IFAAC values; Tables 7, 8). The catch of West Australian dhufish in the WCB by the recreational sector (2011/12) was < 50 per cent of 2005/06 catches, while catches of snapper and baldchin groper were greater.

Table 9. Summarised results of assessments of fishing mortality and comparison of catches (commercial – 2010/11 or 2011; recreational 2009/10) of indicator species with 50 % of 2005/06 catches. Note that the assessment estimates are based on one method of estimating *F* and do not present the full range of uncertainty among methods. *F* = fishing mortality; T = Target; Th = Threshold; Lim = Limit.

Indicator	Bioregion/area	F	Comm. catch		Rec. catch	
			t	<, >, ≈ 50%	t	<, >, ≈ 50%
West Australian dhufish	WCB	F ≈ Lim	80	<	86	<
	Mid-west	F > Lim	44	≈	-	
	Metropolitan	F > Lim	-		-	
	South-west	F ≈ Th	19	≈	-	
Snapper	WCB	F > Lim	189	>	43	>
	North	F > Lim	-			
	South	F ≈ Lim	-			
	Kalbarri	F > Lim	88	>		
	Mid-west	F > Lim	91	>		
	Metropolitan	F > Lim	-			
Baldchin groper	WCB		19	≈	38	>
	Zone A	F > Lim	9.5	>		
	Mid-west	F > Lim	4.4			
	Metropolitan	F > Lim				

Advice

- *The combination of catch data and stock assessment results indicate that further reductions in catches in the northern management region would be required if an adequate rate of recovery of stocks in these areas is to be achieved.*
- There has been considerable unused commercial effort entitlement in each management area of the WCDSIMF since its introduction in 2009. This latent effort, if exercised, is likely to further increase commercial catches of snapper and baldchin groper in the Mid-west and Kalbarri areas.
- Any future increases in entitlement consumption by the WCDSIMF and increased effort by the recreational sector will raise catches of demersal fishes. This would include increased catches of; (1) the demersal suite, dhufish and baldchin groper to levels above 50 per cent of 2005/06 catches; (2) snapper by both sectors further above 50 per cent of 2005/06 catches and; (3) baldchin groper by the recreational sector further above 50 per cent of 2005/06 catches.

- It is expected that the high recreational catch of baldchin groper in 2011/12 would have been driven primarily by catches in the northern half of the WCB, where it is more abundant and targeted. Snapper is targeted by recreational fishers across the whole WCB. Thus, as recreational catch estimates are not available for each management area, it is not clear if catches in any particular area were responsible for the high catches of this species in the WCB in 2011/12.
- WCRLF fishers and their families land and consume baldchin groper at the Abrolhos Islands when staying there. These are not accounted for in the *iSurvey* or previous creel surveys and have been demonstrated to be significant (Sumner, 2008). If such catches are still significant, this may be contributing to the lack of evidence of recovery of stocks in Zone A.
- Recovery of stocks of West Australian dhufish and baldchin groper may be affected by the high numbers of fish known to be released by the recreational sector and the associated mortality. These species can suffer barotrauma, even in relatively shallow water, while snapper are less susceptible to barotrauma. Any level of post-release mortality, will however, be accounted for within future age structures and therefore within future assessments.
- The bag limit for West Australian dhufish for the recreational sector is two per boat, but for snapper and baldchin groper is two per person. The higher catch allowances for snapper and baldchin groper may limit the effectiveness of management changes for these species and may explain why recreational catches of these species in 2009/10 were not reduced to ≤ 50 per cent of 2005/06 catches.

Overall outcome

- ***Although stock status results and catch data demonstrate that management changes have allowed some level of recovery of demersal stocks at the bioregion level, these stocks have not yet recovered.***
- ***There was evidence of adequate recovery of WA dhufish occurring in all management areas at current catch levels.***
- ***Evidence of adequate recovery was not present for two indicator species (snapper and baldchin groper) in the northern half of the WCB. Their estimated catches and fishing mortality were not reduced sufficiently in the northern management areas to allow adequate recovery of these stocks in this region, and fishing pressure may need to be further reduced in those areas if an adequate recovery rate is to be achieved.***

Future assessments

- Ongoing monitoring and assessment in each management area (collection of frames and assessments of age structure) is required to ensure recovery continues and there are improvements for snapper and baldchin groper in the northern part of the bioregion.
- A fourth assessment could be conducted following three years of sampling (i.e. 2011/12 - 2013/14) with the assessment undertaken in 2015.
- Given that the biological characteristics of the indicator species for the WCDSR dictate that stock recovery will require at least 10 years, a four to five year sampling programme/ assessment cycle is appropriate.

Appendix 1.

Assessment analyses of baldchin groper

For gonochoristic species (no sex change), *SPR* is determined for the female portion of a stock. As baldchin groper is protogynous, its females occur in the smaller length and younger age classes and males in the larger length and older age classes and individuals would contribute to reproduction first as a female and later in life as a male.

As there is a MLL of 400 mm, the age at 50 per cent recruitment to the fishery is high, providing perceived significant protection to the female portion of the stock. However, this species suffers barotrauma in shallow waters and thus post-release mortality would be high.

Thus, we consider the *SPR* for the male (fully-exploited) part of the stock to be more representative of the reproductive potential of the stock. There is greater potential for sperm limitation under heavy fishing to affect reproductive success. This would be exacerbated if the species cannot respond and change sex at a smaller size/younger age. However, that is not ideal.

Recreational catch data

Table of *iSurvey* results for the top 15 species

<i>Isurvey</i>	Estimated catch (kept numbers)	Average weight (kg)	Estimated catch (tonnes)
Baldchin groper	12,271	2.337 ^B	28.677
Bass groper	12	n/a	<1
Bight redfish	1,288	1.171 ^S	1.508
Blue morwong	1,348	2.717 ^S	3.663
Blue-eye trevalla	18	n/a	<1
Breaksea cod	9,949	1.031 ^S	10.257
Eightbar grouper	48	5.270 ^C	0.253
Emperor	3,119	1.18 ^C	3.665
Foxfish	973	0.811 ^S	0.789
Hapuku	0	n/a	0
Ruby snapper	0	n/a	0
Sea sweep	805	1.252 ^S	1.008
Sergeant Baker	1,627	0.940 ^S	1.529
Snapper	14,354	2.315 ^B	33.23
WA dhufish	16,495	4.485 ^B	73.98
Total	62,307		158.561

S = statewide, B = bioregion, C = unpublished data/data unavailable.

