

WEST COAST BIOREGION

ABOUT THE BIOREGION

The marine environment of the West Coast Bioregion between Kalbarri and Augusta is predominantly a temperate oceanic zone, but it is heavily influenced by the Leeuwin Current, which transports warm tropical water southward along the edge of the continental shelf. The Integrated Marine and Coastal Regionalisation for Australia (IMCRA V 4.0) scheme divides this Bioregion into three meso-scale regions: Abrolhos Islands, Central West Coast and Leeuwin-Naturaliste (West Coast Overview Figure 1).

Most of the fish stocks of the region are temperate, in keeping with the coastal water temperatures that range from 18° C to about 24° C. The Leeuwin Current is also responsible for the existence of the unusual Abrolhos Islands coral reefs at latitude 29° S and the extended southward distribution of many tropical species along the West Coast and even into the South Coast.

The Leeuwin Current system, which can be up to several hundred kilometres wide along the West Coast, flows most strongly in autumn/winter (April to August) and has its origins in ocean flows from the Pacific through the Indonesian archipelago. The current is variable in strength from year-to-year, typically flowing at speeds around 1 knot, but has been recorded at 3 knots on occasions. The annual variability in current strength is reflected in variations in Fremantle sea levels, and is related to El Niño or Southern Oscillation events in the Pacific Ocean.

Weaker counter-currents on the continental shelf (shoreward of the Leeuwin Current), such as the Capes Current that flows northward from Cape Leeuwin as far as Shark Bay, occur during summer and influence the distribution of many of the coastal finfish species.

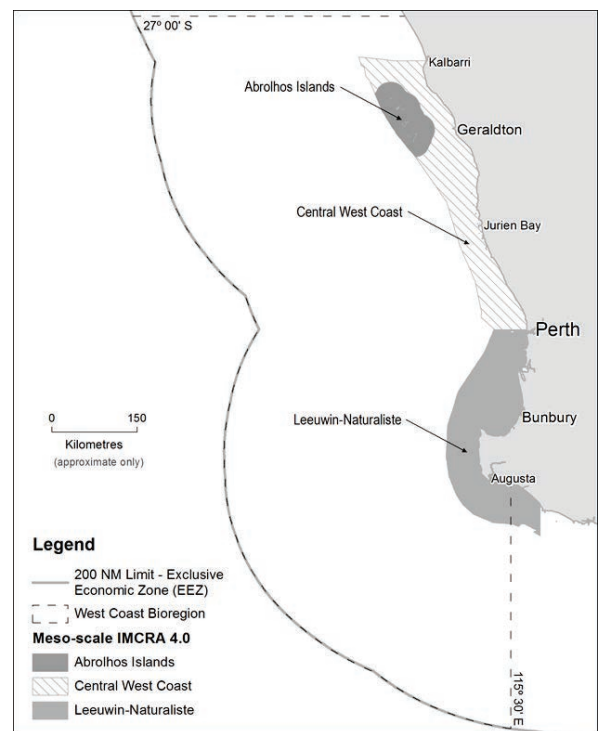
The most significant impact of the clear, warm, low-nutrient waters of the Leeuwin Current is on the growth and distribution of the temperate seagrasses. These form extensive meadows in protected coastal waters of the West Coast Bioregion, generally in depths of less than 20 m (but up to 30 m), and act as major nursery areas for many fish species and particularly for the western rock lobster stock.

The West Coast is characterised by exposed sandy beaches and a limestone reef system that creates surface reef lines, often about 5 kilometres off the coast. Further offshore, the continental shelf habitats are typically composed of coarse sand interspersed with low limestone reef associated with old shorelines. There are few areas of protected water along the west coast, the exceptions being within the Abrolhos Islands, the leeward sides of some small islands off the Midwest Coast, plus behind Rottnest and Garden Islands in the Perth metropolitan area.

The two significant marine embayments in the West Coast are Cockburn Sound and Geographe Bay. Along the West Coast, there are 4 significant estuarine systems – the Swan/Canning, Peel/Harvey and Leschenault estuaries and Hardy Inlet (Blackwood estuary). All of these are permanently open to the sea and form an extension of the marine environment except when freshwater run-off displaces the oceanic water for a short period in winter and spring.

Southward of Cape Naturaliste, the coastline changes from limestone to predominantly granite and becomes more exposed to the influences of the Southern Ocean.

The ecosystem boundaries as defined by IMCRA (V 4.0) in the bioregion are depicted in West Coast Overview Figure 1. The potential threats and risks to these ecosystems are often similar. For simplicity risk ratings were allocated by grouping the ecosystems into two broad groups, estuarine or marine. However, if a particular ecosystem is unique and/or is exposed to different or significant threats, risk was allocated to these ecosystems separately.



WEST COAST OVERVIEW FIGURE 1.

Map showing the three main IMCRA (V4.0) ecosystems in the West Coast Bioregion: Abrolhos Is.; Central West Coast and the Leeuwin-Naturaliste.

SUMMARY OF ACTIVITIES POTENTIALLY IMPACTING THE BIOREGION

Climate Change

Some of the key environmental trends that may be affecting ecosystems in WA include:

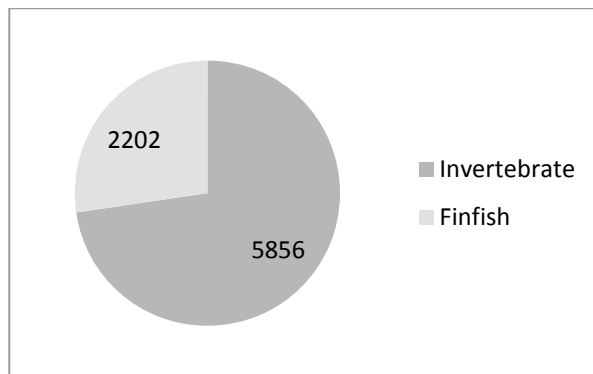
- Increasing frequency of El Niño/Southern Oscillation (ENSO) events;
- More years with a weaker Leeuwin Current;
- Increase in water temperature off the west coast of WA, particularly the lower west coast;
- Increase in salinity, which includes some large annual fluctuations;
- Change in the frequency and location of storms (and rainfall) affecting the lower west coast; and
- Change in the frequency of cyclones (and summer rainfall) affecting the north-west coast.

The West Coast Bioregion is predicted to be at enhanced risk from the effects of climate given that it spans a transitional zone between tropical and temperate regions. The variables expected to drive climate change impacts include changes in water temperature, ocean currents, winds, rainfall, sea level, ocean chemistry and extreme weather conditions.

It is apparent that climate change will impact the biological, economic, and social aspects of many fisheries, and both positive and negative impacts are expected. Climate change can influence biological systems by modifying the timing of spawning, range and distribution, composition and interactions within communities, exotic species invasions and impacts, and the structure and dynamics of communities, including changes in productivity. Species distribution shifts are the most commonly reported changes and are often the easiest to recognise and measure. Changes in the distribution of key species are monitored in a national citizen-science program (www.redmap.org.au) in which the Department is a collaborator.

Commercial Fishing

The principal commercial fishery in this region is the western rock lobster fishery, which is Australia’s most valuable single-species wild capture fishery. There are also significant commercial fisheries for other invertebrates including scallops, abalone, blue swimmer crabs and octopus that use trawl, diving and potting methods. Commercial fishers also take a range of finfish species including sharks, West Australian dhufish, snapper, baldchin groper and emperors using demersal line and net methods. Beach-based methods such as beach seining and near-shore gillnetting, and hand-hauled nets are used to capture whitebait, mullet and whiting in a very restricted number of locations.

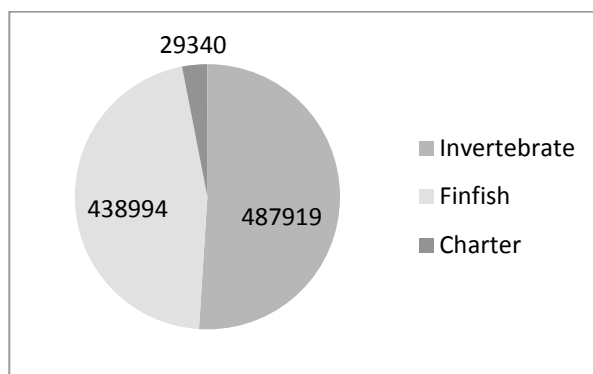


WEST COAST OVERVIEW FIGURE 2

Relative contribution of finfish and invertebrates to the total commercial wild fishery catch originating from the West Coast Bioregion. Numbers represent total catch (in tonnes) based on all major assessed fisheries identified in the Overview section of this report (West Coast Overview Table 1).

Recreational Fishing

The West Coast Bioregion, which contains the state’s major population centres, is the most heavily used bioregion for recreational fishing (including charter based fishing). The range of recreational fishing opportunities includes estuarine fishing (both shore- and boat-based), beach fishing and boat fishing either in embayments or offshore for demersal and pelagic/game species often around islands and out to the edge of the continental shelf.



WEST COAST OVERVIEW FIGURE 3

The West Coast Bioregion finfish and invertebrate catch numbers as assessed in the integrated survey of boat-based recreational fishing in WA 2015/16, and the charter boat catch numbers for the same period.

Aquaculture

The principal aquaculture development activities in the West Coast Bioregion are the production of blue mussels (*Mytilus galloprovincialis*), marine algae (*Dunaliella salina*) for beta-carotene production and the emerging black pearl industry based on the production of *Pinctada margaritifera* at the Abrolhos Islands. The main mussel farming area is in southern

Cockburn Sound, where conditions are sheltered and the nutrient and planktonic food levels are sufficient to promote good growth rates. Owing to the generally low productivity of the Western Australian coastline under the influence of the Leeuwin Current, areas outside embayments (where nutrient levels are enhanced) are unsuitable for bivalve aquaculture. Initiatives to expand the number of aquaculture sectors in this bioregion currently include those for octopus, live rock/coral and finfish. Further, the Department has established a Mid-West Aquaculture Development Zone which aims to provide a platform to stimulate aquaculture investment and development in the bioregion.

Tourism

The State capital, Perth, is the principal gateway for more than two million visitors to Western Australia each year and a major international transit point for travellers arriving in Australia from Europe and Asia. The south-west of the state is also an important tourism destination for international and interstate visitors, as well as for Western Australian residents. Beach-going is among the most popular leisure activities for tourists in the West Coast Bioregion. Surfing, fishing, SCUBA diving and snorkelling, windsurfing, whale watching and other marine wildlife experiences are also popular tourist activities.

Shipping and Maritime Activity

The West Coast Bioregion contains several major port facilities, including the State's busiest general cargo port (Fremantle), as well as the Royal Australian Navy's largest base (HMAS Stirling) on Garden Island. In addition to handling most of Western Australia's container trade, significant quantities of non-containerised cargo passes through Fremantle, including: motor vehicles, steel and machinery imports, livestock exports and bulk commodities, such as petroleum, grain, alumina, iron ore, mineral sands, fertilisers and sulphur. Two other major commercial ports at Bunbury and Geraldton, primarily export iron ore, grain, mineral sands and alumina. In addition to commercial and naval shipping, international cruise ship visitations have increased to record levels in recent years and some cruise liners are now home-based in Fremantle.

Major shipbuilding, repair, maintenance and offshore construction support industries are also located at Henderson in the north-eastern corner of Cockburn Sound. Collectively, these enterprises directly employ over 2,000 people, indirectly support 3,000 more jobs and generate around \$700 million annually in trade.

Other Activities

High rates of population growth and boat ownership in Western Australia have strained recreational boating facilities around major population centres, particularly in the Perth metropolitan region. New and upgraded marinas and boat launching facilities have been

completed or are planned to accommodate this demand. In addition, major coastal infrastructure developments have been planned for an outer deep-water harbour at Fremantle and for a deep-water iron-ore port at Oakajee, 24 km north of Geraldton. Two large desalination plants at Kwinana and Binningup (22km North of Bunbury), which supply approximately half of Perth's freshwater requirements, also operate in the bioregion.

BIOREGIONAL SPECIFIC ECOSYSTEM MANAGEMENT

Within each Bioregion there are a range of management measures that have been implemented to manage the potential impact of activities. Management measures specific to the West Coast Bioregion include:

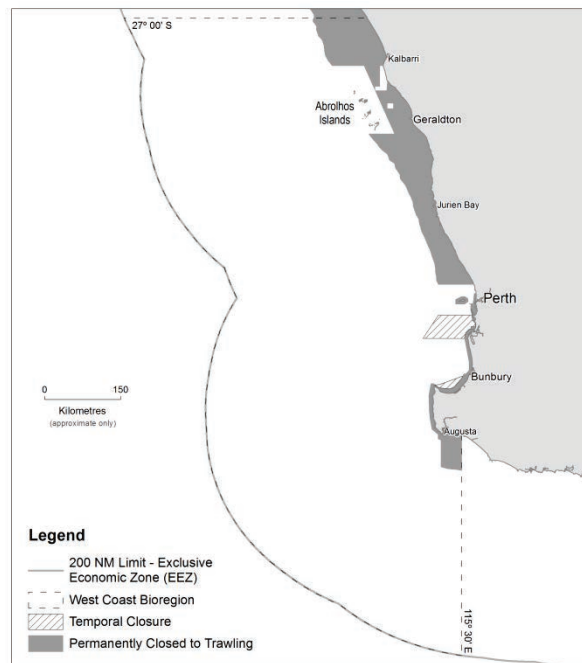
Spatial Closures

The marine benthic habitats and their associated biodiversity along most of the West Coast are largely protected from any physical impact of commercial fishing due to the extensive closures to trawling. These closures inside 200m depth were introduced in the 1970s and 1980s, in recognition of the significance of extensive areas of seagrass and reef as fish habitat (West Coast Overview Figure 4). Demersal gillnet and longline fishing was also prohibited from waters inside the 250m isobath between 31° and 33° South from November 2007. The extent of these areas means that most of the West Coast Bioregion inside 200m depth could be classified as one of the marine protected area IUCN categories (West Coast Ecosystem Management Table 1).

Protection of fish habitat and biodiversity is also provided by marine protected areas consistent with IUCN categories of I, II and III along the West Coast including: Fish Habitat Protection Areas (FHPAs) at the Abrolhos Islands, Lancelin Island Lagoon, Cottesloe Reef, and Kalbarri Blueholes; Reef Observation Areas within the Abrolhos Islands FHPA and closures to fishing under s.43 of the Fish Resources Management Act 1994 at Yallingup Reef, Cowaramup Bay, the Busselton Underwater Observatory and around the wrecks of the Saxon Ranger (Shoalwater Bay), HMAS Swan (Geographe Bay) and Lena (Off Bunbury). In addition, marine conservation areas proclaimed under the Conservation and Land Management Act 1984 exist at Jurien Bay, Marmion, Swan Estuary, Shoalwater Islands, and Ngari Capes Marine Park between Cape Leeuwin and Cape Naturaliste and the Rottne Island Marine Reserve. (West Coast Overview Figure 5).

The Commonwealth Government is also undertaking a Marine Bioregional Planning process for Commonwealth waters between Kangaroo Island (South Australia) and Shark Bay.

WEST COAST BIOREGION



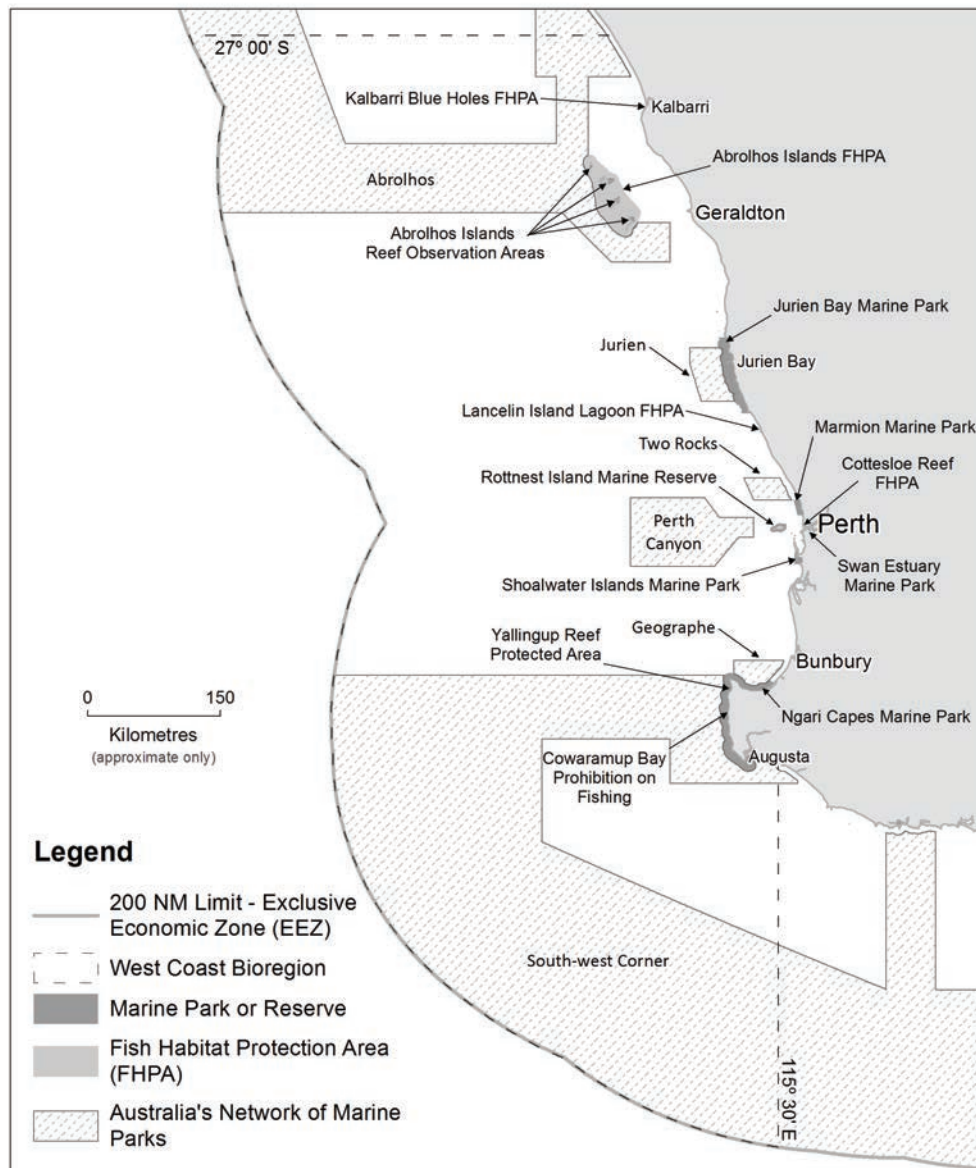
WEST COAST OVERVIEW FIGURE 4

Map showing areas of permanent and extended seasonal closures to trawl fishing in the West Coast Bioregion. The areas permanently closed are consistent with IUCN marine protected area category IV.

WEST COAST ECOSYSTEM MANAGEMENT TABLE 1

The areas and proportions of the West Coast Bioregion making up State Waters and all continental shelf waters, out to 200 m depth, which meet the IUCN criteria for classification as marine protected areas. This table does not yet include the closures that may be implemented by the Commonwealth as part of their marine planning zones (see next Figure).

IUCN category or equivalent	State Waters only (10,088 km ²)				All Waters (481,488 km ² (including State Waters))			
	Fisheries km ²	%	Existing MPA km ²	%	Fisheries km ²	%	Existing MPA km ²	%
I	0	0	0	0	0	0	0	0
II	1	< 1	171	2	1	< 1	171	< 1
III	0	0	0	0	0	0	0	0
IV	4,500	44	1,900	19	33,600	7	1,900	< 1
V	0	0	0	0	0	0	0	0
VI	3,400	34	116	1	445,700	93	116	< 1



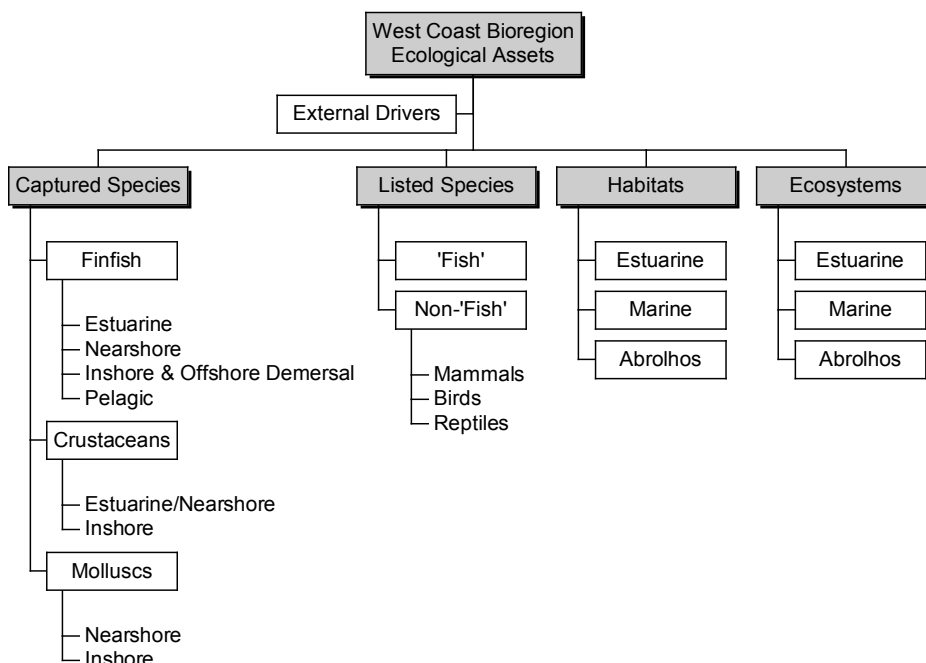
WEST COAST OVERVIEW FIGURE 5

Map showing current and proposed formal marine protected areas in the West Coast Bioregion.

ECOSYSTEM MONITORING AND STATUS

In order to assess the adequacy of management arrangements aimed at ensuring sustainability of the ecological assets within the West Coast Bioregion, the Department must identify and monitor trends in the condition of these resources. This is achieved through application of an Ecosystem Based Fisheries Management (EBFM) framework (Fletcher *et al.*, 2010 – see How to use this Volume for more information) to

identify, in a hierarchical manner, the key ecological resources that require ongoing monitoring and assessment. These key ecological assets identified for the West Bioregion are identified in West Coast Ecosystem Management Figure 6 and their current risk status reported on in the following sections.



WEST COAST ECOSYSTEM MANAGEMENT FIGURE 6

Component tree showing the ecological assets identified and separately assessed for the West Coast Bioregion.

External Drivers

External drivers include factors impacting at the bioregional-level that are likely to affect the ecosystem as a whole and may not fall within the direct control of Fishery legislation (e.g. climate change). An understanding of these factors, which are typically environmental (e.g. ocean currents), is necessary to fully assess the performance of the ecological resource. The main external drivers identified with potential to affect the West Coast Bioregion include climate and introduced pests and diseases.

Climate

External Drivers	Current Risk Status
Climate	HIGH (long term)

The south west of Western Australia is predicted to be heavily influenced by the impacts of climate change (e.g. increasing sea temperatures, declines in rainfall). Some climate change information has been taken into account in the rock lobster stock assessment process and the effect of the marine heat wave in 2010/11 on fisheries has been assessed but further information is required to examine potential impacts on this bioregion.

Introduced Pests and Diseases

External Drivers	Current Risk Status
Introduced Pests	LOW
Introduced Diseases	LOW

Port monitoring plans have been implemented targeting high risk port locations. These designs have been developed in line with the National System for introduced marine pest monitoring.

Captured Species

FINFISH

Estuarine

Captured Species	Aquatic zone	Ecological Risk
Finfish	Estuarine	HIGH (non-fishing)

There is concern for some fish stocks within estuaries in the West Coast Bioregion mainly due to external (non-fishing) factors (e.g. poor water quality, reduced water flows, water diversion, other environmental factors).

Nearshore

Captured Species	Aquatic zone	Ecological Risk
Finfish	Nearshore	SIGNIFICANT

Concerns for status of a range of nearshore species including Australian herring and southern garfish, have resulted in additional activities being undertaken to further monitor and assess stock status and estimate recreational shore-based fishing catch and effort.

Inshore (20-250m depth) and Offshore (>250m depth) Demersal

Captured Species	Aquatic zone	Ecological Risk
Finfish	Inshore and Offshore Demersal	MODERATE

Following assessments of inshore demersal indicator species (West Australian dhufish, pink snapper, baldchin groper), management actions were implemented to reduce both the commercial and recreational catch levels by 50% of their 2005/06 levels. Based on assessments of indicator stocks this resource is considered to be in a recovery phase.

While the deep-water indicator species are vulnerable to overfishing, current catch levels are low and therefore the stocks are not at risk. However, long term management arrangements for fishing in these depths, particularly for the recreational sector, are still being finalised.

Pelagic

Captured species	Aquatic zone	Ecological Risk
Finfish	Pelagic	LOW

There is minimal capture of pelagic fish in this bioregion, with most emphasis focussed on samsonfish by recreational anglers.

INVERTEBRATES**Crustaceans**

Captured species	Aquatic zone	Ecological Risk
Crustaceans (Crabs)	Estuarine/ Nearshore	HIGH
Crustaceans (Lobsters)	Inshore	LOW
Crustaceans (Prawns)	Inshore	LOW

The stocks of crabs in Cockburn Sound are recovering and breeding stock levels are improving. However, the fishery remains closed to fishing in 2016/17 with a review of the stock status being conducted in 2017.

Assessment of other crab stocks in this region (e.g. Peel/Harvey) has been completed and all are considered to be in an adequate state and fishing levels are acceptable. The Peel-Harvey crab fishery achieved MSC certification for the commercial and recreational sectors.

The stock levels of western rock lobster and prawns are both currently at appropriate levels. The strong management that was applied to the rock lobster

fishery has ensured that the lobster spawning stock is currently at record high levels.

Molluscs

Captured species	Aquatic zone	Ecological Risk
Molluscs (Abalone)	Nearshore	HIGH
Molluscs (Scallops)	Inshore	HIGH

The stocks of abalone are conservatively managed with strong management controls on both commercial and recreational fishers. However, the marine heat wave in 2010/11 caused the almost total loss of Roes abalone in the Kalbarri region and that region has consequently been closed since 2011/12.

The stock of scallops is considered environmentally limited with the Abrolhos Island fishery closed and no fishing occurring in the Mid-West Trawl Fishery for 5 years before re-opening in 2017.

Listed species

A variety of endangered, threatened and protected¹ (ETP) species can be found within the West Coast Bioregion, including cetaceans, pinnipeds, elasmobranchs, seahorses and pipefish and sea/shore birds. These species are protected by various international agreements and national and state legislation. Primary pieces of legislation include the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999*, the *Western Australian Wildlife Conservation Act 1950*, and the *Fish Resources Management Act 1994*.

Fish

Listed species	Ecological Risk
Fish	MODERATE

Grey nurse shark (*Carcharias taurus*) is protected under State and Commonwealth legislation throughout this and all bioregions. Blue groper (Rottnest Island), cobble (Swan-Canning estuary) and baldchin groper (Abrolhos Islands FHPA between 1 November and 31 January) cannot be landed by commercial or recreational fishers in the particular areas and periods.

¹ It must be noted that merely being on the listed species list does not automatically indicate that a species is either threatened or endangered.

Non-Fish

Listed species	Ecological Risk
Mammals	MODERATE
Birds and Reptiles	LOW

The only identified risk to bird species was to little penguins from boat strikes and non-fishing activities.

The West Coast Bioregion lies to the south of most marine turtles' distributions and, thus, there are minimal risks to turtles from fishing activities within this bioregion. The leatherback turtle, which is relatively more common in temperate latitudes, is rarely encountered in continental shelf waters, where the majority of fishing activities occur. Therefore, fishing is also considered to pose a low risk to this species. In addition, the small trawl fishery that operates around the Abrolhos Islands uses bycatch reduction devices, which are effective at minimising the capture of turtles.

Sea lion exclusion devices have now been implemented for rock lobster pots near Australian sea lion breeding colonies. Demersal gillnet fishing effort, which has historically been responsible for a very small number sea lion captures, has been reduced to less than 10% of its peak level of the late 1980s.

Regulated modifications to rock lobster fishing gear configuration during humpback and southern right whales' northerly winter migration, have successfully reduced entanglement rates by more than 65% in recent years. Thus, risks to mammals from fishing activities in the West Coast Bioregion have decreased in recent years (but are not yet considered to be low).

Habitats and Ecosystems

Due to the counter-acting Leeuwin and Capes Currents, the West Coast Bioregion has the unique characteristic of containing tropical, sub-tropical and temperate ecosystems.

The key habitats occurring in depths of less than 40 m (where the vast majority of relevant fisheries resources are located and fishing activities are undertaken in this bioregion) include:

Algae: Along the WCB, algae attach to intertidal and subtidal rocky substrata and in turn, are habitat to a variety of organisms. Algal assemblages contribute to marine nutrient and carbon cycling are also an important as a food source, nursery grounds and shelter for a variety of organisms. Along the WCB, there is a gradual transition from a subtropical flora of the Abrolhos Islands and north of Geraldton to a cold-temperate flora found along the southwest corner and south coast of WA. Macroalgae along the southwestern and southern coasts of Australia are very diverse, with a high level of endemism.

Sand: The majority of seabed of the WCB is composed of soft, unconsolidated sediments. These

sediments provide an important habitat for microalgae and benthic infauna.

Seagrasses: In temperate WA, seagrasses occupy approx. 20 000 km² of shallow coastal waters and grow predominantly on sand from 1 – 35 m depth, but also on deep rock to over 50 m deep. Seagrasses provide habitat for many fish and crustacean species, stabilise coastal sediments and prevent coastal erosion. In addition seagrasses are also important for primary production, CO₂ uptake and nutrient cycling. The diversity of seagrasses in temperate south-western Australia is the highest for any temperate region, with 17 species within WCB and SCB combined.

Corals: Due to the cool temperate waters corals are not common in the WCB with the exception of the Abrolhos Islands, which are located offshore and are more exposed to the warm Leeuwin Current. The Abrolhos Islands are well-known for their high species diversity, coral reefs and unique mixture of temperate and tropical species. Currently there are 184 known coral species at the Abrolhos. Elsewhere in the WCB corals occur in patches around offshore islands, usually comprised of only a few species.

Sponges: In southwestern Australia, sponges are found in areas where algae are less dominant, which includes areas deeper than 30 m and caves. As they are sessile filter-feeders, sponges flourish in areas of high current, although large sponges are also found in calmer deeper waters. In areas with an absence of reef-building corals, sponges function as large epibenthos that form the three-dimensional structure of subtidal reefs providing shelter for other organisms, such as worms, crustaceans, echinoderms, molluscs and fish.

Habitats

Habitats	Aquatic zone	Current Risk Status
West Coast Habitat	Estuarine	SIGNIFICANT (non-fishing)
West Coast Habitat	Marine	LOW
Abrolhos Islands	Marine	MODERATE

The West Coast is a microtidal, relatively high-energy area, with clear water and few rivers. The coastline is characterised by long beaches with occasional limestone cliffs and headlands, with offshore limestone islands and reef complexes. There are numerous protected marine areas in the West Coast (West Coast Overview Figure 5). Spatial zoning restricts activities within these areas, including preventing trawling.

The Peel Harvey Estuary habitats are under pressure due to poor water quality as a result of farming, canal development and urbanisation in the surrounding catchment. A benthic habitat monitoring program is planned to quantify impacts of recreational crabbing as a part of the MSC assessment process. Cockburn Sound, which contains large areas of seagrass, has been mined for shell sand since 1972. The permitted areas

for mining have been increasingly restricted and regulated since the commencement of mining operations.

The main fisheries in the Central West Coast involve fishing gear which has minimal impacts to the benthic habitats. These include: western rock lobster which uses traps, Roes abalone which are hand collected and several finfish fisheries that mainly use lines.

Due to the unique diversity of tropical and temperate habitats, the Abrolhos Islands were gazetted as WA's first Fish Habitat Protection Area (FHPA) and have been placed on the National Estate Register. Due to this, the risks to Abrolhos Islands habitats are assessed separately to the bioregion as a whole.

The main activities at the Abrolhos are commercial rock lobster potting and line fishing and recreational fishing and diving. The Department has a long term coral reef monitoring program at the Abrolhos to detect potential impacts from human use and natural influences. A significant coral bleaching event was observed during the marine heat wave event in 2011 (Abdo *et al.* 2012)¹.

There are 45 public moorings installed at the Abrolhos Islands, distributed around the different island groups, to minimise impacts of anchoring to the benthic habitats. The commercial scallop fishery also operates away from coral reef habitats, predominately in areas of sand.

monitoring of a deep water closed area will allow evaluation of potential ecosystem impacts of lobster fishing in deeper water ecosystems.

The Abrolhos Islands is noted for its high species diversity, which is attributed to the relatively equal mix of temperate and tropical species. Due to the uniqueness of the Abrolhos Islands Ecosystem in the West Coast Bioregion, it is assessed separately to the bioregion as a whole.

The Abrolhos Islands are protected within a 'Fish Habitat Protection Area', and are not considered to be at unacceptable risk from fisheries related activities. The first recorded significant bleaching of corals was observed during the marine heat wave event along the Western Australian coast in 2011 (Abdo *et al.* 2012)¹, with the impact of this event being monitored as part of an ongoing monitoring program run by the Department. The program also includes monitoring of the community structure of finfish within and outside of non-fishing areas.

Ecosystems

Ecosystem	Aquatic zone	Current Risk Status
West Coast	Estuarine	SIGNIFICANT (non-fishing)
West Coast	Marine	MODERATE
Abrolhos Islands	Marine	MODERATE

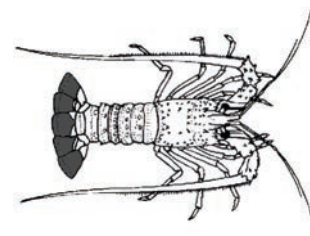
The estuarine ecosystems within this bioregion have been identified as being at significant risk, due to external factors (water quality issues due to high nutrient runoff from surrounding catchment, reduced rainfall) which have the potential to affect fish and other communities. Poor water quality within the Peel–Harvey and Swan–Canning estuaries and mass mortality events in Cockburn Sound are of particular concern.

An assessment of the community structure and trophic level of all commercially caught fish species over the past 30 years found no evidence of systematic changes that could be evidence of an unacceptable impact on this ecosystem (Hall and Wise, 2011)². Continued

¹ Abdo DA, Bellchambers LM, Evans SN. 2012. Turning up the Heat: Increasing Temperature and Coral Bleaching at the High Latitude Coral Reefs of the Houtman Abrolhos Islands. PLoS ONE 7(8): e43878.

² Hall NG, and Wise BS. 2011. Development of an ecosystem approach to the monitoring and management of Western Australian fisheries. FRDC Report – Project 2005/063. Fisheries Research Report, No. 215. Department of Fisheries, Western Australia. 112 pp.

WEST COAST ROCK LOBSTER RESOURCE STATUS REPORT 2017



S. de Lestang, M. Rossbach and N. Blay

OVERVIEW

The West Coast Rock Lobster Managed Fishery (WCRLMF) targets the western rock lobster (*Panulirus cygnus*), on the west coast of Western Australia between Shark Bay and Cape Leeuwin. Lobsters are taken throughout their range by both the commercial and recreational sector and each sector operates to formal IFM allocations.

The WCRLMF was one of the first limited entry fisheries in the world and for over 20 years utilised a sophisticated Individual Transferrable Effort system based on the number of allowable baited pots. In 2010/11 the WCRLMF began the transition to an Individually Transferable Quota (ITQ) fishery and now has a harvest strategy that uses maximum economic yield as its management target (DoF, 2014). The WCRLMF has historically been Australia's most

valuable single species wild capture fishery and, in 2000, became the first fishery in the world to achieve Marine Stewardship Council (MSC) Certification. In 2017 it was the first fishery globally to be certified by MSC for the fourth time (see de Lestang *et al.*, 2016 for further details:

www.fish.wa.gov.au/Documents/wamsc_reports/wamsc_report_no_9.pdf).

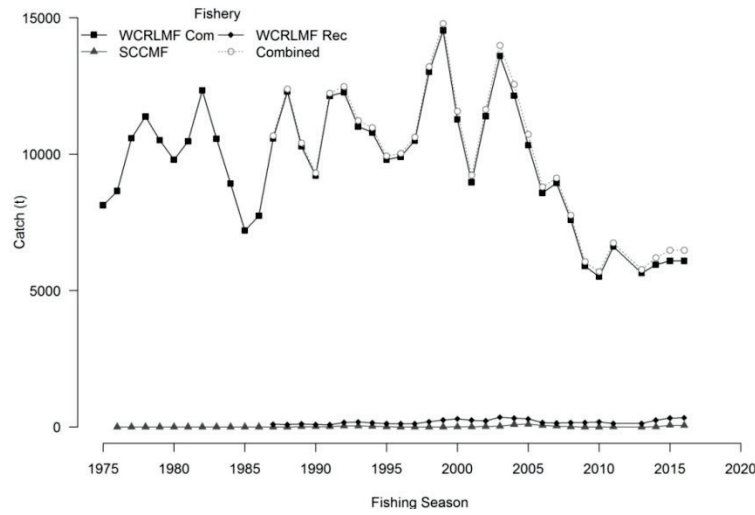
The commercial fishing season now begins on the 15 January each year and runs 12 months. The recreational fishery extends from 15 October each year until 30 June the following year. Licenced recreational fishers are allowed to take lobsters using a maximum of two baited pots or by hand collection when diving to collect legal sized lobsters up to the bag or boat limit.

SUMMARY FEATURES 2017

Fishery Performance		Commercial	Recreational	
Total Catch 2016		6095 t	272-400 t (346-481 t based on updated average weight)	
Fishing Level		Acceptable	Acceptable	
Stock/Resource Performance		Stock Status	Assessment Indicators	
Western Rock Lobster		Sustainable - Adequate	Annual: Integrated Model, Egg Production	
EBFM Performance				
Asset	Level	Asset	Level	
Bycatch	Low Risk	Listed Species	Negligible Risk	
Habitat	Low Risk	Ecosystem	Low Risk	
Social	High Amenity Low Risk	Economic	GVP Level 5 (\$424 mill)- High Risk	
Governance	Review of Harvest Strategy	External Drivers	High Risk (climate)	

CATCH AND LANDINGS

The total landings of western rock lobster in 2016 from the WCRLMF were 6,508t. The commercial catch was 6095 t compared to a total allowable commercial catch of 6090 t (Total Allowable Commercial Catch [TACC] of 6000 plus drip loss). The commercial catch included an additional 8 t as part of a trial to provide lobster to the domestic market. The recreational catch was estimated to be between 272 and 481 t (depending on the average weight assumed) compared to the Total Allowable Recreational Catch (TARC) of 422 t (Western Rock Lobster Figure 1).



WESTERN ROCK LOBSTER FIGURE 1.

Total landings by fishery including the South Coast fishery (SCCMF) (and combined) for western rock lobster.

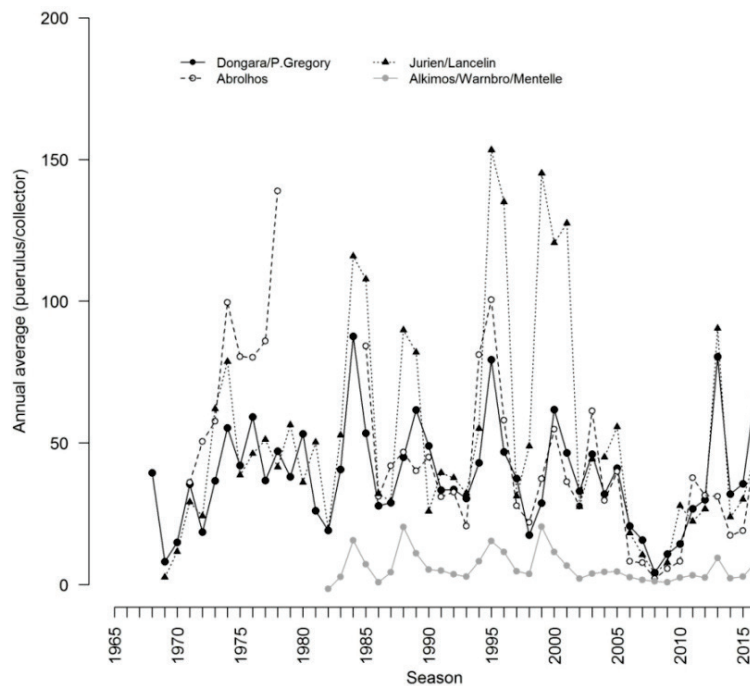
**INDICATOR SPECIES
ASSESSMENTS AND STOCK
STATUS**

Western rock lobster - (Sustainable-Adequate)

Commercial and recreational catch rates have been maintained near their record-high levels. Fishery-independent egg production indices at all sites are well above long-term levels and above threshold reference levels indicating that the biomass and egg production in all locations of the WCRLMF is at record-high levels since the mid-1970s. The breeding stock is therefore considered **sustainable-adequate**.

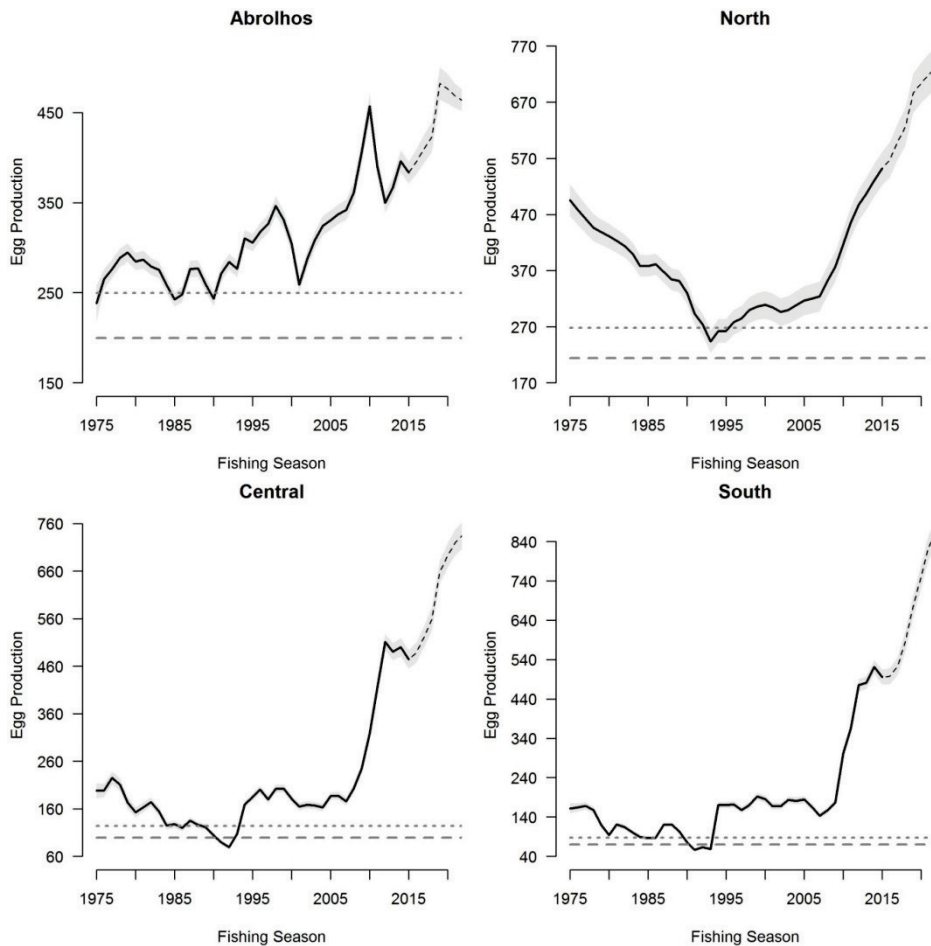
Fishery-independent recruitment (puerulus) monitoring indicates that the puerulus settlement improved in all areas during 2016/17 (Western Rock Lobster Figure 2).

The integrated population model indicates that a continuation of fishing at similar or slightly higher TACCs (e.g. 6300 t) over the coming five-year period will continue to result in increasing legal and spawning biomass and catch rates and reduced harvest rates (see de Lestang *et al.*, 2016 section 9.3.14 and Western Rock Lobster Figure 3).



WESTERN ROCK LOBSTER FIGURE 2.

Levels of puerulus settlement in four regions of the WCRLMF from 1968.



WESTERN ROCK LOBSTER FIGURE 3.

Modelled estimates (black) and projections (dotted line) of egg production for the four breeding stock management areas based on a TACC of 6400 t. 75% CI is denoted in grey. Horizontal lines represent the threshold (upper grey dotted) and limit (lower grey dashed) reference points for breeding stock levels in each breeding stock management area.

BYCATCH AND PROTECTED SPECIES INTERACTIONS

The main bycatch species landed in the WCRLMF are octopus, champagne crabs (CC) and baldchin grouper (BG). Octopus contribute most to total bycatch landings with 12.4 t in 2016 and only incidental landings of the other species being recorded (1.4 and 1.9 t for CC and BG, respectively). See Octopus and Deep Sea Crab reports for further information.

The WCRLMF may interact with a number of protected species with substantial improvements having been achieved during the past decade (see Bellchambers *et al.* (2017) section 4).

To mitigate the risk to juvenile Australian sea lions (ASL) all pots fished within designated sea lion areas are now fitted with devices to stop the accidental drowning of ASL. Since their implementation there have been no records of drowned ASL.

During the whale migration season (May – October inclusive) all pots must comply with mitigation measures aimed at reducing the entanglement of migrating whales (see Bellchambers *et al.* (2017) section 4). This has resulted in a significant (80%)

reduction in reported whale entanglements. There were four entanglements reported in 2016.

Turtles can also get caught in the float rigs of lobster pots. In 2016 no turtles were reported to have been entangled in lobster fishing gear.

HABITAT AND ECOSYSTEM INTERACTIONS

While WRL may use a range of habitats throughout their life-cycle, including shallow water reefs and adjacent seagrass beds as juveniles, or un-vegetated areas during their migratory phase (‘whites’), the algal covered limestone reefs form the habitat for the majority of the population.

WRL are an omnivorous generalist feeder, with a diet that consists on a variety of invertebrate, algae, carrion and bait. Results from monitoring in areas closed and open to WRL fishing, established to examine the potential ecosystem effects of WRL removal, suggest that lobsters do not play a keystone role in ecosystem functioning (see Bellchambers *et al.* (2017) section 6.2).

SOCIAL AND ECONOMIC OUTCOMES

Social

The WCRLMF is important for regional employment with 226 commercial vessels operating in 2016 with catch handled by four main processing establishments. The rock lobster fishery is also a major recreational activity and provides a significant social benefit to the Western Australian community with over 55,000 recreational fishers holding rock lobster licences in 2016. At current high stock levels there is **low risk** to this valuable social amenity.

Economic

The estimated average price across all processors and all zones of the WCRLMF received by commercial fishers for the western rock lobster in 2016 was \$69.65/kg. This was essentially the same as that paid in 2015 (the \$69.52/kg). The similar beach price with the same TACC resulted in the overall value of the WCRLMF remaining similar at \$424 million. As the majority of landed lobsters are exported to a single market (China) this represents a **moderate risk**.

GOVERNANCE SYSTEM

Allowable Catch Tolerance Levels

The landed commercial catch of 6095 t was very close to the TACC of 6090 t (including 1.5% for water loss and 8 t of domestic quota) and therefore the catch level was **acceptable**. The average of the estimate of recreational catch based on the higher average weight (413 t) was close to the TARC of 422 t for the 2015/16 season and was therefore also considered **acceptable**. The harvest control rules surrounding recreational catch are based on a five-year moving average (FYMA). Further work on the exact method by which to calculate and compare the FYMA to the TARC is currently being conducted.

Harvest Strategy

A common Harvest Strategy and Control Rules 2014-2019 (HSCR) (DoF, 2014) are used to set catch limits for both commercial and recreational sectors on an annual basis. The HSCR have a primary sustainability objective to maintain egg production at sustainable levels and a secondary economic objective to target maximising the profitability of the WCRLMF i.e. at Maximum Economic Yield (MEY) levels. The upper limit of the MEY assessment is currently used to determine the upper limit of the annual Total Allowable Catch (TAC) as this is the basis of setting the TARC.

Modelled future projections of the WCRLMF and MEY analysis indicates that a small (5 – 10%) increase in TAC will move the WCRLMF towards MEY and maintain healthy levels of egg production.

Compliance

The majority of enforcement effort is applied to ensure that fishers' catches are within their quota entitlement. There is also at-sea compliance to check that rock lobster gear is compliant with ASL and whale mitigation devices.

Consultation

Consultation occurs between the Department and the commercial sector either through the Western Rock Lobster Council or the Annual Management Meetings convened by the Western Australian Fishing Industry Council. Consultation with Recfishwest and other interested stakeholders is conducted through specific meetings and the Department's website.

Consultation with non-fisher stakeholders is undertaken in accordance with the Department's Stakeholder Engagement Guidelines.

Management Initiatives

Consultation with the commercial industry and Recfishwest on the review of the HSCR has begun. This process will aim to incorporate some of the outcomes from a recent FRDC project (Rogers *et al.* 2017) which examined the current TACC setting methodology. A TACC sub-committee of the Western Rock Lobster Council has recently been convened and this group will have direct input into the development of the new HSCR.

EXTERNAL DRIVERS

The variations in WRL recruitment to the fishery are largely a result of variable levels of puerulus settlement 3-4 year previously. Catches are also dependent upon the environmental conditions at the time of fishing. Investigation into the puerulus downturn in 2007-2009 have identified that when the spawning started early (water temperature driven) and was coupled with low numbers of winter storms during the larval phase, the puerulus settlement was significantly lower.

At a longer time scale, WRL have been rated a **high risk** to the effects of climate change as many aspects of its life history are highly sensitive to environmental conditions (Caputi *et al.*, 2010).

The economic performance of the WCRLMF is strongly affected by the value of the Australian dollar (affecting the price of lobsters), fuel and labour costs and status of the Chinese economy as China imports nearly all of the WRL.

REFERENCES

- Bellchambers LM, How J, Evans SN, Pember MB, de Lestang S and Caputi N. 2017. Ecological Assessment Report: Western Rock Lobster Resource of Western Australia Fisheries Research Report No. 279, Department of Fisheries, Western Australia. 92pp.
- Caputi N, Melville-Smith R, de Lestang S, Pearce P, and Feng M. 2010. The effect of climate change on the western rock lobster (*Panulirus cygnus*) fishery of Western Australia. *Canadian Journal of Fish and Aquatic Sciences*, 67, 85-96.
- de Lestang S, Caputi N, and How J. 2016. *Western Australian Marine Stewardship Council Report Series No. 9: Resource Assessment Report: Western Rock Lobster Resource of Western Australia*. Department of Fisheries, Western Australia.
- DOF. 2014. West Coast Rock Lobster Harvest Strategy and Control Rules 2014 – 2019. *Fisheries Management Paper*, no. 264.
- Rogers. P., de Lestang. S., How. J., Caputi, N., McLeod. P., Harrison. N. and McMath. J. 2017. Establishing a low risk incremental approach for setting TACCs (changing quotas) in the Western Rock Lobster Fishery, taking into account maximum economic yield and other objectives. FRDC Project No 2015-236
- Thompson A.P., Hanley J.R. and Johnson M.S. 1996. *Genetic structure of the western rock lobster, Panulirus cygnus, with the benefit of hindsight*. *Marine and Freshwater Research*, 47: 889–896.

WEST COAST ROE'S ABALONE RESOURCE STATUS REPORT 2017

L. Strain, J. Brown and S. Walters



OVERVIEW

The Roe's abalone (*Haliotis roei*) resource is accessed by both commercial and recreational sectors, and is a dive and wade fishery operating in shallow coastal waters along WA's western and southern coasts. The commercial Roe's abalone fishery is managed primarily through Total Allowable Commercial Catches (TACCs), which are set annually for each of the six management areas and allocated as Individually Transferable Quotas (ITQs).

The recreational fishery is divided into three zones: Zone 1 (Western Zone - including Perth metropolitan area), Zone 2 (Northern Zone) and Zone 3 (Southern Zone), with management arrangements that include a specific abalone recreational fishing licence, size limits, daily bag and possession limits, temporal and spatial closures, and a Total Allowable Recreational Catch (TARC) in the Western Zone. Further details on the fishery can be sourced from Hart *et al.* (2017).

SUMMARY FEATURES 2017

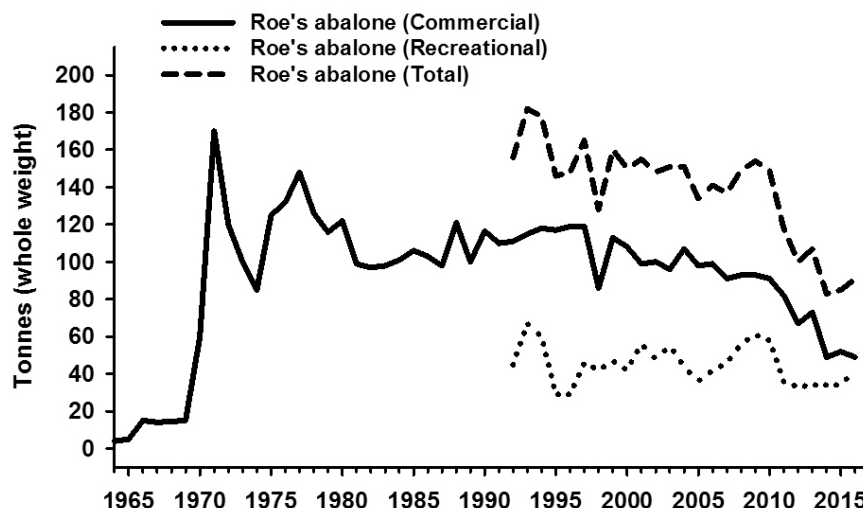
Fishery Performance		Commercial	Recreational	
Total Catch 2016		49 t	26–30 t Perth Metro Area; 14 t Other	
Fishing Level		Acceptable	Acceptable	
Stock/Resource Performance		Stock Status	Assessment Indicators	
Roe's abalone		Sustainable - Adequate (open areas)	Annual: Catch, Catch Rates, Surveys	
EBFM Performance				
Asset	Level	Asset	Level	
Bycatch	Negligible Risk	Listed Species	Negligible Risk	
Habitat	Negligible Risk	Ecosystem	Negligible Risk	
Social	High Amenity High Risk	Economic	GVP - \$1.17 mill High Risk	
Governance	TAC prediction model (Area 7 / Zone 1) MSC full assessment complete		External Drivers	High - Extreme Risk

CATCH AND LANDINGS

In 2016 the total commercial catch was 49 t whole weight, a 4% decrease from 2015 (51 t) and only 56% of the 87 t whole weight TACC set at the beginning of the season (Roe's Abalone Figure 1). The commercial catch was less than the TACC in Area 1 (0% caught), Area 2 (90% caught), Area 5 (37% caught) and Area 6 (12% caught), which was primarily driven by economic reasons (low value of catch and few viable markets), high cost of accessing these areas and prevailing weather conditions (Area 6). In Area 7 (Perth metropolitan fishery) only 23.5 t whole weight was caught due to a voluntary in-season TACC

reduction from 32 t to 24 t. This was done to bring the TACC in line with the stock prediction and allocation models for the Perth Metropolitan Roe's Abalone Fishery (DoF 2017).

The total recreational catch of Roe's abalone in 2016 was 42.2 t whole weight, which represents about 46% of the total Roe's abalone catch (Roe's Abalone Figure 1). The recreational catch includes 26–30 t (28.2 t) from the Perth metropolitan stocks, and an estimate of 14 t for the rest of the state (Western Zone excluding the Perth metropolitan stocks and Southern Zone) derived from a 2007 phone diary survey.



ROE'S ABALONE FIGURE 1.

Roe's abalone commercial and recreational catch (t, whole weight) by season as recorded against the nearest calendar year.

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Roe's abalone (Sustainable - Adequate for open areas)

The stock status is assessed using commercial and recreational catch and effort, and fishery-independent sampling. Trends in stock indicators were used to determine the 2016 TACC for each management area, and the TARC for Zone 1 of the recreational fishery.

Area 1 (near WA/SA border): There was no fishing in 2016. This area is a marginal part of the fishery in a remote location making it uneconomical for fishers given current market conditions.

Area 2 (Esperance): The catch in 2016 was 16.2 t whole weight of the 18 t TACC. The standardised catch per unit effort (SCPUE) has been gradually declining since 2010 until an increase in 2016, and is still above the threshold reference level.

Area 5 (Albany): The catch in 2016 was 7.5 t whole weight of the 20 t TACC. The SCPUE has been slightly lower than the historical trend in the last four years but has increased in the last two years and is still above the threshold reference level.

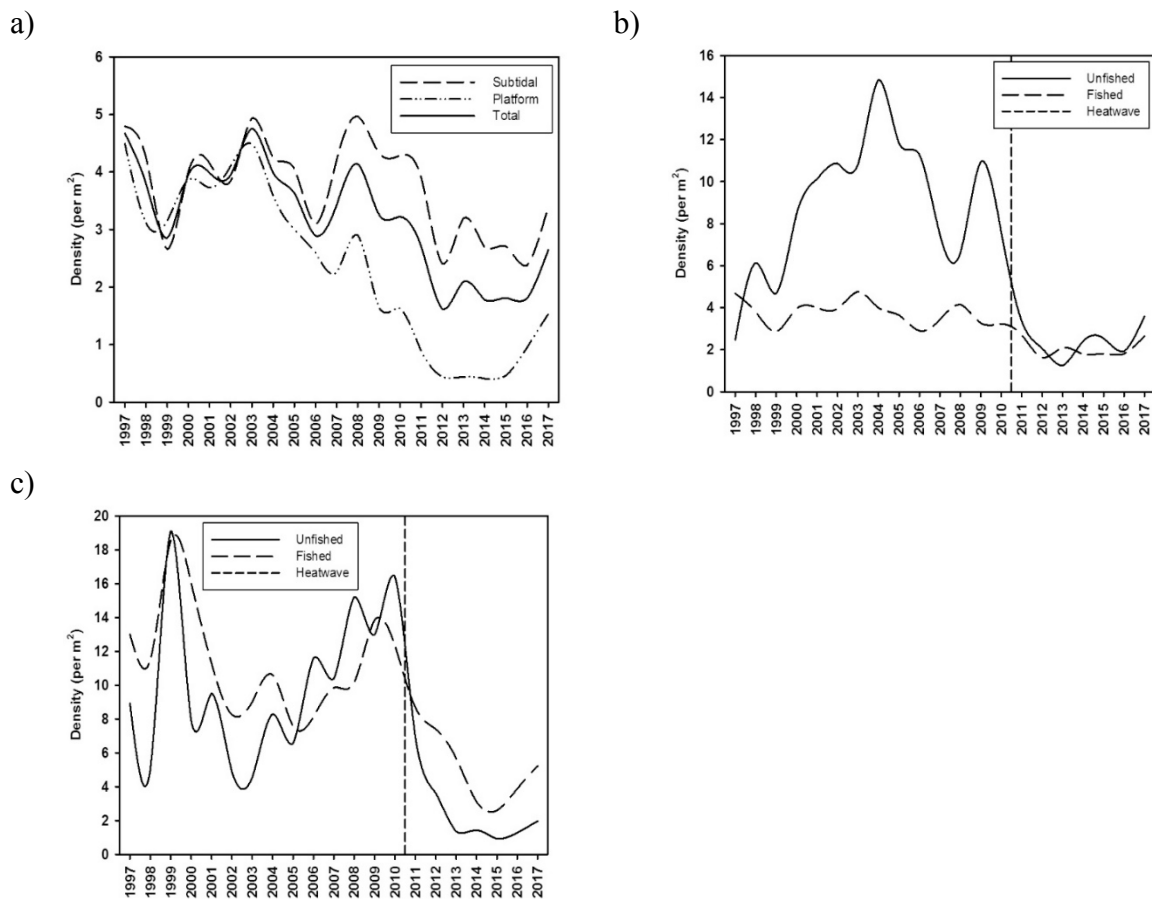
Area 6 (Capes): The catch in 2016 was 1.5 t whole weight of the 12 t TACC. The SCPUE in 2016 was above the threshold reference level and within the historical range, but due to the prevailing weather conditions resulting in low catch there is a degree of uncertainty around the SCPUE estimate.

Area 8 (Kalbarri): Closed since the 2011/12 season due to catastrophic mortality following the 2011 marine heatwave. With no evidence of natural recovery, a trial-scale restocking project was undertaken over several years but it has yet to be determined if restocking would be successful in the longer term (Strain *et al.* in press).

Perth Metropolitan Roe's Abalone Fishery

(Area 7 / Zone 1): The commercial catch in 2016 was 23.5 t of the 32 t TACC, due to an in-season voluntary reduction in the TACC from 32 t to 24 t. The SCPUE in Area 7 has declined since 2005 until a slight increase in the last two years. The SCPUE is above the threshold reference level and the TACC was set using the stock prediction model. The recreational catch estimate was 26 – 30 t (28.2 t) whole weight and has been managed to the 20 t (± 2 t) TARC for the last 6 years. The higher recreational catch was due to two anomalous factors: (1) a 10% increase in average weight of animals caught, (2) changes to the effort distribution as more people fished in areas outside of the historical high usage zones. These factors are not accounted for until the data are collated at the end of season but will be incorporated into next year's in-season catch prediction model.

Fishery-independent surveys indicate that the density of harvest-sized (commercial) Roe's abalone in both the subtidal and platform habitats, and across both fished and unfished areas experienced substantial declines between 2002 and 2012 (Roe's Abalone Figure 2a and b). The density of harvest-sized animals on the reef platform has increased in the last two years from the record-low levels during 2012-2015, while the density on the subtidal habitat is at the highest level since 2011. (Roe's Abalone Figure 2a). Importantly, this recent increase in density is present in both unfished and fished stocks, suggesting that favourable environmental conditions for growth may have returned (Roe's Abalone Figure 2b). Age 1+ (17 – 32 mm) animals have also shown an increase in density over the last two years, after the juvenile recruitment density declined by 80% between 2010 and 2013 (post marine heatwave), with 2015 being the lowest year on record (Roe's Abalone Figure 2c).



ROE'S ABALONE FIGURE 2.

Density of Roe's abalone in the Perth metropolitan fishery (Area 7/Zone 1) from fishery-independent surveys. a) Density of Roe's abalone (71 mm+) in the subtidal and platform fished areas, b) Density of Roe's abalone (71 mm+) in the fished and unfished areas, c) Density of Roe's Age 1+ abalone (17 – 32 mm) in the fished and unfished areas.

BYCATCH AND PROTECTED SPECIES INTERACTIONS

Divers have the ability to target abalone of choice (species, sizes and quality of abalone) and do not inadvertently harvest bycatch in their normal fishing activities. The only potential listed species interaction is with the white shark (*Carcharodon carcharias*), with some divers adopting the 'shark shield' technology. **Negligible** risk.

HABITAT AND ECOSYSTEM INTERACTIONS

The fishing activity makes minimal contact with the habitat, which typically consists of hard rock surfaces in a high wave energy environment. As abalone feed on drift algae, their removal is unlikely to result in any changes to the algal growth cover in fished areas, and hence it is considered unlikely that the fishery has any significant effect on the food chain in the region. **Negligible** risk.

SOCIAL AND ECONOMIC OUTCOMES

Social

There are 22 vessels commercially fishing for Roe's abalone, employing approximately 45 people across WA. The dispersed nature of the Roe's abalone fishery means that small coastal towns from Perth to Eucla receive income from the activity of divers. The recreational fishery provides a major social benefit to those members of the community that appreciate the abalone as a delicacy, and 18,002 licences were issued that would have allowed fishers to participate in the recreational abalone fishery. **High** risk.

Economic

Estimated annual value (to fishers) for 2016 was \$1.17 million, based on the estimated average price for Roe's abalone of \$23.81/kg whole weight. The price of Roe's abalone has dropped by over 50% since 2000, when it was \$55/kg whole weight. This is due to the value of the Australian dollar and wild caught Roe's abalone being in direct market competition with abalone produced by aquaculture. **High** risk.

GOVERNANCE SYSTEM

Annual Catch Tolerance Levels

Commercial – Acceptable: 87 t (TACC) (530 - 640 fishing days)

Recreational – Acceptable: 18–22 t (TARC) Perth metropolitan fishery only (Zone 1).

Low overall commercial catch was due to an in-season voluntary TACC reduction in Area 7 (Perth metropolitan fishery), plus economic and accessibility issues in Areas 1, 2, 5 and 6. The fishing effort (383 days) was also below the expected range. Area 8 is still closed due to the catastrophic mortality following a marine heatwave. Recreational catch was above the catch target partly due to larger size of abalone taken.

Harvest Strategy (Formal)

The harvest strategy (DoF 2017) uses SCPUE as a proxy for biomass as the key performance indicator, which are assessed against specified biological reference levels for each management area. The Perth metropolitan fishery (Area 7 / Zone 1) is managed using a stock prediction model with a temperature factor (DoF 2017). The predicted recruitment is used to set the Total Allowable Catch (TAC), with the habitat biomass and sectoral patterns of usage separating the TAC into TACC and TARC.

Compliance

The Department conducts regular inspections of commercial catch at both the point of landing and processing facilities to ensure the commercial industry is adhering to governing legislation. The recreational fishery, particularly the Perth metropolitan fishery, has a high level of enforcement given its high participation rate combined with restrictive season length and bag limit.

Consultation

The Department undertakes consultation directly with the Abalone Industry Association of Western Australia

(AIAWA), the West Coast Abalone Divers Association and licensees on operational issues. Annual Management Meetings are convened by the West Australian Fishing Industry Council (WAFIC), who are also responsible for statutory management plan consultation under a Service Level Agreement with the Department. Recreational consultation processes are facilitated by Recfishwest under a Service Level Agreement, although the Department undertakes direct consultation with the community on specific issues.

Consultation with non-fisher stakeholders is undertaken in accordance with the Department's Stakeholder Engagement Guidelines.

Management Initiatives (MSC Assessment)

Management arrangements for the Western Zone (Zone 1) of the recreational abalone fishery are currently under review.

The commercial Roe's abalone fishery has undergone full MSC assessment and achieved certification (<https://fisheries.msc.org/en/fisheries/western-australia-abalone-fishery/@@view>).

EXTERNAL DRIVERS

During the summer of 2010/11, the West Coast experienced a marine heatwave such that in the area north of Kalbarri (Area 8) mortalities on Roe's abalone were estimated at 99.9%, and a complete closure of the commercial and recreational fisheries was implemented. The heatwave also affected the Perth metropolitan stock but to a lesser extent.

Annual weather conditions during the time of fishing have a significant effect on catch rates and total catch of recreational fishers.

The small size of Roe's abalone results in its direct competition with hatchery-produced abalone and therefore, there has been a decline in beach price and overall economic value during the last decade.

High-Extreme risk.

REFERENCES

- DoF. 2017. Abalone Resource of Western Australia Harvest Strategy 2016 - 2021. *Fisheries Management Paper*, No. 283. Department of Fisheries, Western Australia, 36pp.
- Hart A, Strain L, Hesp A, Fisher E, Webster F, Brand-Gardner S, and Walters S. 2017. *Marine Stewardship Council Full Assessment Report Western Australian Abalone Managed Fishery*. Department of Fisheries, Western Australia, 288pp.
- Sandoval-Castillo J, Robinson N, Strain L, Hart A, and Beheregaray LB. 2015. *Use of next generation DNA technologies for revealing the genetic impact of fisheries restocking and ranching*. *Australian Seafood CRC Report*, No. 2012/714. Flinders University, Adelaide, 47pp.
- Strain LWS, Brown JM, and Hart AM. in press. *Recovering a collapsed abalone stock through translocation*. Seafood CRC Project No. 2011/762. Fisheries Research Report, No. xxx. Department of Fisheries, Western Australia, xxxpp.

WEST COAST BLUE SWIMMER CRAB RESOURCE STATUS REPORT 2017

D. Johnston, R. Marks and J. O'Malley



Overview

Blue swimmer crabs (*Portunus armatus*) are found in waters less than 50 m depth along the entire Western Australian coast. The commercial crab fisheries within the West Coast Bioregion are the Cockburn Sound Crab Managed Fishery, the Warnbro Sound Crab Managed Fishery, Area 1 (Swan-Canning Estuary), Area 2 (Peel-Harvey Estuary) and Area 3 (Hardy Inlet) of the West Coast Estuarine Managed Fishery and Area 1 (Comet Bay) and Area 2 (Mandurah to Bunbury) of the Mandurah to Bunbury Developing Crab Fishery. Commercial crab fishers currently use purpose-designed crab traps and gill nets. For more detailed descriptions of the crab fisheries see Johnston *et al.*, 2015a.

Blue swimmer crabs represent the most important recreationally-fished inshore species in the southwest of WA in terms of participation rate. Recreational crab fisheries are centred largely on the estuaries and coastal embayments from Geographe Bay to the Swan River and Cockburn Sound. Recreational fishers use either baited drop nets, scoop nets or diving. Management arrangements for the commercial and recreational fisheries include minimum size, protection of breeding females and seasonal closures with effort controls in place for the commercial fishery (Johnston *et al.* 2015a).

Both the commercial and recreational Peel-Harvey crab fisheries attained MSC Certification in 2016 (see Johnston *et al.*, 2015b for full details).

SUMMARY FEATURES 2017

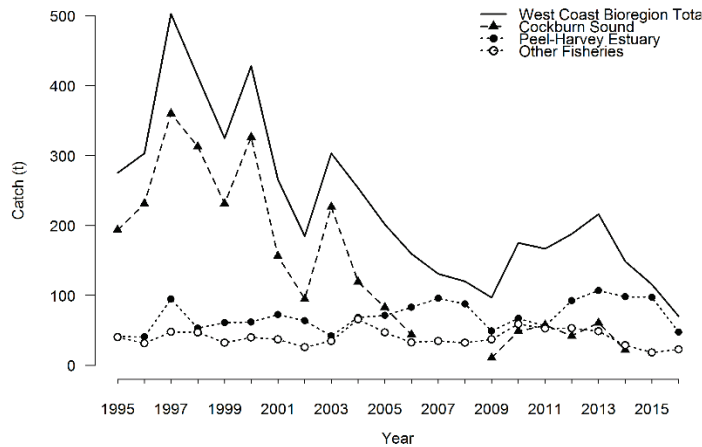
Fishery Performance	Commercial	Recreational	
Total Catch 2016	70 t	36–50 t (2015/16 boat-based only)	
Fishing Level	Cockburn Sound: Closed Peel-Harvey: Acceptable Other fisheries: Acceptable	Cockburn Sound: Closed Peel-Harvey: Acceptable Other fisheries: Acceptable	
Stock/Resource Performance	Stock Status	Assessment Indicators	
Cockburn Sound	Recovering	Level 4 Direct Survey	
Peel-Harvey	Sustainable – Adequate	Level 2 Catch Rates	
Other SW	Sustainable - Adequate	Level 2 Catch Rates	
EBFM Performance			
Asset	Level	Asset	Level
Bycatch	Negligible Risk	Listed Species	Negligible Risk
Habitat	Low Risk	Ecosystem	Low Risk
Social	High Amenity Moderate-High Risk	Economic	GVP Level 1 -<\$1m Moderate-High Risk
Governance	Management Review Underway	External Drivers	Moderate- High Risk

CATCH AND LANDINGS

Commercial Sector

The total commercial catch from the West Coast Bioregion in 2016 was the lowest in over 20 years at 70 t. This represents a 39% decrease on the 116 t taken in 2015 primarily due to the continued closure of

Cockburn Sound, cessation of fishing in Area 2 of the Mandurah to Bunbury Developing Crab Fishery, and reduced catch and effort in the Peel-Harvey Estuary (West Coast Blue Swimmer Crab Figure 1).



WEST COAST BLUE SWIMMER CRAB FIGURE 1

West Coast bioregion commercial catch history for the blue swimmer crab in Western Australia since 1995. Other fisheries include Warnbro Sound, Mandurah to Bunbury (Area 1 and 2), Swan River and Hardy Inlet.

Recreational Sector

The estimated boat-based recreational catch of blue swimmer crab in the West Coast represented 92% of the statewide boat-based recreational catch (kept by numbers) in 2015/16. The estimated boat-based recreational harvest range for blue swimmer crab in the West Coast was steady in 2015/16 (95% CI 36–50 tonnes) compared with 2013/14 (50–68), but lower than 2011/12 (75–97) (Ryan *et al.* 2017).

A previous (2008) comprehensive survey of recreational fishing in Peel-Harvey covering fishing from boats, shore, canals, and houseboats estimated the recreational catch to be between 107–193 t. This was lower compared to the recreational catch estimate of 251–377 t in 1998/99 (Johnston *et al.*, 2014). Additional recreational surveys have been conducted in Cockburn Sound, Warnbro Sound, Swan-Canning Estuary, Leschenault Inlet and Geographe Bay (see Johnston *et al.*, 2015a,b). A recent study on recreationally important fisheries Swan-Canning Estuary, Leschenault Estuary and Geographe Bay investigated breeding stock and recruitment levels and recreational fishing data from a recreational angler logbook program (Harris *et al.*, 2017).

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Cockburn Sound (Recovering)

Since the fishery was closed in 2014, a preliminary harvest strategy has been determined for the Cockburn Sound Crab Fishery where the primary performance

indicators are the juvenile abundance index and egg production index (Johnston *et al.*, 2015a,b). A weight-of-evidence approach is used for the stock assessment where the indices, in addition to commercial catch rates and the proportion of females in the commercial catch, are taken into account to assess stock status.

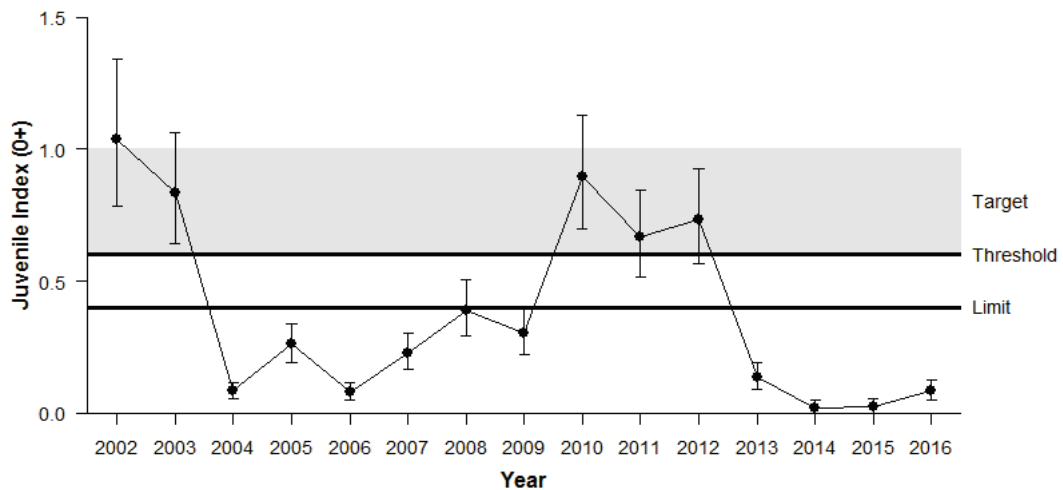
Juvenile index: The juvenile index for 2015 of 0.02 juveniles/100m² trawled was still below the limit of 0.4 juveniles/100m² trawled. The juvenile index for 2016 was a slight improvement but continues to be below the limit at 0.08 juveniles/100m² trawled (West Coast Blue Swimmer Crab Figure 2).

Egg Production index: The egg production index of 11.98 for 2016 was a significant increase from 2014 (4.0) and 2015 (2.8) and was at the harvest strategy threshold level of 12. Despite this increase in egg production, the 2017 juvenile recruitment index remained at a low level.

As commercial monitoring catch rates undertaken aboard a leased commercial vessel during the closure also improved during 2016, the status of the stock has been changed from Environmentally Limited to **Recovering** for the 2017/18 season.

As the 2015 egg production index and 2016 juvenile index were below their respective limit levels, the fishery remained closed for the 2016/17 season.

Potential reasons for the stock decline include combined effects of reduced levels of primary productivity within Cockburn Sound, changes in water temperature, increased predation and the negative effects of density-dependent growth which appears to have had an effect on the proportion of berried females. The declines in abundance are believed to be substantially attributable to environmental changes, rather than fishing.



WEST COAST BLUE SWIMMER CRAB FIGURE 2

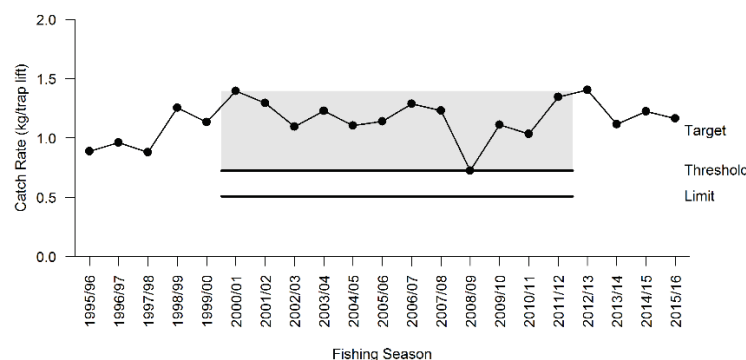
Annual standardised index of juvenile (0+) blue swimmer crabs in Cockburn Sound calculated using data from juvenile research trawls conducted in April, May and June of each year. The index units are numbers of juveniles/100m² trawled. The associated reference points (target, threshold and limit) for the preliminary harvest strategy and the 95% confidence intervals are shown.

Peel-Harvey Estuary (Sustainable-Adequate)

The commercial catch and effort from the Peel-Harvey Estuary for the 2015/16 fishing season was 58 t from 56,746 trap lifts which is a 40% reduction in catch and a 19% decrease in effort compared to the 2014/15 season.

Since the conversion from nets to traps in 2000/01 annual commercial catch rates have fluctuated between 0.8 and 1.7 kg/trap lift, but have generally remained above 1 kg/trap lift. The nominal annual catch rate for 2015/16 in the Peel-Harvey Estuary was 1 kg/trap lift.

The standardised catch rate of 1.2 kg/traplift for the 2015/16 fishing season was well above the harvest strategy threshold of 0.7 kg/traplift, indicating the stock is currently being fished at sustainable levels (West Coast Blue Swimmer Crab Figure 3). A weight-of-evidence approach is used for the stock assessment where information from fishery-independent surveys, commercial monitoring and environmental data are also taken into account to assess stock status. On the basis of this evidence, the crab stock in the Peel Harvey is classified as **Sustainable**.



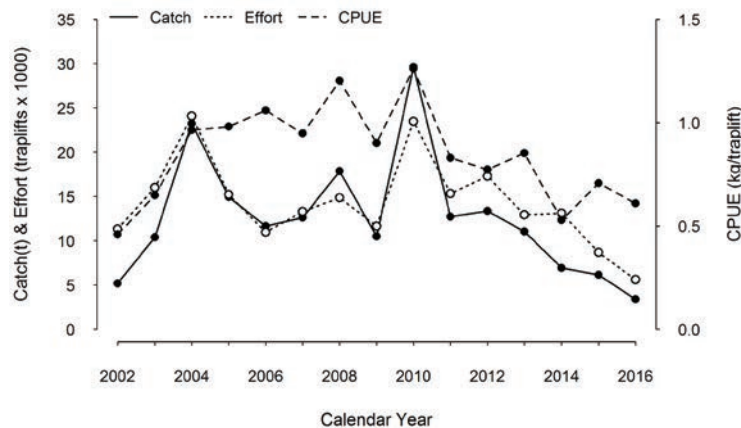
WEST COAST BLUE SWIMMER CRAB FIGURE 3.

Annual standardised commercial catch rate (kg/traplift) of blue swimmer crabs in the Peel-Harvey crab fishery relative to the associated reference points (target, threshold and limit) for the harvest strategy. The reference period is from 2000/01 to 2011/12; defined as the period where the fishery was operating with traps only and during which time the threshold (lowest historical catch rate), limit (30% below the lowest catch rate) and target (range between the threshold and highest historical catch rate) were set. Fishing season is defined as 1 November to 31 August.

Mandurah to Bunbury Developing Crab Fishery (Sustainable-Adequate)

The Mandurah to Bunbury Developing Crab Fishery (Area 1 and Area 2) reported a total annual catch and effort for 2016 of 3.4 t from 5,600 trap lifts, representing 44% and 36% decreases compared to 2015, primarily due to reduced fishing effort in Area 1 (West Coast Blue Swimmer Crab Figure 4). These

were the lowest catch and effort in over 15 years. The mean catch rate for 2016 of 0.6 kg/traplift was a 14% decrease on the 2015 catch rate of 0.7 kg/traplift (West Coast Blue Swimmer Crab Figure 4). However these catch rates are above the preliminary threshold levels that have been established. On the basis of this evidence, the crab stock in this region is classified as **Sustainable**.



WEST COAST BLUE SWIMMER CRAB FIGURE 4.

Blue swimmer crab trap catch (t), effort (traplifts x 1000) and catch per unit effort (kg/traplift) in Area 1 and Area 2 of the Mandurah to Bunbury Developing Crab Fishery since 2002.

BYCATCH and PROTECTED SPECIES INTERACTIONS

Crab traps are purpose-designed to minimise the capture of non-target species and are therefore an inefficient way to capture fish. The low number of fish caught and returned poses a **negligible risk** to these stocks.

The crab trap longline system is conducted in a manner that avoids mortality of, or injuries to, endangered, threatened or protected species and avoids or minimises impacts on threatened ecological communities and are therefore considered a **low risk**.

HABITAT and ECOSYSTEM INTERACTIONS

Retrieval of traps may result in minor dragging across the mostly sandy substrate. The small amount of living seagrass removed, results in minimal habitat damage and hence trapping poses a **low risk** to benthic habitats. The potential impacts of wading on near shore habitats by the recreational fishers who scoop net in the Peel-Harvey Estuary is currently being assessed.

As the commercial take of crabs represents a relatively small portion of the biomass, which is effectively renewed annually and subject to high levels of natural variation in abundance, secondary food chain effects are likely to be minimal. These crab fisheries are a **low risk** to the ecosystem.

SOCIAL AND ECONOMIC OUTCOMES

Social

West Coast blue swimmer crab fisheries provide a **high social amenity** to recreational fishing and diving and to consumers via commercial crab supply to markets and restaurants. During 2016, approximately 20 people were employed as skippers and crew on vessels targeting blue swimmer crabs in the West Coast Bioregion. Blue swimmer crabs provide a highly popular recreational fishery, particularly in the Swan River, Cockburn Sound, Warnbro Sound, the Peel-Harvey Estuary and the Geographe Bay region, where they dominate the inshore recreational catch. They are the highest captured (by number) recreational species. **Moderate-High risk**.

Economic

The commercial blue swimmer crab catch in the West Coast Bioregion for 2016 had an estimated gross value of production (GVP) of approximately \$0.38 million, a decrease on the \$0.62 million in 2015 (**level 1** <\$1 million). Most of the catch from the West Coast Bioregion was sold through local markets. Price data was generated by collecting monthly returns recording prices paid to fishers by fish processors. A weighted average price is then calculated for the financial year from the monthly data and for 2016 was \$5.41 per kg. **Moderate-High risk**.

GOVERNANCE SYSTEM

Allowable Catch Tolerance Levels

Cockburn Sound: Under review

Peel Harvey: 45 - 107 tonnes

Other West Coast fisheries: Under review

A catch range for Cockburn Sound crabs will need to be developed when the management arrangements and stock levels have stabilised. The acceptable catch range for Peel Harvey is based on the last 10 years of catch values. The other west coast crab fisheries are yet to develop a sufficiently stable catch history or set of management arrangements to develop a definitive catch range.

Harvest Strategy

Cockburn Sound: Closed

A preliminary harvest strategy has been determined for the Cockburn Sound Crab Fishery where the primary performance indicators are the juvenile index and egg production index.

As the 2015 egg production index and 2016 juvenile index were below their respective limit levels, the fishery remained closed for the 2016/17 season.

Peel Harvey:

A harvest strategy has been determined for the Peel-Harvey Crab Fishery (Johnston *et al.*, 2015b) where the primary performance indicator is standardised annual commercial catch rate with the reference period between 2000/01 and 2011/12.

As the indicator was above the threshold for 2015/16, no management changes occurred for the 2016/17 season.

Other West Coast fisheries:

A preliminary harvest strategy has been determined for Area 1 and Area 2 of the Mandurah to Bunbury Developing Crab Fishery where the primary performance indicator is nominal annual commercial catch rate using the reference period for Area 1 Comet Bay between 2006 and 2012, and for Area 2 Mandurah-Bunbury between 2004 and 2012.

As the indicators were above the threshold in 2016 (Area 1 Comet Bay ≤ 0.53 kg/trap lift and Area 2 Mandurah-Bunbury ≤ 1.22 kg/traplift), no changes to the management occurred for the 2017 season.

Compliance

Current risks to enforcement are low for West Coast crab fisheries. However, the Peel-Harvey Estuary has a high level of enforcement risk in the recreational fishery as it has the highest level of non-compliance in the State, particularly for undersize crabs being taken and during night-time periods.

Consultation

The Department undertakes consultation directly with licensees on operational issues and processes and is responsible for the statutory management plan consultation. Industry Annual Management Meetings are convened by the Western Australian Fishing Industry Council (WAFIC), who are also responsible for statutory management plan consultation under a Service Level Agreement with the Department.

Consultation processes are now facilitated by Recfishwest under a Service Level Agreement although the Department undertakes direct consultation with the community on specific issues.

Consultation with non-fisher stakeholders is undertaken in accordance with the Department's Stakeholder Engagement Guidelines.

Management Initiatives

A south-west blue swimmer crab resource management review is being undertaken during 2017/18 with the aim of increasing efficiency and consistency of management across the entire resource. As a consequence of periodic environmental impacts on the resource, there is likely a need to provide a greater buffer to female breeding stock. Potential options include extending or introducing season closures and increasing minimum size.

EXTERNAL DRIVERS

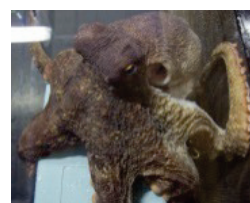
Levels of recruitment to many of the crab fisheries fluctuate considerably mainly due to environmental influences (e.g. water temperature) both on spawning success and larval survival through to recruitment. Temperature appears to be an important factor contributing to the decline of the Cockburn Sound Crab Fishery. The level and timing of rainfall may also affect the Peel-Harvey and Swan River fisheries. The effect of the marine heat wave in the summer of 2010/11 and above average water temperatures on the following two summers on the spawning and juvenile phase of the crabs is being investigated for Cockburn Sound (and adjacent coastal areas), as well as the cause of the low proportion of berried females in the 2012/13. Although these temperature changes have also resulted in the increased abundance of blue swimmer crabs in the South Coast estuaries, on the West Coast this species is rated as having a **high** risk to climate change.

REFERENCES

- Harris, D.C., Johnston, D.J., Baker, J.D. and Foster, M. 2017. Adopting a Citizen Science approach to develop cost-efficient methods that will deliver annual information for managing small-scale recreational fisheries: The Southwest Recreational Crabbing Project. Fisheries Research Report No. 281, Department of Fisheries, Western Australia. 121pp.
- Johnston, D., Chandrapavan, A., Wise, B. and Caputi N. 2014. Assessment of blue swimmer crab recruitment and breeding stock levels in the Peel-Harvey Estuary and status of the Mandurah to Bunbury developing crab fishery. Fisheries Research Report No. 258.
- Johnston, D, Evans, R, Foster, M, Oliver, R, and Blay, N. 2015a, West Coast Blue Swimmer Crab Fishery Status Report, in WJ Fletcher and Santoro, K. (eds), *Status reports of the fisheries and aquatic resources of Western Australia 2014/15: the state of the fisheries*, Western Australian Department of Fisheries, 62–70.
- Johnston, DJ, Smith, KA, Brown, JI, Travaille, KL, Crowe, F, Oliver, RK & Fisher, EA. 2015b. Western Australian Marine Stewardship Council Report Series No 3: West Coast Estuarine Managed Fishery (Area 2: Peel-Harvey) & Peel-Harvey Estuary Blue Swimmer Crab Recreational Fishery. Department of Fisheries, Western Australia. 284 pp.
- Ryan KL, Hall NG, Lai EK, Smallwood CB, Taylor SM, Wise BS 2017. Statewide survey of boat-based recreational fishing in Western Australia 2015/16. Fisheries Research Report No. 287, Department of Primary Industries and Regional Development, Western Australia.

WEST COAST OCTOPUS RESOURCE STATUS REPORT 2017

A. Hart, D. Murphy, M. Yerman



OVERVIEW

The octopus fishery in Western Australia targets the gloomy octopus (*Octopus tetricus*). Commercial octopus catch is harvested from three different fisheries with the majority of commercial catch coming from the Octopus Interim Managed Fishery (OIMF). The primary harvest method in the OIMF is a ‘trigger trap’. Unbaited or passive (shelter) pots are also used and

octopus are also caught as by-product by rock lobster pots. Commercial management arrangements include input controls on the total allowable number of pots/traps permitted in each spatial management zone. More details will become available in the octopus Resource Assessment Report (in prep).

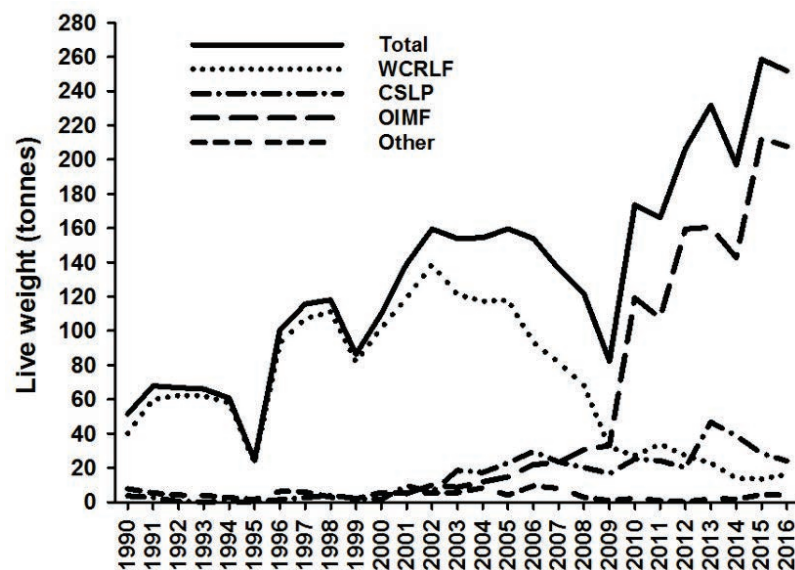
SUMMARY FEATURES 2017

Fishery Performance	Commercial	Recreational	
Total Catch 2016	252 t	2 t (2015/16 boat-based only)	
Fishing Level	Acceptable	Acceptable	
Stock/Resource Performance	Stock Status	Assessment Indicators	
Gloomy Octopus	Sustainable - Adequate	Annual: Catch, CPUE	
EBFM Performance			
Asset	Level	Asset	Level
Bycatch	Low Risk	Listed Species	Low Risk
Habitat	Low Risk	Ecosystem	Low Risk
Social	Low Amenity Low Risk	Economic	GVP Level 2 (\$2.1 mill) Low Risk
Governance	New Management Plan	External Driver	Low Risk

CATCH AND LANDINGS

In 2016 the total commercial octopus catch was 252 t live weight, which was a 3% decrease over last year's record high catch of 259 t¹ (Octopus Figure 1). The recreational catch by boat-based fishers at both the state-wide and bioregional levels estimated the total

number of octopus captured during 2015/16 for all bioregions was 2,800 (92% in the West Coast Bioregion), which equates to a total weight of 2.0 tonnes (Ryan *et al.* 2017).



OCTOPUS FIGURE 1.

Commercial catch (t) of *Octopus tetricus* in Western Australia since 1990. WCRLF (West Coast Rock Lobster Managed Fishery), CSLP (Cockburn Sound Line and Pot Managed Fishery), OIMF (Octopus Interim Managed Fishery) and Other, which is bycatch from trawl and miscellaneous pot fisheries.

¹ This figure has been revised down from the 274 t reported last year.

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Gloomy octopus (Sustainable-Adequate)

Octopus tetricus was subject to a recent comprehensive stock assessment which looked at biology, fishing efficiency and stock abundance and distribution (Hart *et al.* 2016). The overall conclusion was that the stock is highly productive, with an average maximum age of 1.5 years, as well as abundant and widely distributed along the West and South Coast of Western Australia. The estimated area of fished habitat in 2016 was 460 km², similar to 2015 when it was 507 km². This area was only a minor percentage (~2%) of the total estimated habitat area of >30,000 km² (Hart *et al.* 2016). The current catch of 252 t is considerably lower than the estimate of sustainable harvest derived by Hart *et al.* (2016), which was in the range of 800 – 2200 tonnes. Consequently, the breeding stock is considered to be **adequate**.

BYCATCH AND PROTECTED SPECIES INTERACTIONS

The selective method of fishing used results in a minimal level of bycatch of other species. In 2016 there were no reported entanglements with whales. This compares favourably with 2015 and 2014 when there were two reported whale entanglements in octopus fishing gear. Fishers have adopted gear changes to mitigate entanglements, which includes setting pots on longlines, and using weighted ropes that hang vertically in the water column. **Low risk**.

HABITAT AND ECOSYSTEM INTERACTIONS

Habitat effects

In the CSLPMF and OIMF, octopus-specific pots are set in similar habitats to those fished in the WCRLMF, as well as sandy and seagrass areas, particularly in Cockburn Sound. These are not expected to impact on benthic habitats as the soak times are at long intervals, averaging 12 days in the OIMF and 15-20 days in the CSLPMF. Rock lobster potting in the WCRLMF occurs primarily on sand areas around robust limestone reef habitats covered with coralline and macro-algae, and these habitats are considered resistant to lobster potting due to the hard nature of the bottom substrate (see WCRLMF report for full details). **Low Risk**.

Food chain effects

This fishery harvests only a small amount of octopus per annum. The effect from this harvesting on the rest of the ecosystem, given that the catch is spread over a wide region, is likely to be **insignificant**.

SOCIAL AND ECONOMIC OUTCOMES

Social

Each dedicated octopus fishing vessel employs between 2 and 4 people. In 2016, ~ 200 vessels caught octopus, although the vast majority of these landings were small (< 100 kg), as they were bycatch in the WCRLMF. Within the octopus specific fisheries, 4 vessels fished in the CSLPMF, and 16 (includes 1 vessel operating under Condition 20) vessels in the OIMF. There is also a substantial processing and value-added component to the octopus catch with factories in Fremantle and Geraldton. **Low Risk**.

Economic

The estimated annual value for 2016 was \$2.1 million based on the total catch of 252 t and an average product price of \$8.29 /kg live weight. **Low Risk**.

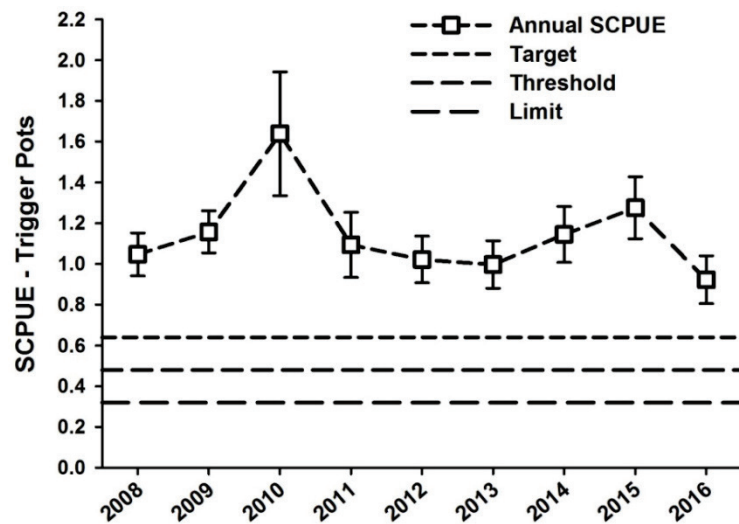
GOVERNANCE SYSTEM

Annual Catch Tolerance Range (Acceptable)

The target catch range for octopus is 200-500 t. The 2016 catch of 252 t was within the acceptable range.

Harvest Strategy

The harvest strategy and catch range was reviewed in 2016 to reflect increased knowledge of sustainable harvest levels. Fishery is in a planned expansion phase. The main performance indicator for the proposed new harvest strategy will be a standardised catch per unit effort (SCPUE) in kg/pot lift, which accounts for environmental and efficiency changes in the fishery. Draft Target, Threshold, and Limit reference points have been proposed, and the fishery is currently above the target level (Octopus Figure 2).



OCTOPUS FIGURE 2.

Standardised catch per unit effort (SCPUE) ($\pm 95\%$ CL) in kg / pot (kg in live weight) of *Octopus tetricus*. Proposed biological reference points (Target, Threshold, Limit) are also given.

Compliance

There are no significant issues but it is important to highlight the importance of timely logbook data from fishers to reflect current status of the fishery.

Consultation

The Department undertakes consultation directly with licensees on operational issues. Industry Annual Management Meetings are convened by the Western Australian Fishing Industry Council (WAFIC), who are also responsible for statutory management plan consultation under a Service Level Agreement with the Department.

Consultation processes are now facilitated by Recfishwest under a Service Level Agreement with the Department, although the Department undertakes direct consultation with the community on specific issues.

Consultation with non-fisher stakeholders is undertaken in accordance with the Department's Stakeholder Engagement Guidelines.

Management Initiatives (New Management Plan)

The Department has developed formal management arrangements for the OIMF. Following the conclusion of an independent panel process on access and

allocation, an Interim Management Plan for the OIMF was gazetted in 2015.

The Cockburn Sound (Line and Pot) Managed Fishery Management Plan (Plan) 1995 was reviewed following the Minister for Fisheries' decision on octopus pot entitlement allocation in the CSLPMF. Amendments to the Plan were made on 1 May 2015 to introduce an octopus pot scheme of entitlement which is now in effect.

EXTERNAL DRIVERS

Cephalopods in general, including octopus, are known to be subject to large environmentally-driven fluctuations in abundance. Octopus was rated as a **low risk** to climate change.

The move of the rock lobster fishery from an effort-controlled fishery to a catch quota fishery, coupled with significant effort reductions, will ensure the octopus catch in the WCRLMF remains a low proportion of the overall catch.

REFERENCES

- Hart AM, Leporati SC, Marriott RJ, and Murphy D. 2016. Innovative development of the Octopus (cf) tetricus fishery in Western Australia. FRDC Project No 2010/200. *Fisheries Research Report*, No. 270. Department of Fisheries, Western Australia. 120pp.
- Ryan KL, Hall NG, Lai EK, Smallwood CB, Taylor SM, Wise BS 2017. Statewide survey of boat-based recreational fishing in Western Australia 2015/16. *Fisheries Research Report* No. 287, Department of Primary Industries and Regional Development, Western Australia.

WEST COAST NEARSHORE AND ESTUARINE FINFISH RESOURCE STATUS REPORT 2017



K. Smith, M. Holtz, E. Bunbury, J. O'Malley and M. Yerman

OVERVIEW

In the West Coast Bioregion (WCB) nearshore and estuarine finfish are targeted by beach-based fishers and boat-based fishers operating in shallow water. The main recreational method is line fishing. The main commercial methods are haul, beach seine and gill netting. Fishery landings of nearshore species include western Australian salmon (*Arripis truttaceus*), Australian herring (*Arripis georgianus*), southern school whiting (*Sillago bassensis*), yellowfin whiting (*Sillago schomburgkii*), yelloweye mullet (*Aldrichetta forsteri*), whitebait (*Hyperlophus vittatus*), tailor (*Pomatomus saltatrix*), southern garfish (*Hyporhamphus melanochir*), silver trevally (*Pseudocaranx georgianus*) and King George whiting

(*Sillaginodes punctatus*). Landings of estuarine finfish are mainly sea mullet (*Mugil cephalus*), estuary cobbler (*Cnidogobius macrocephalus*) and black bream (*Acanthopagrus butcheri*).

Six commercial fisheries target nearshore and/or estuarine finfish in the WCB. Four estuaries are open to commercial fishing. The Peel-Harvey Estuary commercial fishery (Area 2 of the West Coast Estuarine Managed Fishery) received Marine Stewardship Council (MSC) certification for sea mullet (and blue swimmer crabs) in June 2016 (see Department of Fisheries 2015, Johnston *et al.* 2015 for full details).

SUMMARY FEATURES 2017

Fishery Performance		Commercial	Recreational
Total Catch 2016		380 t	58–77 t (2015/16 boat-based only)
Fishing Level		Acceptable	Acceptable
Stock/Resource Performance		Stock Status	Assessment Indicators
Nearshore		Inadequate (Herring, garfish)	Annual: Catch, Catch Rate; Periodic: Fishing mortality, SPR
Estuarine		Adequate (sea mullet)	Annual: Catch, Catch Rate
EBFM Performance			
Asset	Level	Asset	Level
Bycatch	Low Risk	Listed Species	Negligible Risk
Habitat	Negligible Risk	Ecosystem	Moderate Risk (from fishing)
Social	High Amenity	Economic	GVP Level 1 (<\$1 mill)
	Moderate Risk		Low Risk
Governance	Harvest strategy for herring under development	External Drivers	High Risk (habitat degradation, climate change)

CATCH AND LANDINGS

In 2016, the total commercial catch of nearshore and estuarine finfish in the WCB was 380 t, comprising 236 t from ocean waters and 144 t from estuaries (Nearshore and Estuarine Finfish Table 1). The commercial catch was taken predominantly by six fisheries: West Coast Estuarine Managed Fishery, South West Coast Salmon Managed Fishery, South West Beach Seine Fishery, West Coast Demersal Scalefish Managed Fishery, Cockburn Sound (Fish Net) Managed Fishery and the West Coast Beach Bait Managed Fishery.

The total recreational shore-based catch was not estimated but is believed to represent a significant proportion of the overall catches of nearshore and estuarine species. The top 10 nearshore and estuarine species (or species groupings) in the West Coast represented 93% of the total boat-based recreational catch (kept by numbers) in 2015/16. The estimated boat-based recreational harvest range for the top 10 nearshore and estuarine species in the West Coast was steady in 2015/16 compared with estimates from previous statewide surveys (95% CI 58–77 tonnes compared with 68–87 in 2013/14, but lower than 101–126 in 2011/12) (Ryan *et al.* 2017).

NEARSHORE AND ESTUARINE FINFISH TABLE 1.

Total catches (tonnes) of finfish in commercial fisheries in nearshore and estuarine waters in West Coast Bioregion in previous five years. (*Calendar year 2011/12, 2012/13 etc)

Common name	Scientific name	2012	2013	2014	2015	2016
Sea mullet	<i>Mugil cephalus</i>	103.7	100.1	123.4	143.4	138.4
Western Australian salmon	<i>Arripis truttaceus</i>	47.1	92.7	60.1	37.9	98.0
Australian herring	<i>Arripis georgianus</i>	28.5	47.1	46.6	49.0	61.7
White bait	<i>Hyperlophus vittatus</i>	65.7 (83)*	18.6 (12)*	63.5 (13)*	61.2 (97)*	16.3 (34)*
Yellowfin whiting	<i>Sillago schombergkii</i>	18.4	24.1	36.6	46.5	31.8
Yelloweye mullet	<i>Aldrichetta forsteri</i>	22.6	18.6	19.8	6.3	12.5
Tailor	<i>Pomatomus saltatrix</i>	9.0	14.2	10.5	9.8	3.0
Southern garfish	<i>Hyporhamphus melanochir</i>	5.8	4.3	4.8	2.4	2.4
Perth herring	<i>Nematalosa vlaminghii</i>	1.0	1.5	2.5	2.5	3.0
Trevallies	<i>Pseudocaranx</i> spp.	2.3	2.8	2.2	1.7	1.2
Estuary cobbler	<i>Cnidoglanis macrocephalus</i>	5.2	1.8	0.2	1.3	1.2
King George whiting	<i>Sillaginodes punctatus</i>	3.7	2.0	0.9	0.8	1.1
Black bream	<i>Acanthopagrus butcheri</i>	1.4	1.3	0.8	1.1	3.6
Other finfish		10.9	17.1	6.4	6.8	5.7
Total		325.4	346.4	378.4	370.8	380.1

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

The status of each stock is assessed using a weight-of-evidence approach that considers all available information about the stock. For level 3 assessments, performance indicators include both spawning potential ratio (SPR) and fishing mortality (F).

Sea mullet (Sustainable-Adequate)

In the WCB, the majority (~60% p.a.) of commercial landings are taken in the Peel-Harvey Estuary. Recent commercial landings are low compared to historical levels due to effort reductions. Since 2000, landings have been relatively stable and ranged from 77 t (in 2011) to 143 t (in 2015) (Table 1). The boat-based recreational catch is estimated to be <1 t (Ryan *et al.* 2017) and, while the current recreational shore-based catch is not known, it is believed to be low.

A level 3 assessment of the WCB stock is underway. Until this assessment is completed, the main performance indicator is the Peel-Harvey standardised commercial catch rate. The catch rate has been stable since the 1970s, suggesting a relatively stable WCB stock level over a long period. On the basis of this evidence, the sea mullet stock in this region is classified as **sustainable-adequate**.

Yellowfin whiting (Sustainable-Adequate)

In 2016, the total commercial catch of the southern stock was 37 t. The majority (>95%) of commercial landings of the southern stock occur in the WCB. The West Coast Estuarine Managed Fishery (WCEMF) takes ≥70% of these landings each year, with the South West Beach Seine Fishery contributing significant amounts in some years. The commercial catch in the Peel-Harvey Estuary (i.e. Area 2 of the WCEMF) rapidly increased in 2012 to 30 t in 2015 in response to strong recruitment. The Peel-Harvey catch fell to 20 t in 2016.

The total recreational catch is unknown due to lack of information about the shore-based sector which is believed to take almost all recreational landings of this species (Brown *et al.* 2013). Anecdotal reports suggest a recent increase in the recreational catch also occurred in the Peel-Harvey region. The boat-based recreational catch is estimated to be very low (<1 t) (Ryan *et al.* 2017).

A level 3 assessment based on age structure data collected in 2015 and 2016 confirmed that the higher catches in recent years are due to strong recruitment (Department of Primary Industries and Regional Development, in prep 1). Catches in both sectors are now declining and returning to more typical levels as the influence of the recruitment event wanes. Currently, SPR is estimated to be above the threshold level (30%). On the basis of this evidence, the

yellowfin whiting stock in this Bioregion is classified as **sustainable-adequate**.

King George whiting (Sustainable-Adequate)

In WA, the majority of landings are taken recreationally. The current shore-based recreational catch is unknown, but likely to be smaller than the boat-based recreational catch (Brown *et al.* 2013). The estimated boat-based recreational harvest range for King George whiting in the West Coast was steady in 2015/16 (95% CI 8–15 tonnes compared with 9–18 in 2013/14 and 11–20 in 2011/12) (Ryan *et al.* 2017). In those years, the total commercial catch was 15 t and 14 t, respectively. In 2016, the total commercial catch was 19 t. The catch level can fluctuate markedly in response to recruitment variations.

A level 3 assessment in 2010–2012 indicated that F was moderate in inshore waters where juveniles occur, but low in offshore waters where adults occur (Fisher *et al.* 2014). SPR was estimated to be around the target level of 40%. The total catch (commercial plus recreational) in 2015 is likely to be higher than in 2010–2012, due to recruitment variations, but still within the historical range. On the basis of this evidence, the King George whiting breeding stock is classified as **sustainable-adequate**.

Australian herring (Sustainable-Recovering)

The species is caught by commercial and recreational fisheries in WA and South Australia, with negligible quantities also taken in Victoria (Smith *et al.* 2013a).

In 2016, the total WA commercial catch was 83 t (Nearshore and Estuarine Finfish Figure 1). The South Coast Estuarine Managed Fishery, Cockburn Sound (Fish Net) Managed Fishery and South West Beach Seine Fishery reported most of the commercial catches in 2016. The estimated boat-based recreational harvest range for Australian herring in the SCB was steady in 2015/16 (95% CI 8–14 tonnes) compared with 2011/13 (10–15), but lower than 2011/12 (21–31) (Ryan *et al.* 2017). The current shore-based recreational catch is unknown. Partial estimates of shore-based catch are available for the Perth area, April–June only (Smallwood *et al.* 2012). The April–June catch has progressively declined from 22 t in 2010 to 6 t in 2016.

SPR is the key indicator of stock status. SPR was estimated to be below the limit reference level of 20% in the most recent assessment, based on data collected in 2013/14 and 2014/15. SPR has been below 20% since 2009/10. A recovery plan has been implemented for this stock. On this basis, the Australian herring stock is classified as **sustainable-recovering**.

Southern garfish (Perth metropolitan zone) (Inadequate)

Southern garfish ranges across southern Australia from WA (Lancelin) to New South Wales (Eden). Population structure is complex. Semi-discrete populations can arise over small distances (<60 km)

due to the low rates of movement/dispersal by individual fish (Smith *et al.* 2016). In the WCB, the main fishing area is the Perth metropolitan zone, particularly Cockburn Sound. Garfish in this area are likely to have limited connectivity with populations further south (e.g. in Geographe Bay).

Total commercial landings in the WCB peaked at 44 t in 1999 and then steadily declined, reaching an historical low of 2 t in 2015. The catch remained at 2 t in 2016. Partial estimates of shore-based recreational catch are available for the Perth area, April–June only. The April–June catch was estimated to be >5 t in 2010, but <0.5 t in subsequent years (Smallwood *et al.* 2012). In the WCB, the total boat-based recreational catch was estimated to be 2–5 t per year in 2005/06, 2008/09 and 2009/10. The estimated boat-based recreational catch of southern garfish was steady in 2015/16 (1,994 kept by number, SE=992) compared with 2013/14 (1,636, SE=673) and 2011/12 (16,340, SE=3,477) (Ryan *et al.* 2017, Smith *et al.* 2016).

Commercial catch rates have been declining since 1996 (Nearshore and Estuarine Finfish Figure 1).

Recreational catch rates recorded in voluntary fishing logbooks follow a similar downward trend. The trends suggest a substantial decline in stock level since the late 1990s. SPR declined from 40% in 1998 to approximately 20% in 2010/11 (Smith *et al.* 2016). The current spawning biomass is likely to be below 20% of the unfished level, which is the limit reference level, and therefore the southern garfish stock in this region is classified as **unsustainable-inadequate**.

Whitebait (Unsustainable-Inadequate)

Since 2003/04, virtually all commercial landings have been reported in the Bunbury area by the South West Beach Seine Fishery. Landings followed a relatively stable trend (i.e. non-directional) from the late 1980s until 2009/10. Since then, relatively low catches have been reported that are likely due to low stock abundance. Whitebait has a lifespan of only 3–4 years, and so catches are likely to be strongly driven by recruitment variability. The 2011 heatwave event along the west coast appears to have resulted in reduced spawning success in winter 2011, followed by exceptionally low catches and catch rates in 2012/13 and 2013/14 (Nearshore and Estuarine Finfish Table 1). The total catch was 34 t in 2015/16. Standardised catch rates in three of the last five years were the lowest since the early 1980s (Nearshore and Estuarine Finfish Figure 2). The evidence suggests that the stock is **unsustainable-inadequate**. The contracted distribution and apparent heatwave impacts also suggest environmental limitations.

Tailor (Adequate)

In WA, tailor occurs from Onslow to Esperance and is believed to constitute a single stock over this range (Smith *et al.* 2013b). In 2016, the total commercial catch of tailor was 14 t. Most of this catch was taken in the Gascoyne Coast Bioregion (11 t, see Inner Shark Bay Scalefish Status Report), with the remainder in the

WCB (3 t) and the South Coast Bioregion (<1 t). In the WCB, the total commercial catch has typically been less than 20 t per year since records commenced in 1912. The majority of the WCB commercial catch is taken in the Peel-Harvey Estuary.

Most of the recreational catch of tailor is taken in the WCB. The current recreational catch is unknown due to lack of information about the shore-based sector, which is believed to take a larger catch share of tailor than the boat-based sector (Smith *et al.* 2013b). The estimated boat-based recreational harvest range for tailor in the West Coast was steady in 2015/16 (95% CI 3–7 tonnes compared with 3–7 in 2013/14 and 6–22 in 2011/12) (Ryan *et al.* 2017).

The catch rate of tailor fluctuates markedly in response to recruitment variations, which are linked to environmental factors (Smith *et al.* 2013b). Fishery catch rates and juvenile recruitment are monitored annually in the Perth area. Current catch, catch rates and recruitment levels have been stable (non-directional) over the past 20 years. On this basis, the stock is classified as **adequate**.

Estuarine cobbler (Peel-Harvey-Adequate)

In WA, cobbler occurs in ocean and estuarine waters but is mainly caught by commercial fishers in estuaries. Landings by recreational fishers are believed to be negligible. Each estuary has a discrete stock of cobbler, which is genetically distinct to other estuarine populations and also distinct to cobbler populations in adjacent ocean waters.

Since 1996, annual landings of cobbler in the WCB have ranged from <1 t to 10 t. Almost all WCB commercial landings occurred in the Peel-Harvey Estuary. In 2016, approximately 1 t of cobbler was reported from this estuary. Commercial landings of cobbler in the Peel-Harvey Estuary are now managed under a Harvest Strategy, which uses catch and catch rate as indicators of fishery performance (Department of Fisheries 2015). Both catch and catch rate were within the target range in 2016, suggesting a low fishing impact on this stock. On the basis of this evidence, the cobbler breeding stock in this estuary is assumed to be **sustainable-adequate**.

Perth herring (Environmentally Limited)

Perth herring is endemic to the WCB, where a single breeding stock is believed to occur. Stock level was assessed via commercial catch rate trends in the Swan-Canning Estuary until cessation of fishing for this species in 2007 (Smith 2006). Swan-Canning catch rates suggested a major decline in the stock after 1980, which is attributed to historical overfishing and environmental degradation in estuaries (Smith 2006). Limited fishery-independent evidence suggests regional abundance remains low compared to historical levels. The Peel-Harvey Estuary is now the only area where this species is caught commercially, albeit in low quantities. Landings by recreational fishers are negligible.

Perth herring is anadromous (i.e. spawns in rivers then migrates back to ocean waters after spawning). Low spawning success due to environmental degradation in the upper reaches of WCB estuaries and low rainfall is believed to be the main cause of ongoing low stock abundance. Commercial landings within the Peel-Harvey Estuary are managed under a Harvest Strategy, which specifies a limited annual catch (<2.7 t) for this vulnerable species (Department of Fisheries 2015). The catch was slightly above this target level in 2016. The stock is classified as **environmentally limited**.

BYCATCH AND PROTECTED SPECIES INTERACTIONS

Bycatch

The small-scale commercial finfish fisheries in nearshore and estuarine waters mainly use gill, seine and haul nets that are deployed in a targeted manner. Few non-target species are taken. Mesh size regulations ensure that target species caught by these methods are within an appropriate size range. Minimal discarding occurs because virtually all fish taken can be retained and marketed. Recreational fishers mainly use line-based methods in nearshore and estuarine waters. This method can result in the capture and release of non-target species and undersized fish. The risks associated with post-release mortality vary considerably among species. In general, fish in nearshore and estuarine waters are captured from shallow depths and have a lower risk of barotrauma-related injuries than deep water oceanic species and so bycatch species are at **low risk**.

Protected Species

Interactions with listed species by the fishing gear used in these commercial fisheries are negligible. Estuarine birds have been known to interact with fishing nets, but none have been reported in recent years and the risks to their populations are negligible. Commercial fishers are required to report all interactions with listed species. Recreational fishers using line-fishing methods are unlikely to capture listed species and interactions are expected to be a **negligible risk**.

HABITAT AND ECOSYSTEM INTERACTIONS

Habitat

The operation of gillnets and haul nets over predominantly sand and mud bottoms is unlikely to have any impact on these habitats in estuaries and nearshore waters. Similarly, line fishing methods used by recreational fishers have a negligible impact on the bottom substrates. Anchoring by recreational fishing vessels may have localised impacts on habitats such as seagrass and reefs. Hence there is a **negligible risk** to benthic habitats.

Ecosystem

Whitebait is a key prey item for little penguins (*Eudyptula minor*) and whitebait availability may affect their breeding success (Cannell *et al.* 2012). Little penguins from colonies at Penguin Island and Garden Island forage for whitebait and other baitfish between Cockburn Sound and Geographe Bay (Cannell 2016). Whitebait removals by fishing pose a **moderate** risk to these penguins when whitebait abundance is low.

SOCIAL AND ECONOMIC OUTCOMES

Social

The nearshore and estuarine recreational fisheries of the WCB provide a **high social amenity** for the WA community. This Bioregion hosts the main population centres and fishery resources are very accessible to shore-based and small vessel recreational fishers. There is currently a **moderate risk** to these values.

In the WCB, there were 51 commercial fishers employed (either part or full time) in nearshore and estuarine fisheries in 2016, largely supplying fresh fish to meet demand for locally-caught product.

Economic

Estimated annual value (Gross Value of Production) to commercial fishers for 2015: Level 1 (less than \$1 million). **Low Risk**.

GOVERNANCE SYSTEM

Allowable Catch Tolerance Levels

West Coast Estuarine Managed Fishery (Peel-Harvey Estuary only):

Finfish caught commercially in the Peel-Harvey Estuary are managed according to a Harvest Strategy which uses catches and catch rates as indicators of fishery performance (Department of Fisheries 2015). In 2016, the catches of sea mullet and yellowfin whiting exceeded their threshold reference levels (70 t and 14 t, respectively). The Department reviewed the risks posed by these catch levels and determined that they were **acceptable**.

Australian herring fisheries:

The commercial catch tolerance range is 50-179 tonnes. This range represents the minimum and maximum total annual catches by 'minor' herring fisheries (i.e. excluding G-trap net fishery) over the period 2000-2014. The 2016 catch was 83 t, which was **acceptable**. The current catch tolerance range used to assess annual recreational fishery performance is based on boat-based catches remaining below the estimated 2015/16 state-wide catch of herring, i.e. <16 t.

Whitebait:

The catch tolerance range is 60-275 tonnes. The catch was 34 t in 2015/16 and was therefore **unacceptable**.

Harvest Strategy

This resource is harvested using a constant exploitation approach, where the annual catch taken varies in proportion to variations in the stock abundance. Indicator species are used to determine the status of the resource. All indicator species are assessed annually based on catch and/or catch rate trends, where data is available (noting that recreational fishery data is limited for these stocks). Additionally, higher level assessments are periodically undertaken for some stocks. A formal harvest strategy exists for finfish captured commercially within the Peel-Harvey Estuary (Department of Fisheries 2015). A draft Harvest Strategy for Australian herring was released for public comment in 2016 (Department of Primary Industries and Regional Development, in prep 2). A formal harvest strategy is not currently in place for the remainder of this resource.

Compliance

The Department undertakes regular compliance inspections to ensure fishing is being undertaken in accordance with the governing legislation and runs education programs with various stakeholder groups to increase the levels of voluntary compliance.

Consultation

The Department undertakes consultation directly with licensees on operational issues. Industry Management Meetings are convened by the Western Australian Fishing Industry Council (WAFIC), who are also responsible for statutory management plan consultation under a Service Level Agreement with the Department. Consultation with the recreational sector is undertaken via the peak representative body, Recfishwest, and/or the Department's website when documents are released for public comment.

Consultation with non-fisher stakeholders is undertaken in accordance with the Department's Stakeholder Engagement Guidelines.

Management Initiatives

A draft Harvest Strategy for Australian herring was released for public comment in 2016. The draft harvest strategy will be finalised and published following a herring stock assessment workshop to be held in September 2017.

On 20 June 2017 the Perth Metropolitan waters were closed to the take of southern garfish. The closure, which extends from 31 degrees south (near Lancelin) to 33 degrees south (adjacent to Lake Preston), was introduced to ease fishing pressure on southern garfish stocks to aid their recovery and following consultation

with WAFIC, Recfishwest and affected commercial fishers.

EXTERNAL DRIVERS

Annual variations in coastal currents (particularly the Leeuwin and Capes Currents) appear to influence the spawning and recruitment patterns of species such as whitebait, tailor, Australian herring and western Australian salmon (Lenanton *et al.* 2009).

Changes in environmental variables due to climate change (such as ocean temperature, currents, winds, nutrient supply, rainfall, ocean chemistry and extreme weather conditions) are expected to have major impacts on marine ecosystems. These impacts are expected to create both difficulties and opportunities for fisheries.

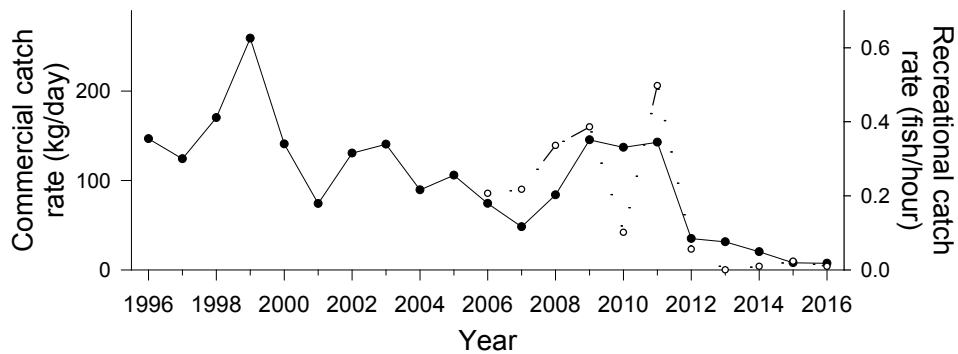
In 2011, a ‘heatwave’ event in coastal waters of south-western WA altered the distribution (e.g. tropical

species occurring in temperate waters) and behaviour (e.g. spawning activity, migration) of many nearshore finfish species, which appears to have affected the abundance of these species in 2011 and in subsequent years (Caputi *et al.* 2014).

WCB estuaries are highly modified and often degraded environments and the impacts of environmental factors on estuarine fish are likely to be more important than fishing pressure. Impacts in estuaries are most pronounced among ‘estuarine-dependent’ species, i.e. those that rely on estuarine habitats for spawning, feeding and/or nursery areas (e.g. cobbler, Perth herring, black bream).

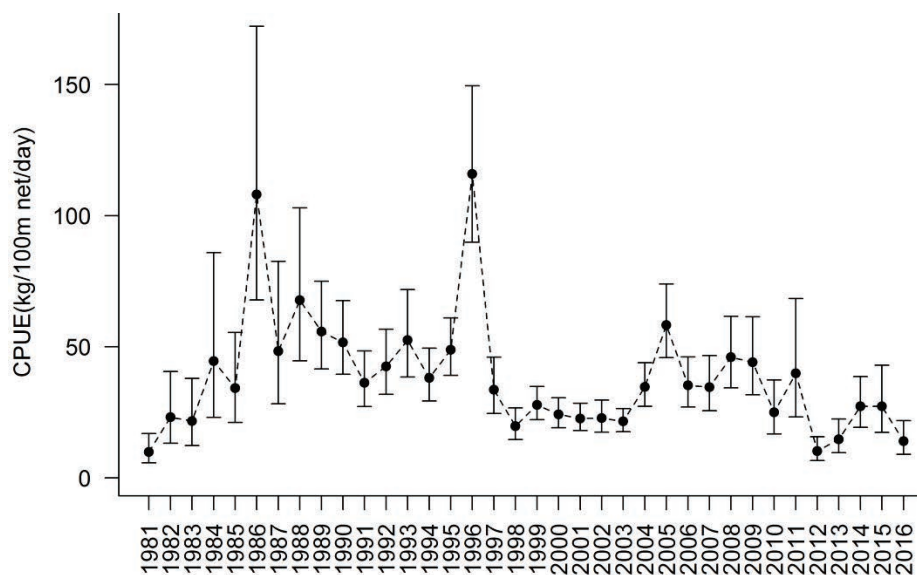
Fluctuating market demand is a significant factor affecting the annual commercial catch levels of many species.

High risk.



NEARSHORE AND ESTUARINE FINFISH FIGURE 1.

Standardised commercial and recreational catch rates of southern garfish in Cockburn Sound.



NEARSHORE AND ESTUARINE FINFISH FIGURE 2.

Standardised commercial catch rate of whitebait in the Bunbury area.

REFERENCES

- Brown J, Dowling C, Hesp A, Smith K, and Molony B. 2013. Status of nearshore finfish stocks in southwestern Western Australia. Part 3: Whiting (Sillaginidae). *Fisheries Research Report*, No. 248. Department of Fisheries, Western Australia. 128pp.
- Cannell BL, Chambers LE, Wooller RD, and Bradley JS. 2012. Poorer breeding by little penguins near Perth, Western Australia is correlated with above average sea surface temperatures and a stronger Leeuwin Current. *Marine and Freshwater Research* 63:914-925.
- Cannell B. 2016. How resilient are the Little Penguins and the coastal marine habitats they use? Report Year 3. Report for City of Rockingham, Fremantle Ports. Murdoch University. 40 pp.
- Caputi N, Jackson G, and Pearce A. 2014. The marine heat wave off Western Australia during the summer of 2010/11 – 2 years on. *Fisheries Research Report*, No. 250. Department of Fisheries, Western Australia. 40pp.
- Department of Fisheries. 2015. Finfish Resources of the Peel-Harvey Estuary Harvest Strategy 2015 – 2020. Version 1.0. West Coast Estuarine Managed Fishery (Area 2). May 2015. Fisheries Management Paper No. 274. Department of Fisheries, Western Australia. 28pp.
- Department of Primary Industries and Regional Development (in prep 1). Western Australian Marine Stewardship Council Report Series, Number 3. West Coast Estuarine Managed Fishery (Area 2: Peel-Harvey Estuary) & Peel-Harvey Estuary Blue Swimmer Crab Recreational Fishery.
- Department of Primary Industries and Regional Development (in prep 2). Australian Herring Resource Harvest Strategy 2016 – 2021. Fisheries Management Paper No. xxx. Department of Fisheries, Western Australia. 27pp.
- Fisher EA, Hesp SA, Hall NG, and Sulin EH. 2014. Predicting the impacts of shifting recreational fishing effort towards inshore species. FRDC Project No. 2010/001. Fisheries Research and Development Corporation.
- Gaughan D, Fletcher WJ, Tregonning RJ, and Goh J. 1996. Aspects of the biology and stock assessment of the whitebait, *Hyperophus vittatus*, in south western Australia. *Fisheries Research Report*, No. 108. Department of Fisheries, Western Australia. 127pp.
- Jenkins GP, Hamer PA, Kent JA, Kemp J, Sherman CDH, and Fowler AJ. 2016. Spawning sources, movement patterns, and nursery area replenishment of spawning populations of King George Whiting in south-eastern Australia — closing the life history loop, Fisheries Research and Development Corporation Final Report, Deakin, Canberra.
- Johnston DJ, Smith KA, Brown JI, Travaille KL, Crowe F, Oliver RK, and Fisher EA. 2015. *Western Australian Marine Stewardship Council Report*, Series No 3: West Coast Estuarine Managed Fishery (Area 2: Peel-Harvey) & Peel-Harvey Estuary Blue Swimmer Crab Recreational Fishery. Department of Fisheries, Western Australia. 284 pp.
- Lenanton RC, Caputi N, Kangas M, and Craine M. 2009. The ongoing influence of the Leeuwin Current on economically important fish and invertebrates off temperate Western Australia – has it changed? *Journal of the Royal Society of Western Australia* 92: 111–127.
- Ryan KL, Hall NG, Lai EK, Smallwood CB, Taylor SM, Wise BS 2017. Statewide survey of boat-based recreational fishing in Western Australia 2015/16. Fisheries Research Report No. 287, Department of Primary Industries and Regional Development, Western Australia.
- Smallwood CB, Pollock KH, Wise BS, Hall NG, and Gaughan DJ. 2012. Expanding Aerial–Roving Surveys to Include Counts of Shore-Based Recreational Fishers from Remotely Operated Cameras: Benefits, Limitations, and Cost Effectiveness. *North American Journal of Fisheries Management*, 32:1265-1276.
- Smith KA. 2006. Review of fishery resources and status of key fishery stocks in the Swan-Canning Estuary. *Fisheries Research Report*, 156. Department of Fisheries, Perth. 84pp.
- Smith K, and Brown J. 2014. Biological synopsis of Australian herring (*Arripis georgianus*). *Fisheries Research Report*, No. 251. Department of Fisheries, Western Australia. 40pp.
- Smith K, Brown J, Lewis P, Dowling C, Howard A, Lenanton R, and Molony B. 2013a. Status of nearshore finfish stocks in south-western Western Australia, Part 1: Australian herring. *Fisheries Research Report*, No. 246. Department of Fisheries, Western Australia. 200pp.
- Smith K, Lewis P, Brown J, Dowling C, Howard A, Lenanton R, and Molony B. 2013b. Status of nearshore finfish stocks in south-western Western Australia, Part 2: Tailor. *Fisheries Research Report*, No. 247. Department of Fisheries, Western Australia. 112pp.
- Smith K, Dowling C, Mountford S, Hesp A, Howard A, and Brown J. 2016. Status of southern garfish (*Hyporhamphus melanochir*) in Cockburn Sound, Western Australia. *Fisheries Research Report*, No. 271, Department of Fisheries, Western Australia. 139pp.

WEST COAST SMALL PELAGIC SCALEFISH RESOURCE STATUS REPORT 2017



J. Norriss and E. Bunbury

OVERVIEW

The five species comprising the west coast small pelagic scalefish resource are tropical sardine (scaly mackerel, *Sardinella lemuru*), pilchard (*Sardinops sagax*), Australian anchovy (*Engraulis australis*), yellowtail scad (*Trachurus novaezelandiae*) and maray (*Etrumeus teres*). They are taken predominantly by the West Coast Purse Seine Fishery (WCPSF), using purse seine gear in waters between Geraldton and Cape

Leeuwin, which includes three separate zones - Northern Development Zone (22° 00'S to 31° 00'S), Perth Metropolitan (31° 00'S to 33° 00'S) and Southern Development Zone (33° 00'S to Cape Leeuwin). The WCPSF is also entitled to take Perth herring (*Nematalosa vlaminghi*), which forms part of the West Coast Nearshore and Estuarine Finfish Resource, but has not done so since 1997.

SUMMARY FEATURES 2017

Fishery Performance		Commercial	Recreational
Total Catch 2016		1,177 t	<1 t (2015/16 boat-based only)
Fishing Level		Acceptable	Acceptable
Stock/Resource Performance		Stock Status	Assessment Indicators
West Coast Small pelagic		Sustainable - Adequate	Biology and total catch
EBFM Performance			
Asset	Level	Asset	Level
Bycatch	Negligible Risk	Listed Species	Low Risk
Habitat	Negligible Risk	Ecosystem	Low Risk
Social	Low Amenity	Economic	GVP (\$1-5 mill)
	Low Risk		Low Risk
Governance	Stable	External Drivers	Low Risk

CATCH AND LANDINGS

The total combined catch of the six species that can be taken by the WCPSF in 2016 was 1,177 t, of which about 80% was tropical sardine and 20% pilchards (West Coast Small Pelagic Scalefish Figure 1). Tropical sardines have dominated the catch since pilchards suffered mass mortality events in 1995 and 1998/99 caused by a herpesvirus.

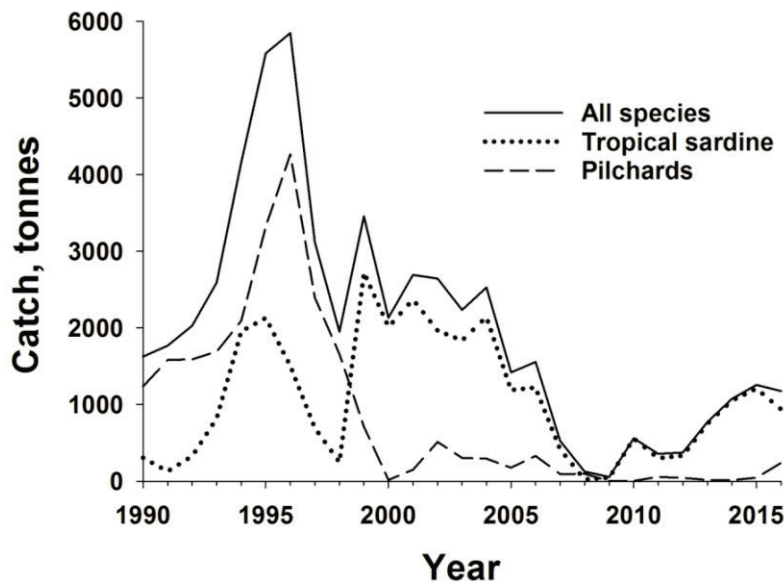
trend since 2011 (West Coast Small Pelagic Scalefish Figure 1). These catches were well below previous historical high levels. The limited spatial distribution of fishing effort for what appears to be a highly mobile species suggests that only a small proportion of a widespread stock is being targeted. Catches are therefore considered sustainable and the biological stock **sustainable-adequate**.

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Tropical sardine (Sustainable-Adequate)

The WCPSF operates at the southern limit of the species distribution in WA. Analysis of otolith chemistry showed no evidence for the existence of separate stocks between Carnarvon and Fremantle, where they appear to be highly mobile resulting in a patchy but widespread distribution.

The WCPS catch of tropical sardines in 2016 was 938 t, a 22% decrease from 2015 following an upward



WEST COAST SMALL PELAGIC SCALEFISH FIGURE 1.

Time series of total annual catch of tropical sardines, pilchards and the total for all six species combined in the WCPSF from 1990 to 2016.

Pilchard (Sustainable-Adequate)

The pilchard is a small, low trophic level pelagic species that feeds by filtering plankton. Longevity is up to 9 years and the maximum size is 200-250 mm SL.

The WCPSF catch of pilchards in 2016 was 237 t, the highest annual catch since 2006 (West Coast Small Pelagic Scalefish Figure 1). Much higher pilchard catches were recorded in the mid-1990s, primarily from the Perth Metropolitan Zone, declined precipitously during the mid to late 1990s following two mass mortality events. While the stock had recovered by the mid-2000s (see below), catches have remained low since then as the WCPSF has transitioned to take mostly tropical sardine.

Population modelling, based on spawning biomass estimates (from egg surveys), catch-at-age and catch data, suggested that by the mid-2000s the stock had recovered from the 1998/99 mass mortality event. The mid-2000s annual exploitation rate for the WA west coast stock was less than 5 per cent (around 400 t) of the estimated spawning biomass of approximately 25,000 t. Annual catches were below 100 t until 2016. The current exploitation rate is therefore unlikely to cause the stock to become recruitment overfished. The biological stock is therefore considered **adequate**.

BYCATCH AND PROTECTED SPECIES INTERACTIONS

The species available for capture in the WCPSF is restricted by the West Coast Purse Seine Limited Entry Fishery Notice 1989. Small quantities of finfish species are sometimes taken as bycatch, but this occurs infrequently and the majority are released from the net unharmed. **Negligible** risk.

Interactions with endangered, threatened and protected species (ETPs) must be reported to the Department on

monthly statutory CAES returns. No interactions were reported by the WCPSF in 2016 indicating the fishery poses a **negligible** risk to ETPs.

HABITAT AND ECOSYSTEM INTERACTIONS

Purse seine nets are pelagic in nature, with limited impact on benthic habitats during normal operations. On rare occasions nets may be deployed in shallow waters and come into contact with habitats such as seagrass beds. The light structure of the net is expected to cause minimal damage to benthic habits when this occurs, and would be kept to a small, localised area. The WCPSF is therefore considered to be a **negligible** risk to these habitats.

SOCIAL AND ECONOMIC OUTCOMES

Social

Local employment was provided by 7 active vessels as well as local processing factories. The estimated recreational catch (boat fishing) of small pelagic species is very small (<1 t annually), comprising yellowtail scad, scaly mackerel and pilchards. **Low** risk.

Economic

A small proportion of the catch is sold for human consumption while the vast majority is sold for bait, aquaculture feed or pet food. The estimated gross value of production (GVP) for the WCPSF in 2015 was level 2 (\$1-5 million). There is currently a **low level of risk** to this level of return.

GOVERNANCE SYSTEM

Allowable Catch Tolerance Levels

Currently, a notional combined Total Allowable Catch (TAC), covering both the Perth metropolitan fishery and the Southern Development Zone, is set for pilchards and another for other small pelagic species. For the 2015/16 licensing period (1 April 2015 – 31 March 2016) the notional TAC was 2,328 t for pilchards and 672 t for other small pelagic species (including *Sardinella*). Reaching or exceeding the notional TACs will trigger a management response.

Harvest Strategy

The WCPSF is currently managed under a constant catch harvest strategy, with catches limited to zonal TACs.

Compliance

Compliance is monitored via aerial patrols and both at-sea and on-land inspections.

Consultation

Consultation with licensees occurs directly on operational issues and through industry Management Meetings convened by the West Australian Fishing Industry Council (WAFIC), who are responsible for statutory management plan consultation under a Service Level Agreement with the Department.

Consultation with non-fisher stakeholders is undertaken in accordance with the Department's Stakeholder Engagement Guidelines.

Management Initiatives

There are no broader management reviews planned for the WCPSF in 2017. Stocks will continue to be monitored principally through Level 1 (catch based) assessments.

EXTERNAL DRIVERS

Climate change is likely to be causing a southward contraction in the natural distribution of pilchards (**moderate** risk) and facilitating a southward extension for tropical sardine (**negligible** risk).

REFERENCES

- Gaughan D, Craine M, Stephenson P, Leary T, and Lewis P. 2008. Regrowth of pilchard (*Sardinops sagax*) stocks off southern WA following the mass mortality event of 1998/99. Final FRDC Report – Project 2000/135. Fisheries Research Report, No. 176, Department of Fisheries, Western Australia, 82p.
- Gaughan DJ, and Mitchell RWD. 2000. The biology and stock assessment of the tropical sardine, *Sardinella lemuru*, off the mid-west coast of Australia. Final Report, FRDC Project 95/037. Fisheries Research Report, No. 119, Department of Fisheries, Western Australia, 136p.

WEST COAST DEMERSAL SCALEFISH RESOURCE STATUS REPORT 2016



D. Fairclough, S. Walters and M. Holtz

OVERVIEW

The West Coast Demersal Scalefish Resource (WCDSR) comprises over 100 species in inshore (20-250 m deep) and offshore (>250 m) demersal habitats of the West Coast Bioregion (WCB) which are exploited by both commercial and recreational (including charter) boat-based line fishers. The indicator species for inshore waters include West Australian dhufish, Snapper and Baldchin grouper, while the proposed indicators for offshore waters include Hapuku, Blue-eye trevalla and Eightbar grouper (see DoF 2011).

Following an assessment in 2007 demonstrating overfishing of the inshore demersal resource, management arrangements designed to recover the resource were progressively introduced between late 2007 and early 2010. These include maintaining the

retained catches of demersal species by all sectors to below 50% of their 2005/06 catches in order to reduce fishing mortality rates (F) of indicator species to below the threshold reference point and to manage the resource in accordance with a formal IFM sectoral allocation decision.

To achieve these management goals each of the commercial fisheries authorised to land demersal scalefish in the WCB have individual management arrangements with access, gear, area and/or entitlement limitations. Similarly, boat-based recreational and charter fishers are licensed and managed by input and output controls including a closed season. For further details see the West Coast Demersal Scalefish Resource Assessment Report and SAFS (2016).

SUMMARY FEATURES 2017

Fishery Performance		Commercial	Recreational	
Total Catch 2016 (demersal)		256t	193–230 t (2015/16 boat-based only), 56 t (Charter)	
Fishing Level		Acceptable (≤ 450 t)	Acceptable (~250 t)	
Stock/Resource Performance		Stock Status	Assessment Indicators	
Inshore Demersal		Sustainable -Recovering	Annual: Catch; Periodic: Fishing mortality, SPR	
Offshore Demersal		Sustainable - Adequate	Annual: Catch	
EBFM Performance				
Asset	Level	Asset	Level	
Bycatch	Low Risk	Listed Species	Negligible Risk	
Habitat	Negligible Risk	Ecosystem	Low Risk	
Social	High Amenity Moderate Risk	Economic	GVP Level 2 -\$1-5m Moderate Risk	
Governance	Stable	External Driver	Moderate Risk	

CATCH AND LANDINGS

The total retained catch in 2016 by the West Coast Demersal Scalefish Interim Managed Fishery (WCDSIMF) was 234 t, comprising 214 t of demersal species. Other commercial fisheries in the WCB landed a total of 42 t of demersal species (during 2016 or 2015/16), with the Temperate Demersal Gillnet and Demersal Longline fisheries taking almost 40 t and the Cockburn Sound Line and Pot Managed Fishery, South-west Trawl Managed Fishery and West Coast Rock Lobster Managed Fishery combined, taking less than 3 t.

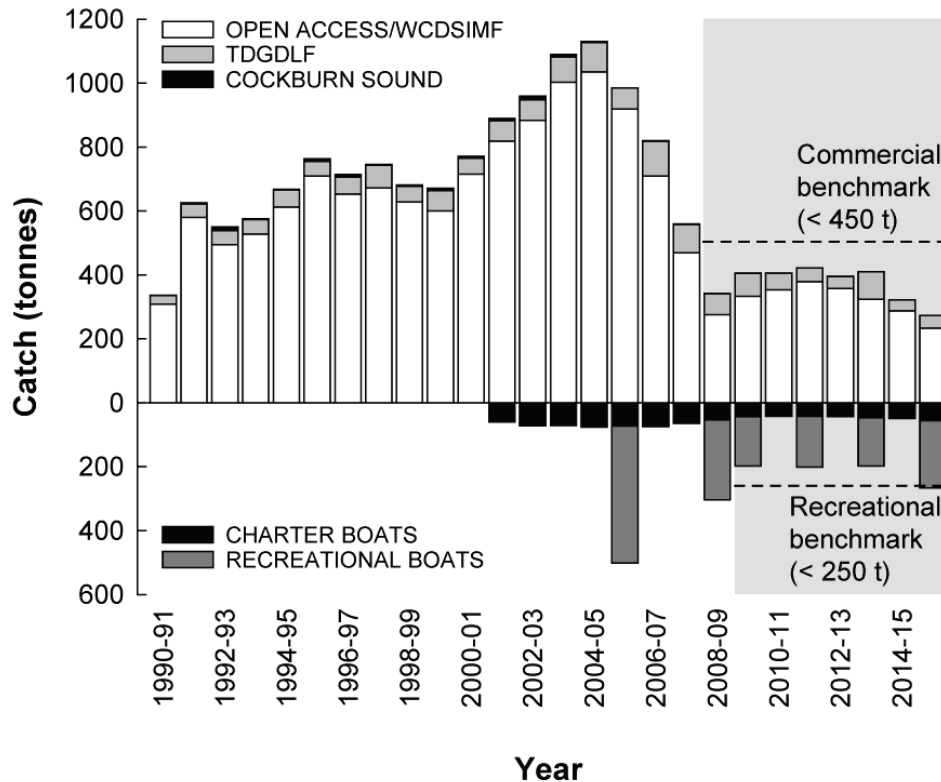
Catches of demersal species by the WCDSIMF and by all commercial fisheries in the WCB were below stock recovery benchmarks (50% of 2005/06 catches) of 410 t and 450 t, respectively, and much lower than prior to management changes (West Coast Demersal Scalefish Resource Figure 1). Catches of the WCDSIMF have declined steadily since 2011. This is partly influenced by reductions in available effort entitlement (and thus reduced effort expended) in 2015 in the Kalbarri and Mid-west Areas to limit catches of snapper. Catches of this indicator species had exceeded its stock recovery retained-catch benchmark for over

three years. Catches of demersal species in 2016 in the Kalbarri Area (92 t), Mid-west Area (78 t) and South-west Area (44 t) were each less than their 2015 catches of 111 t, 85 t and 52 t, respectively.

Total annual retained catches of the top 15 demersal species by the recreational sector have remained around or below the stock recovery benchmark of 250 t (Fig. 1). Charter fishers retained 56 t of the top 15 demersal species in 2015/16, an increase from 50 t landed in 2014/15 and 46 t in 2013/14. This is despite a

gradual decrease in effort from ~22,000 lines fished in 2012/13 to 20,400 lines fished in 2015/16.

The top 15 species in the West Coast demersal suite represented 93% of the total boat-based recreational catch (kept by numbers) of demersal species in 2015/16. The estimated boat-based recreational harvest range for the top 15 demersal species in the WCB was higher in 2015/16 (95% CI 193–230 t) compared with 140–169 t in 2013/14 and 146–174 t in 2011/12) (Ryan *et al.*, 2017).



WEST COAST DEMERSAL SCALEFISH RESOURCE FIGURE 1.

Estimated retained catches of demersal species in the West Coast Bioregion since 1990-91 and stock recovery catch benchmarks introduced between 2008 and 2010 (grey shading). Estimated recreational sector retained catches combine data for financial year for charter (since logbooks introduced in 2001/02) and survey year for recreational boats. Recreational catches are point estimates of the mean and do not show 95% CIs (see Ryan *et al.*, 2017). 2011/12, 2013/14 and 2015/16 estimates were derived from integrated phone diary surveys, while prior estimates were derived from boat ramp creel surveys.

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Inshore

Annual assessments are undertaken using catch levels. Periodic Level 3 assessments of stock status of indicator species evaluate additional key performance indicators including fishing mortality (F) and spawning potential ratio (SPR), using a weight-of-evidence approach that considers all available information (Wise *et al.*, 2007; Fairclough *et al.*, 2014). The next Level 3 assessment for WA dhufish and Snapper will be completed in 2017.

West Australian dhufish (Sustainable - Recovering)

Retained catches of West Australian dhufish in the WCB by all commercial fisheries, the WCDSIMF and the recreational sector (boat-based fishers plus charter fishers) have been around or below respective stock recovery benchmarks of 82 t, 72 t and 126 t, since inception of the current management regime in 2008, e.g. 37 t, 28 t and ~127 t (Charter fishers: 14 t; boat-based fishers: 113 t, 95% CI: 97-129 t) in 2016 or 2015/16 (Fig. 2a). WCDSIMF catches of WA dhufish in the Mid-west and South-west areas have remained around or below recovery benchmarks of 44 t and 19 t since 2008, but had declined to 20 t and 4 t in those areas by 2016. The reduction in effort entitlements in

the Mid-west in 2015 would have contributed to catch declines in that area.

The estimated boat-based recreational harvest range of West Australian dhufish was higher in 2015/16 (95% CI 97–129 t) compared with 2013/14 (69–94 t) and 2011/12 (64–87 t) (Ryan *et al.* 2017). The numbers of discarded dhufish represented 45% of the ~4,600 landed by charter fishers in 2015/16 and 68% of the 49,020 (95% CI: ±8,063) landed by boat-based recreational fishers in 2015/16. Boat-based recreational fishers discarded dhufish mainly as a result of them being undersize.

The last assessment (Fairclough *et al.*, 2014) of F at the biological stock (bioregion) level, using age composition data collected between 2008/09 and 2010/11 (during management changes), was lower than from the previous period 2005/06–2007/08 (Fig. 2a; Fairclough *et al.*, 2014). However, F was still above the limit reference point of 1.5M. Spawning potential ratio lay between the limit (0.2) and threshold (0.3) reference points. These results indicate an improvement in status of the stock.

The above evidence indicates that the current level of fishing pressure should allow the stock to recover from overfishing. The biological stock is classified as **sustainable-recovering**.

Snapper (Sustainable - Recovering)

Retained catches of Snapper in the WCB by all commercial fisheries and the WCDSIMF were continuously above respective recovery benchmarks of 126 t and 120 t between 2010 and 2014. Reductions in entitlements to fishers in the Kalbarri and Mid-west areas of the WCDSIMF in 2015 contributed to reducing catches below those benchmarks in that year (84 t) and in 2016 (68 t) (Fig. 2b). Catches of snapper in 2016 in the Kalbarri (40 t) and Mid-west (26 t) areas were more than 20% below benchmarks of 65 t and 43 t for those areas.

Estimated total retained catches of the recreational sector (recreational boat-based fishers and charter fishers) during years of the integrated surveys of 2011/12, 2013/14 and 2015/16 have been above the recovery benchmark of 37 t, e.g. ~54 t in 2015/16 (Charter fishers: 19 t; boat-based fishers: 36 t, 95% CI 30–42 t).

The estimated boat-based recreational harvest range of snapper was steady in 2015/16 (95% CI 30–42 tonnes) compared with 2013/14 (25–36) and 2011/12 (27–38) (Ryan *et al.* 2017). The numbers of discarded snapper represented 44% of the ~10,370 landed by charter fishers in 2015/16 and 74% of 50,741 (95% CI: 9,698) landed by boat-based recreational fishers in 2015/16. Boat-based recreational fishers discarded snapper mainly as a result of them being undersize.

Estimates of F at the biological stock level derived from age composition data collected between 2008/09 and 2010/11 decreased from the previous period 2005/06–2007/08 (Fig. 2b; Fairclough *et al.*, 2014). However, F was still above the limit reference point of

1.5M and $SPR \leq$ the limit (0.2). The above evidence indicates that the current level of exploitation if maintained should allow the stock to recover from overfishing. The biological stock is classified as **sustainable-recovering**.

Baldchin groper (Sustainable - Recovering)

Retained catches of Baldchin groper in the WCB by all commercial fisheries and the WCDSIMF have been around or below stock recovery benchmarks of 22 t and 17 t respectively, since commencement of the current management regime, e.g. ~9 t and 7 t in 2016 or 2015/16 (Fig. 2c). Retained catches of Baldchin groper by the recreational sector have varied above and below the benchmark of 33 t, but were at their highest in 2015/16, i.e. ~48 t (Charter fishers: 12 t, boat-based recreational fishers 36 t, 95% CI: 28–42 t).

The estimated boat-based recreational harvest range of Baldchin groper in 2015/16 (95% CI 28–42 tonnes) was higher than the harvest range in 2013/14 (17–25) and similar to the harvest range in 2011/12 (24–36) (Ryan *et al.* 2017). The numbers of discarded Baldchin groper represented 38% of the ~6,500 landed by charter fishers in 2015/16 and 40% of 24,302 (95% CI: 5,116) landed by boat-based recreational fishers in 2015/16. Boat-based recreational fishers discarded baldchin groper mainly as a result of them being undersize.

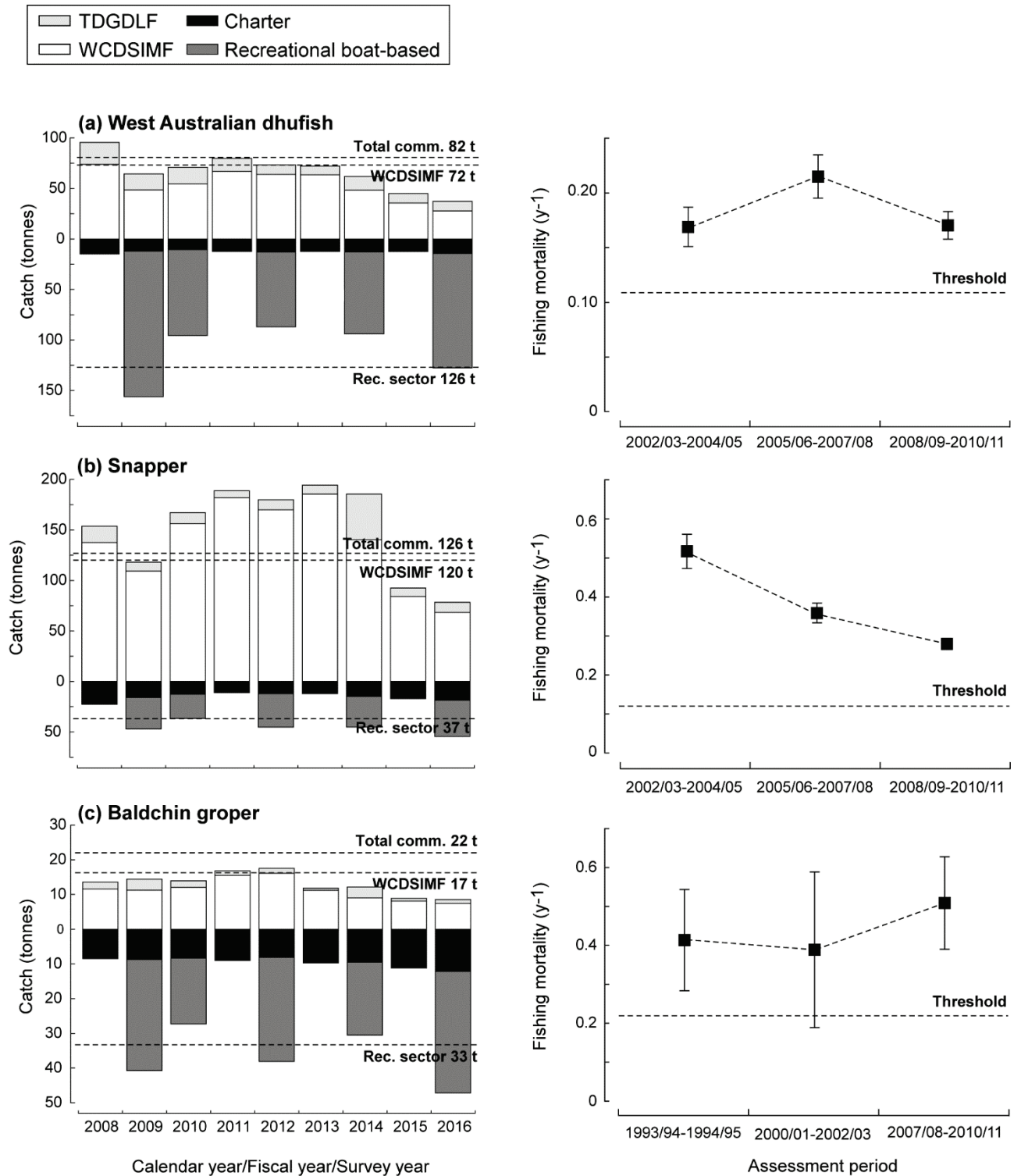
The last assessment of Baldchin groper demonstrated that rates of F at the biological stock level, using age composition data collected from 2008/09 to 2010/11 (i.e. during management changes) did not change from the previous assessment. F estimates were above the limit reference point of 1.5M (Fig. 2c; Fairclough *et al.*, 2014). Similarly, little change was identified in SPR , with point estimates between 0.2 and 0.3.

The current level of fishing pressure if maintained should allow the stock to recover from overfishing. The biological stock classified as **sustainable-recovering**.

Offshore Demersal

Estimated retained catches of the dominant offshore demersal species (6–14 t) by the WCDSIMF have remained below the nominal sustainable catch range for this suite (20–40 t) since the fishery commenced in 2008. Offshore demersal species are rarely caught by other state commercial fisheries, but are sometimes caught by the Commonwealth Western Deepwater Trawl Fishery. However, effort and estimated annual catches since 2002 have remained relatively low (e.g. Ruby snapper < 25 t, Hapuku/Bass groper < 1 t, Blue-eye trevalla = 0 t) (<http://data.gov.au/dataset/reported-retained-annual-catch-from-commonwealth-fisheries-logbooks>).

The current level of fishing pressure is such that the biological stocks of offshore demersal species are considered **sustainable-adequate**.



WEST COAST DEMERSAL SCALEFISH RESOURCE FIGURE 2.

Commercial and recreational estimated retained catches vs 50% of 2005/06 catch benchmarks (dashed lines) for stock recovery (left column) and fishing mortality estimates vs threshold reference points (right column; Fairclough *et al.*, 2014) for (a) West Australian dhufish, (b) Snapper and (c) Baldchin groper. Note recreational catches are point estimates and do not show 95% CIs (Ryan *et al.*, 2017). 2012/13 and 2014/15 estimates were derived from integrated phone diary surveys, while prior estimates were derived from boat ramp creel surveys.

BYCATCH and PROTECTED SPECIES INTERACTIONS

Bycatch: Line fishing for demersal species using baited hooks is highly selective for demersal fishes. While other demersal species that are caught but not normally retained during demersal fishing activities (including inedible species, e.g. Silver Toadfish, and small species, such as wrasses) may not all survive, this still represents a minor impact to their stocks and therefore a **low risk**.

Protected Species: Commercial WCDSIMF and charter fishers are required to record listed species interactions in their statutory returns. Interactions with listed species by commercial, charter and recreational demersal fishers in the WCB are minimal. During 2016, no interactions with protected species were reported by WCDSIMF fishers. In 2015/16, charter fishers caught and released alive one grey nurse shark. The level of interactions with listed species is therefore considered a **negligible risk** to their populations.

HABITAT and ECOSYSTEM INTERACTIONS

Habitat: Line fishing is the main fishing method used in the commercial and recreational fishery for demersal species which has little physical impact on the benthic environment and hence **negligible risk** to benthic habitats.

Ecosystem: Hall and Wise (2011) found that while the species composition in catches of commercial wetline, gillnet and longline fisheries in the WCB had changed over a 30-year timeline this may be a function of changes in targeting or differences in reporting methods. There was no evidence of a decline in the trophic level or mean size in catches and the fishery therefore represents a **low risk** to the ecosystem.

SOCIAL AND ECONOMIC OUTCOMES

Social

The WCDSR provides **high social amenity** to recreational fishing and diving and to consumers via commercial fish supply to markets and restaurants. There is currently a **moderate level of risk** to these values

The demersal resource in the WCB is highly accessible to boat fishers with 137,388 Recreational Fishing from Boat Licences held in WA from September 2015 to August 2016. The annual estimated boat-based recreational fishing effort in the West Coast was steady in 2015/16 (271,311 boat days, SE=11,032) compared with 2013/14 (249,719, SE=10,563) and 2011/12 (293,112, SE=10,688) (Ryan *et al.* 2017).

WCDSIMF vessels operating in 2016 employed between zero and three crew excluding the skipper. Sixty three licensed charter operators fished in the WCB in 2015/16. The number of people employed in the charter industry has not been estimated.

Economic

The estimated gross value of product (GVP) for the WCDSIMF in 2016 was \$1-5 million (level 2). There is currently a **moderate level of risk** to this level of return.

GOVERNANCE SYSTEM

Allowable Catch Tolerance Levels (Acceptable)

The catch levels of both the commercial and recreational sectors indicate that the fishery performance for both sectors is considered **acceptable**. Total catches of demersal species by the commercial and recreational sectors were maintained around or below recovery catch benchmarks of 450 t and 250 t, respectively. Retained commercial catches of snapper in the WCB, total WCDSIMF, Kalbarri WCDSIMF and Mid-west WCDSIMF were above their respective recovery catch benchmarks of 126 t, 120 t, 65 t and 43 t for more than three years. Subsequent management changes reduced entitlements to the WCDSIMF Kalbarri and Mid-west Areas at the beginning of 2015, which has reduced retained catches to acceptable levels (below recovery benchmarks) in each year since then.

Harvest Strategy

The WCDSR is currently managed using a constant catch strategy. Although a formal harvest strategy is not currently in place for this resource, a stock rebuilding program is underway whereby retained catches are to remain < 50% of 2005/06 catches until fishing mortality rates fall below the threshold reference point (see Fletcher *et al.*, 2016).

Compliance

The Department undertakes regular compliance inspections to ensure fishing is being undertaken in accordance with the governing legislation and runs education programs with various stakeholder groups to increase the levels of voluntary compliance.

Consultation

The Department undertakes consultation directly with licensees on operational issues. Industry Management Meetings are convened by the Western Australian Fishing Industry Council (WAFIC), who are also responsible for statutory management plan consultation under a Service Level Agreement with the Department. Consultation with the recreational sector is undertaken via the peak representative body, Recfishwest, and/or

the Department's website when documents are released for public comment.

Consultation with non-fisher stakeholders is undertaken in accordance with the Department's Stakeholder Engagement Guidelines.

Management Initiatives

The trial of filleting on-board commercial vessels presented no compliance issues and will therefore be formalised in the management plan for the fishery. The current management arrangements will be reviewed following the release of the latest stock assessment in 2017. A formal harvest strategy for the WCDSR is expected to be completed in 2018. No other reviews of management are anticipated for 2018.

EXTERNAL DRIVERS

Recruitment success of demersal species, such as West Australian dhufish and Snapper vary annually and are influenced in part by environmental factors. Climate change may lead to a range of factors (e.g. increased water temperatures, changes in current strength) that

could influence recruitment and the biology of demersal species. Declines in demersal catch in the South-west Area followed an extreme event, a marine heatwave in 2011 (Caputi *et al.*, 2014). Ongoing industrial development in Cockburn Sound may affect the spawning aggregation behaviour and survival of juvenile snapper in that area.

There is some overlap of species captured in the WCB by state fisheries and by the Commonwealth Western Deepwater Trawl Fishery and Great Australian Bight Trawl Sector of the Southern and Eastern Scalefish and Shark Fishery (>200 m). These catches are currently small with no estimated catch of demersal species in the WDWTF in 2014, the most recent year of data. The Commonwealth's proposed South-West Marine Bioregional Plan incorporates areas that will restrict access to fishing in parts of the WCB to the commercial and recreational sectors.

Moderate risk.

REFERENCES

- Caputi N., Jackson G. & Pearce A. 2014. The marine heat wave off Western Australia during the summer of 2010/11 – 2 years on. Fisheries Research Report No. 250. Department of Fisheries, Western Australia. 40pp.
- Department of Fisheries (2011). Resource assessment framework (RAF) for finfish resources in Western Australia. Fisheries Occasional Publication No. 85. Department of Fisheries Western Australia, Perth.
- Fairclough, D.V., Molony, B.W., Crisafulli, B.M., Keay, I.S., Hesp, S.A., Marriott, R.J., 2014. Status of demersal finfish stocks on the west coast of Australia. Fisheries Research Report No. 253. Department of Fisheries, Western Australia (96 pp.).
- Fletcher, W.J., Wise, B.S., Joll, L.M., Hall, N.G., Fisher, E.A., Harry, A.V., Fairclough, D.V., Gaughan, D.J., Travaille, K., Molony, B.W., and Kangas, M. (2016). Refinements to harvest strategies to enable effective implementation of Ecosystem Based Fisheries Management for the multi-sector, multi-species fisheries of Western Australia. *Fisheries Research* 183: 594-608.
- Hall, N.G. and Wise, B.S. (2011). Development of an ecosystem approach to the monitoring and management of Western Australian fisheries. FRDC Report – Project 2005/063. Fisheries Research Report No. 215. Department of Fisheries, Western Australia. 112 pp.
- Ryan KL, Hall NG, Lai EK, Smallwood CB, Taylor SM, Wise BS 2017. Statewide survey of boat-based recreational fishing in Western Australia 2015/16. Fisheries Research Report No. 287, Department of Primary Industries and Regional Development, Western Australia.
- SAFS (2016) Status of Australian Fish Stocks. Fisheries Research and Development Corporation. Canberra. <http://fish.gov.au/Reports>
- Wise B S, St John J & Lenanton R C (eds) 2007 Spatial scales of exploitation among populations of demersal scalefish: implications for management. Part 1: Stock status of the key indicator species for the demersal scalefish fishery in the West Coast Bioregion. Final report to Fisheries Research and Development Corporation on Project No. 2003/052. Fisheries Research Report No. 163, Department of Fisheries, Western Australia.