XIX-64 Southwest Australian Shelf: LME #43

T. Irvine, J. Keesing, N. D'Adamo, M.C. Aquarone and S. Adams

The Southwest Australian Shelf LME extends from the estuary of the Murray-Darling River to Cape Leeuwin on Western Australia's coast (~32°S). It borders both the Indian and Southern Oceans and has a narrow continental shelf until it widens in the Great Australian Bight. The LME covers an area of about 1.05 million km^2, of which 2.23% is protected, with 0.03% and 0.18% of the world's coral reefs and sea mounts, respectively, as well as 10 major estuaries (Sea Around Us, 2007). This is an area of generally high energy coast exposed to heavy wave action driven by the West Wind Belt and heavy swell generated in the Southern Ocean. However, there are a few relatively well protected areas, such as around Albany, the Recherche Archipelago off Esperance, and the Cape Leeuwin / Cape Naturaliste region, with the physical protection facilitating relatively high marine biodiversity. Climatically, the LME is generally characterised by its temperate climate, with rainfall relatively high in the west and low in the east. However, rainfall is decreasing and Western Australia is getting warmer, with a 1°C rise in Australia predicted by 2030 (CSIRO, 2007) and an increase in the number of dry days also predicted. The overall environmental quality of the waters and sediments of the region is excellent (Environmental Protection Authority, 2007).

The LME is generally low in nutrients, due to the seasonal winter pressure of the tail of the tropical Leeuwin Current and limited terrestrial runoff (Fletcher and Head, 2006). However, the continental slope of this region comprises some of Australia's most complex networks of submarine canyons and some of the largest areas of abyssal plains within Australia's Exclusive Economic Zone, and thus contains some of the most extensive deepwater benthic environments (Commonwealth of Australia, 2007). Pattiaratchi (2006) identified six such regions that at localised scales, and set against a regionally oligotrophic background, can produce areas of high productivity. The coastal environments include spectacular granite reefs, long pristine sandy beaches, embayments, sponge gardens and communities of filter feeders in deeper waters of the shelf.

There have been few ecological studies to describe the marine flora and fauna over the shelf with any great detail. Some notable exceptions include significant research undertaken to characterise the fish habitats of the Recherche Archipelago (Kendrick *et al.*, 2005), marine biological workshops resulting in publication of a number of papers on the taxonomy, ecology and physiology of local marine flora and fauna (e.g. Wells *et al.* 1991, 2005), marine protected area (MPA) planning studies for State MPAs (see www.dec.wa.gov.au and Department of Environment and Conservation, 2006) and Federal bioregional marine planning studies (see Commonwealth of Australia, 2007).

The LME contains areas of extensive seagrass beds, dominated by genus *Posidonia*, with seagrass found as deep as 45m and diverse kelp habitats dominated by the relatively small *Ecklonia radiata* rather than larger kelps expected in these latitudes where waters are typically colder and have higher nutrients (CALM, 1994). In addition, the area is of global significance as breeding or feeding grounds for a number of threatened marine animals, including Australian sea lions, southern right whales and white sharks (Commonwealth of Australia, 2007). Furthermore, islands off the coast are home to colonies of New Zealand fur seals, penguins and other seabirds, all dependent on the sea for survival.

Some northern species of tropical origin have distributional ranges within this LME due to the influence of the Leeuwin Current. Five tropical coral species extend their distribution into this area (specifically at King George Sound and the Recherche Archipelago) and there are four species endemic to southern coast of Australia (Veron and Marsh, 1988; CALM, 1994). To date, the range of ecological research undertaken in the region reveals a significant number of southwest endemic species. For example, in the Great Australian Bight, one of the world's most diverse soft sediment ecosystems, approximately 85% of fish species, 95% of molluscs and 90% of echinoderms are thought to be endemic (Commonwealth of Australia, 2007). The near shore and archipelago regions are characterised by areas of relatively highly marine biodiversity, many of which have been selected as worthy of representation in national and State-based marine conservation reserve networks, as described in Commonwealth of Australia (2006) and CALM (1994), respectively. Some of these areas are currently undergoing assessment for statutory MPA reservation, such as the proposed Geographe Bay/Leeuwin-Naturaliste/Hardy Inlet Marine Park and Walpole/Nornalup Inlet Marine Park (see www.dec.wa.gov.au) and many others are embedded in Western Australia's aspirational frameworks for a Statewide system of MPAs, such as the Recherche Archipelago (CALM, 1994).

Reports which provide good general reference material pertaining to the ecology and environmental status of this LME include CALM (1994), UNEP (2003), Commonwealth of Australia (2006), Department of Environment and Conservation (2006), Department of the Environment and Water Resources (2007) and Environmental Protection Authority (2007).

I. Productivity

The Southwest Australian Shelf LME is considered a Class III, low productivity ecosystem (<150 $gCm^{-2}yr^{-1}$). With the Leeuwin Current extending into this southwest region, it carries nutrient poor water and generally suppresses upwelling (see the West-Central Australian Shelf LME review for more information). However, there are deep chlorophyll maxima peaking in late autumn/early winter, in phase with the seasonal strengthening of the Leeuwin Current, and the formation of eddies which can generate large productivity pulses (Koslow *et al*., 2006; Feng *et al*., 2007). In addition, counter currents close to coast do allow for upwelling increasing nutrients in a localised sense. In turn, primary productivity is increased when these counter currents are active in spring and summer.

Overall, the LME's waters are oligotrophic and characterised by broad-scale inhibition of upwelling due to the presence of the Leeuwin Current. However, as Pattiaratchi (2007) describes, at localised scales and set against a regionally oligotrophic background, sub-regional effects due to the surface and sub-surface current systems, strong coastal winds, and a combination of topographic features (eg headlands, islands, submarine canyons) can produce areas of relatively high productivity. Pattiaratchi (2007) highlighted six such features: the Perth Canyon; the Albany Canyon group (including the Leeuwin Canyon); the Kangaroo Island canyons and adjacent shelf break; the Kangaroo Island 'Pool'; the predictable large scale eddy field emanating from the main neck of the Leeuwin Current; and Cape Mentelle upwelling. Pattiaratchi (2007) describes these regions as being characterised by high productivity which attracts intense feeding aggregations of large animals such as deep diving mammals, dolphins, seals and sea lions, large predatory fish and seabirds. Some of these areas are also important as pupping zones for school sharks. The areas associated with large eddies are thought to be important for "uplifting" deep ocean water, which is cooler and richer in nutrients, towards the surface where it can embrace the production of plankton communities, which in turn attract larger marine life in an extended food chain.

This LME is a haven to a wide diversity of fish and marine species including scallop, shrimp, trevally, humpback whale, sea lion, penguin and dolphin. Zonation is evidenced by shallow-water reef fish. Three ecological barriers appear to inhibit dispersal: a sharp temperature gradient around Albany near the seasonal cessation of the Leeuwin Current, and two interruptions in the nearshore rocky reef area: in the centre of the Great Australian Bight, and at the mouth of the Murray River. There are numerous rivers and estuaries fed by winter flowing rivers, however the number of rivers and estuaries decreases towards the east of the LME, as the coastline becomes more arid, with limited runoff from rainfall combining with the effect of the Leeuwin Current to limit the nutrients available and hence the productivity of the waters. The waters within this LME are generally clear with low turbidity levels. As a result, light penetrates to greater depths allowing a number of light-dependent species and associated communities to be found in waters deeper than those in which they live in other parts of Australia. For instance, macro-algae and seagrass can be found at depths of up to 120m (Commonwealth of Australia, 2007). The indication from recent and current research programs within the LME is that there is much yet to discover in respect to marine biodiversity in the area. For example, when marine biologists recently surveyed the Recherche Archipelago, some 300-400 species of sponges were collected, of which nearly half were new to science and six new fish species were recorded. Islands off the coast in the Recherche Archipelago area are home to colonies of New Zealand fur seals, Australian sea lions, penguins and other seabirds, all dependent on the sea for survival (http://rmp.naturebase.net/south-coast).

For a general understanding of oceanographic processes affecting nutrient dynamics and the productivity of Australian marine ecosystems, see the Western Australian government's State of the Environment Reports. For more information on productivity, an associated general marine biodiversity, hydrodynamic characteristics and environmental health of the region see, http://rmp.naturebase.net/south-coast (general regional marine planning studies); Department of Environment and Conservation (2006) and www.dec.wa.gov.au (general MPA studies); Australian Fisheries and Research Development Corporation Project 2001/060 (led by Dr Gary Kendrick, University of Western Australia); CALM (1994); Furnas (1995); D'Adamo and Mamaev (1999); UNEP (2003); Commonwealth of Australia (2006); Goldberg *et al*. (2006); Pattiaratchi (2006, 2007); Department of the Environment and Water Resources (2007); Environmental Protection Authority (2007) and Sea Around Us (2007).

Oceanic fronts (Belkin *et al.* 2009)(Figure XIX-64.1): The warm and saline Leeuwin Current (originated within the West-Central Australian Shelf LME) rounds Cape Leeuwin to enter the Great Australian Bight. After rounding Cape Leeuwin, the Leeuwin Current generally flows along the outer continental shelf in its passage eastwards, at least as far as Cape Pasley near 124°E, when it tends to move offshore again because of the distinct northwards kink in the coastline. As on the west coast, large meanders can carry the warm water over 100 kilometres offshore. The Leeuwin Current and the associated TS-front (Leeuwin Current Extension Front, LCEF) continue eastward generally along the shelf edge all the way up to Spencer Gulf. An estuarine front exists across the entrance to Spencer Gulf (SGF). Two inner shelf/near-coastal fronts are observed in the western and eastern parts of the Great Australian Bight (WGABF and EGABF) (Belkin *et al*. 2009).

A series of counter currents exist, moving westward below the Leeuwin Current or existing at times when the Leeuwin Current flow is weakened (spring/summer). The Flinders Current, a westward slope current, exists at depths of 400m or more and is the dominant feature along the southern coast of Australia extending from Tasmania to Cape Leeuwin. It is the only northern boundary current in the Southern Hemisphere. The Flinders Current is driven largely by persistent, deep equator-ward transport across the

Southern Ocean that is turned west due to vorticity constraints. It can result in favourable conditions for upwelling as it flows past the mouths of the Murray Canyons (Arthur, 2006). The Cresswell Current (Pattiratchi, 2006) is a seasonal coastal wind-driven counter-current in the south of Western Australia, just east of the Capes areas, occurring in the summertime.

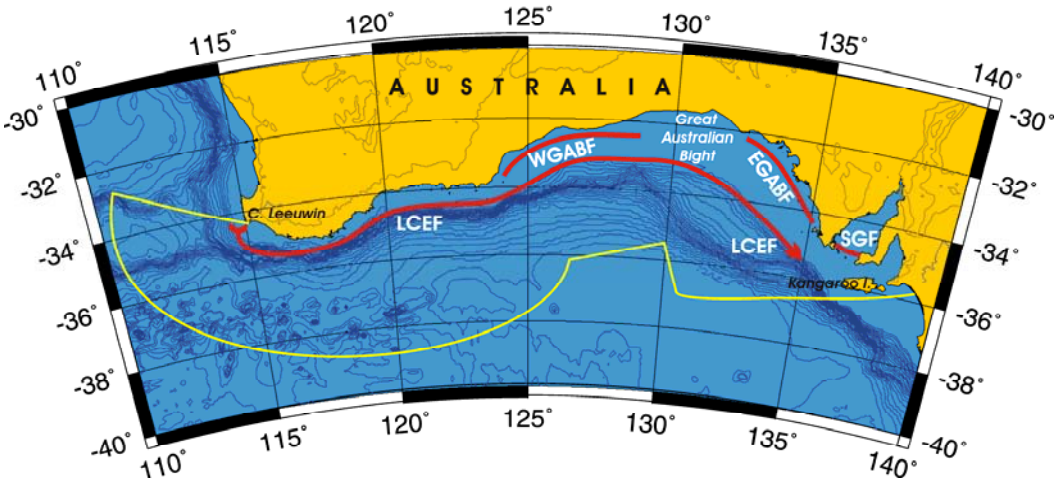

Figure XIX-64.1. Fronts of the Southwest Australian Shelf LME. LCEF, Leeuwin Current Extension Front; LCF, Leeuwin Current Front; EGABF, East Great Australian Bight Front; SGF, Spencer Gulf Front; WGABF, West Great Australian Bight Front. Yellow line, LME boundary; after Belkin *et al.* (2009).

Southwest Australian Shelf LME SST (Belkin 2009)(Figure XIX-64.2):
Linear SST trend since 1957: 0.42°C.
Linear SST trend since 1982: 0.09°C

The moderate, steady warming of the Southwest Australian Shelf was punctuated by several events. The most conspicuous warm events occurred in 1961-63, 1976, 1983 to 1985, and 2000. Three cold events peaked in 1960, 1968, and 1986-87. Most events correlate with similar episodes south and north of Australia. The 2000 warm event can be tentatively linked to a similar event of 1999-2001 in the Southeast Australian Shelf LME.

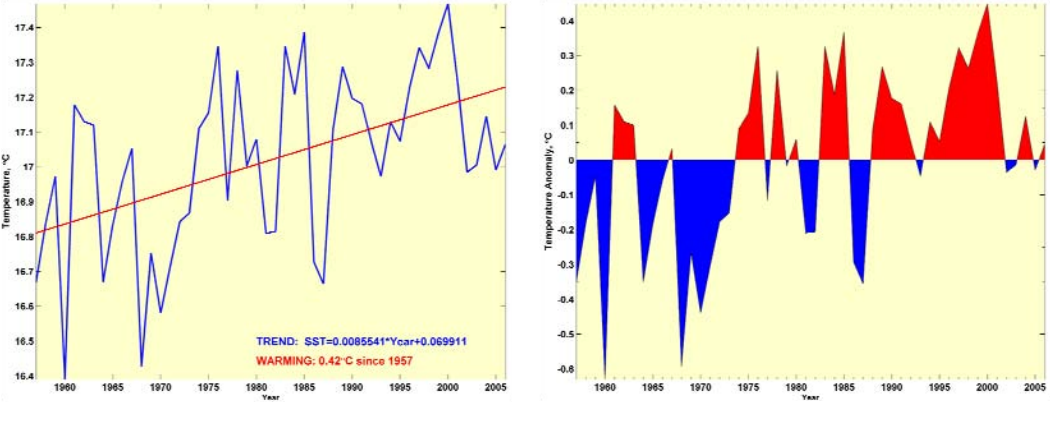

Figure XIX-64.2. Southwest Australian Shelf LME annual mean SST (left) and SST anomaly (right), 1957-2006, based on Hadley climatology. After Belkin (2009).

These two LMEs are the only two areas where the El Niño 1997-98 manifested much later than elsewhere. The two-year delay can be explained by the dampened influence of the Southern Ocean. The warm event of 1983-85 occurred simultaneously in the West-Central Australian Shelf LME. The observed synchronism between West-Central, Southwest, and Southeast Australian Shelf LMEs can be explained by the existence of the Leeuwin Current that carries warm tropical waters from the Southeast Indian Ocean around Cape Leeuwin into the Great Australian Bight and eventually toward Tasmania and into Bass Strait (Ridgway and Condie, 2004).

Southwest Australian Shelf LME Chlorophyll and Primary Productivity

The Southwest Australian Shelf LME is considered a Class III, low productivity ecosystem (<150 $gCm^{-2}yr^{-1}$)(Figure XIX-64.3).

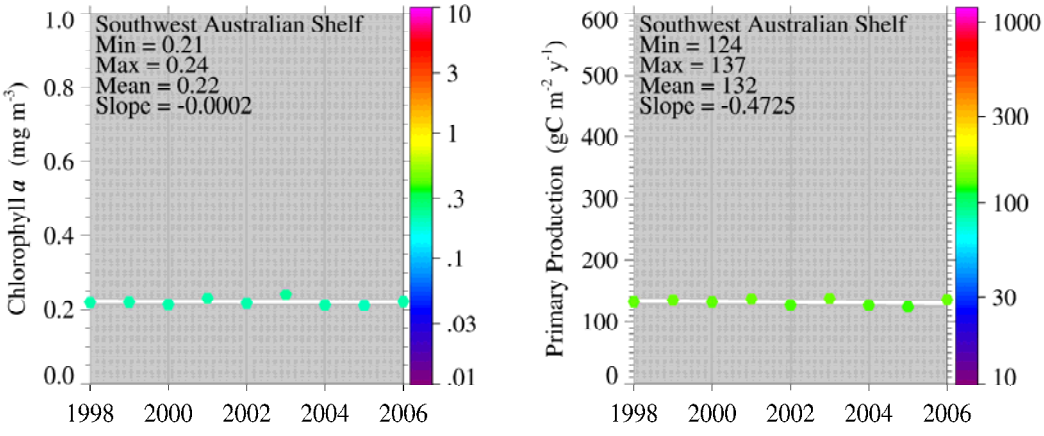

Figure XIX-64.3. Southwest Australian Shelf LME trends in chlorophyll *a* (left) and primary productivity (right), 1998-2006, from satellite ocean colour imagery. Values are colour coded to the right hand ordinate. Figure courtesy of J. O'Reilly and K. Hyde. Sources discussed p. 15 this volume.

II. Fish and Fisheries

Australian waters are relatively nutrient-poor and although not productive by world standards, there are numerous commercial and recreational fisheries based in the waters of this LME. Production is limited by low levels of nutrient-rich upwellings. Fish stocks are predominantly temperate, with most species distributions extending the length of the LME. Many species are endemic to Australia. Under the Australian Constitution, jurisdiction over Australia's fisheries resources is a complex mix of Australian Government and State or territory government responsibilities. Relevant legislation has established the Australian Fisheries Management Authority (AFMA) as the Australian Government statutory body empowered to manage fisheries. Within this LME there are Western Australian and South Australian State managed fisheries, and Commonwealth managed commercial fisheries. For details relating to Western Australia see Fletcher and Head (2006), for South Australia see Primary Industries and Resources South Australia (2007) and for Commonwealth fisheries see Larcombe and McLoughlin (2007).

Major Western Australian State commercial fisheries in this region are abalone, purse seine fishery targeting pilchards and other small pelagics, and demersal gillnet fishery for sharks. Other smaller fisheries are beach seine fishery for Australian salmon and herring, a trap fishery targeting southern rock lobster and deep water crabs and the intermittent scallop fishery in the Recherche Archipelago (Fletcher and Head, 2006). The South Australian Government has responsibility for four fisheries, these are the Northern Zone

Rock Lobster, the Giant Crab, the Sardine and the Marine Scalefish fisheries. In 2004/05, the four fisheries' combined catch was over 43000 tonnes of fish, worth around US$55 million. The most important of South Australian-managed fisheries by value was the Sardine Fishery with a catch value of over US$27 million and landings of over 39000 tonnes (Commonwealth of Australia, 2007). South coast commercial fishing vessels operators often hold a number of licenses to create a viable year round operation.

Commonwealth managed fisheries in the area are the Southern Bluefin Tuna Fishery, Western Tuna and Billfish Fishery, Southern and Eastern Scalefish and Shark Fishery (SESSF), Western Australian Southern Demersal Gillnet and Longline Fishery and Western Skipjack Fishery (see Larcombe and McLoughlin, 2007). The total global catch of Southern Bluefin Tuna in 2005 was 21686 tonnes, of which Australia's share was 5244 tonnes, worth A$140 million (Larcombe and McLoughlin, 2007). The Southern Bluefin Tuna Fishery is an international fishery and listed as globally overfished. It has been managed since 1994 through the Commission for the Conservation of the Southern Bluefin Tuna (CCSBT), which is advised by a scientific committee of member-country scientists and independent international scientists. The Australian Government is party to a number of international conventions or agreements for the management of highly migratory tunas and billfishes that range far beyond the Australian Fishing Zone – see Larcombe and McLoughlin (2007). Responsibility for management of these stocks is shared by multiple governments through Regional Fisheries Management Organisations.

As much of the coast is remote or difficult to access, recreational boat and beach fishing is concentrated around main population and holiday centres. The major target species for such fishing are salmon, herring, whiting, trevally, pink snapper, queen snapper, Bight redfish, shark, samson fish and King George whiting (Fletcher and Head, 2006) The predominant aquaculture activity undertaken in the area is the production of mussels and oysters from Oyster Harbour at Albany. Other forms of aquaculture (e.g. sea cage farming) are restricted on the south coast by the high-energy environment and the very limited availability of protected deep waters typically required by this sector (Fletcher and Head, 2006)

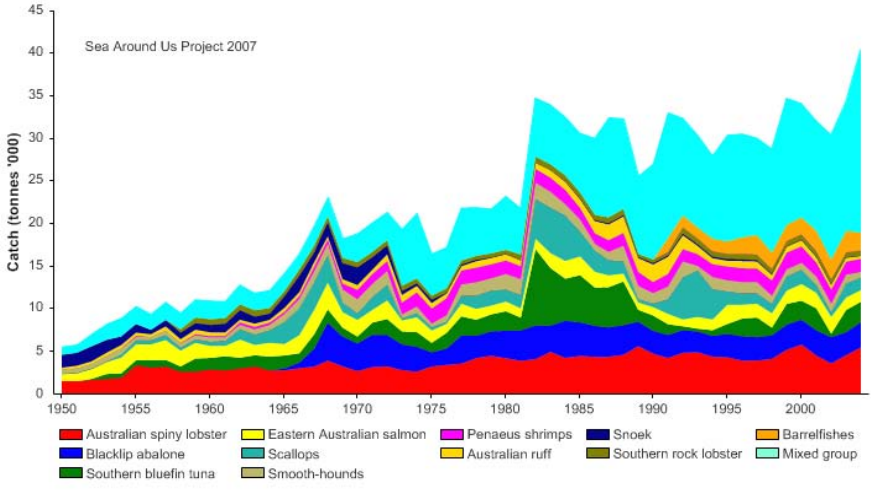

Figure XIX-64.4. Total reported landings in the Southwest Australian Shelf LME by species (Sea Around Us 2007).

The total of reported landings in the LME is still growing with 40,000 tonnes recorded in

2004 (Figure XIX-64.4). However, there is, presumably, a significant fish bycatch from the shrimp fishery which is not included in the reported landings. The reported landings were valued at US$ 333 million in 2000, due to the high value commanded by spiny lobsters (crustaceans) and abalone (molluscs), and US$ 292 million in 2004 (Figure XIX-64.5).

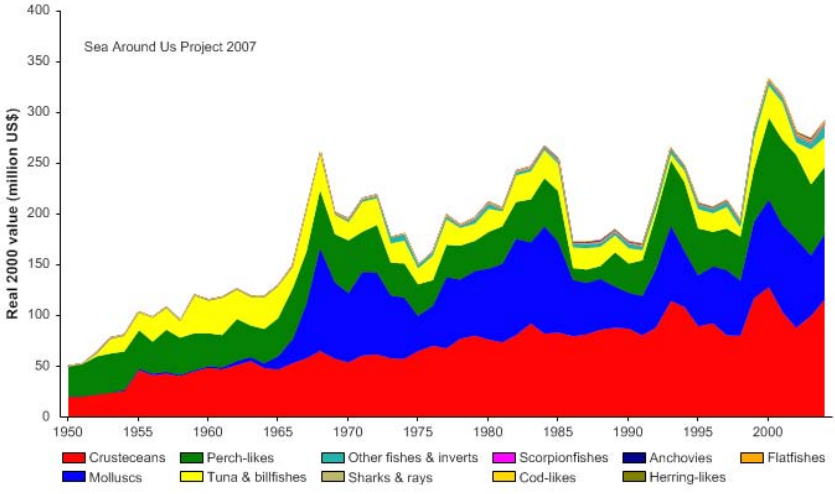

Figure XIX-64.5. Value of reported landings in the Southwest Australian Shelf LME by commercial groups (Sea Around Us 2007).

The primary production required (PPR; Pauly and Christensen 1995) to sustain the reported landings in this LME has been increasing but is still below 2% of the observed primary production (Figure XIX-64.6). Australia accounts for the majority of the ecological footprint in this LME.

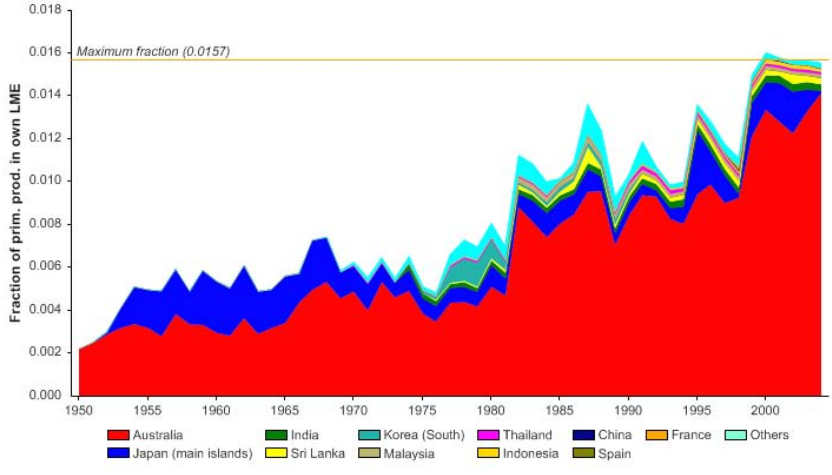

Figure XIX-64.6. Primary production required to support reported landings (i.e., ecological footprint) as fraction of the observed primary production in the Southwest Australian Shelf LME (Sea Around Us 2007). The 'Maximum fraction' denotes the mean of the 5 highest values.

During the 1950s and the 1960s, the mean trophic level of the reported landings (MTI, Pauly and Watson 2005) declined steadily (Figure XIX-64.7 top), indicating a 'fishing down' of the food web in the LME during this period (Pauly *et al*., 1998). The subsequent increase of the mean trophic level, as well as the FiB index (Figure XIX-64.7 bottom), imply a possible geographic expansion of the fisheries (Figure XIX-64.6.)

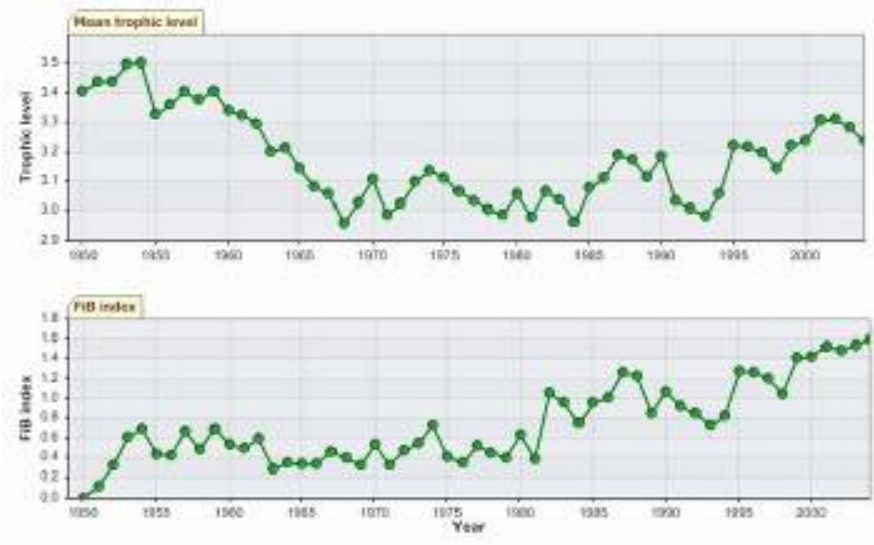

Figure XIX-64.7. Mean trophic level (i.e., Marine Trophic Index) (top) and Fishing-in-Balance Index (bottom) in the Southwest Australian Shelf LME (Sea Around Us 2007).

Until recently, fisheries resources were usually managed in separate fishery units. Under the Environment Protection and Biodiversity Conservation Act 1999 (the EPBC Act), the Commonwealth Government has a framework that helps it to respond effectively to current and emerging environmental problems, and to ensure that any harvesting of marine species is managed for ecological sustainability. All fisheries in the area are subject to management plans which embrace the principles of Ecosystem Based Fishery Management (EBFM) as opposed to single target species management approaches (Smith *et al*., 2007). State commercial fisheries are managed primarily through input controls such as limited entry, catch numbers, size limits and seasonal closures, and stock assessments are undertaken to assess breeding stock levels and exploitation status undertaken for most fisheries. Management includes assessment of bycatch species impacts, protected species interactions, food chain effects and habitat effects (Fletcher and Head, 2006).

The Stock-Catch Status Plots indicate that about 30% of commercially exploited stocks in the LME have collapsed and another 30% are overexploited (Figure XIX-64.8, top). About half of the reported landings appear to be supplied by fully exploited stocks (Figure XIX-64.8 bottom). However, the editors and Australian contributors wish to acknowledge and advise caution that there are several reasons possible for the apparently reduced status of some species. Among them, Australian management authorities have in many cases limited catches and effort to protect the species from overfishing. Landings of these stocks are therefore lowered, giving the appearance of an overfished condition status in Figure 8. In addition, productivity of some of these fisheries is tightly coupled to environmental variability, in particular ENSO, and this also reduces catches in some years in ways not due to exploitation rate. Catches of all species are subject to annual active management intervention and often include temporally and spatially explicit adaptive management measures to prevent overfishing.

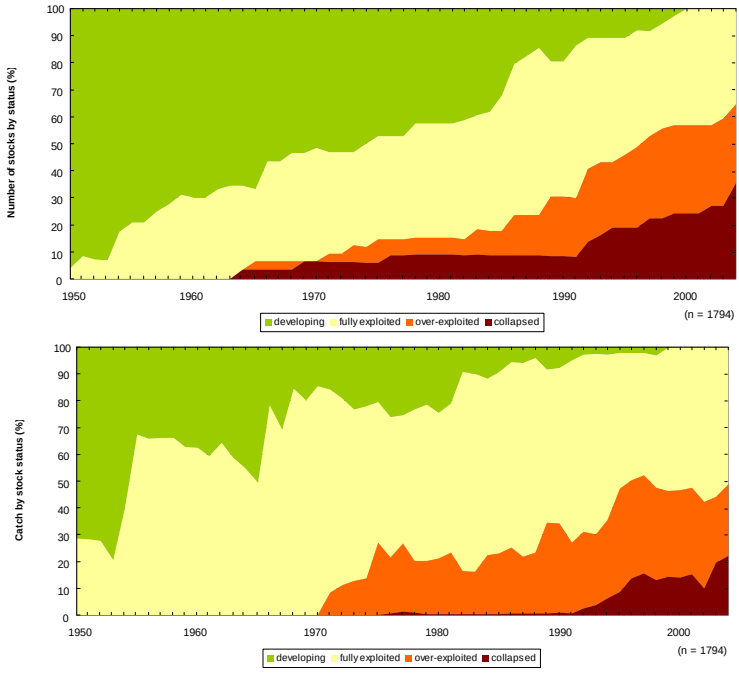

Figure XIX-64.8. Stock-Catch Status Plots for the Southwest Australian Shelf LME, showing the proportion of developing (green), fully exploited (yellow), overexploited (orange) and collapsed (purple) fisheries by number of stocks (top) and by catch biomass (bottom) from 1950 to 2004. Note that (n), the number of 'stocks', i.e., individual landings time series, only include taxonomic entities at species, genus or family level, i.e., higher and pooled groups have been excluded (see Pauly *et al*, this vol. for definitions).

The FAO provides additional information on Australia's fisheries and the characteristics of the industry (www.fao.org).

III. Pollution and Ecosystem Health

The SW Australian Shelf LME is sparsely populated except for the areas of the cities of Perth in Western Australia and Adelaide in South Australia. Thus, the inshore marine habitats of the coast are largely unaffected by human activities, the exceptions being some estuaries and marine embayments (e.g. Princess Royal Harbour, Oyster Harbour and Wilson Inlet) where significant eutrophication associated with nutrient inputs from landbased activities has occurred (Fletcher and Head, 2006). The most visible result of such nutrient enrichment is the seagrass loss or degradation in South Australia (Shepherd *et al*., 1989). In addition, increased nutrient loads to coastal waters have also been directly implicated in the increased frequency of algal blooms, particularly 'Red Tides', and more recently, in the loss of mangroves (Connolly, 1986; Edyvane, 1991). Of the limited environmental threats that exist for this LME as a whole, of particular concern is an increase in shipping-related releases of ballast water, which has been shown to contain harmful bacteria, viruses and algae as well as non-indigenous plankton, and the larval forms of many invertebrates and fish. Other concerns in this LME are ocean dumping, marine debris, new exploration for offshore oil and the risk of oil spills from resulting production. There is also is the potential for environmental impacts caused by tourism and by the provision of infrastructure to support tourism (airports, power generation facilities, accommodation, sewage treatment and disposal facilities, moorings, and marine transport).

In respect to the area surrounding Adelaide, including the Spencer Gulf, pollution derives from mining, manufacturing, petroleum, chemical, agricultural, food processing, gas and power, and sewerage waste water industries. The main discharges are chemical from the industrial plants at the northern end of Spencer Gulf, at the various sewerage outfalls and saline discharges from salt and chemical works at Dry Creek and Osborne (Port Adelaide) (Zann, 1995). In general, the levels of heavy metals in seawater appear relatively low and the levels of contamination of aquatic species are considered within defined limits (Zann, 1995). To name only one of the many local South Australia ongoing water quality improvements, the EPA is currently negotiating with industry in the Northern Spencer Gulf area to curb the discharges of heavy metals into the Gulf.

The condition of WA's coastal and shelf waters, including this southwest region, has historically been poorly monitored, with the exception of certain highly pressured areas, such as Albany harbours (Environmental Protection Authority, 2007). Relevant reports are available through the Western Australian Department of Conservation and Environment (www.dec.wa.gov.au) and the Environmental Protection Agency (www.epa.wa.gov.au). Western Australia's overall marine and coastal monitoring framework is undergoing a significant expansion as part of the State's marine protected area (MPA) implementation and management programs, as discussed in Section V (Governance, p.849 ff.).

The State of the Environment Report for Western Australia 2007 (Environmental Protection Authority, 2007) lists two fundamental pressures of high concern and "likely to deteriorate": first, rainfall is decreasing in the south-west with severe implications as ocean levels are rising and all of Western Australia is getting warmer; and second, population and consumption are of concern. It is noted that Western Australians have among the largest ecological footprints in the world.

With respect to benthic disturbance by fishing, methods which can impact on marine habitats such as trawling are naturally restricted due to the relatively low productivity and abundance of species capable of trawl capture. A small, limited-entry scallop trawl fishery focused in the Esperance region is the only state-managed fishing activity which can have any significant physical interaction with the marine habitat (Fletcher and Head, 2006). Trawling in deep waters off the edge of the continental shelf is managed by the Commonwealth Government. This area, particularly the western part of the Great Australian Bight, was subject to significant exploratory trawling by locally based and international vessels prior to the 1980s, but is only sporadically fished now. There is a coastal trawling closure of state waters along the western Bight sector, enacted under Commonwealth Government fisheries legislation, to ensure deep-sea trawlers do not venture into sensitive coastal areas (Larcombe and McLoughlin, 2007). For more information on pollution and ecosystem health, see Pogonoski *et al*. (2002) and for marine disturbances and coastal pollution see www.ea.gov.au.

IV. Socioeconomic Conditions

Most of South Australia's population of 1.4 million is situated on the coast, with major towns and cities concentrated on the Fleurieu Peninsula (including Adelaide) and northern Spencer Gulf (Whyalla, Port Pirie, Port Augusta). The coastal fringe of the Great Australian Bight from Ceduna to Esperance has a low population density, and few towns with more than 200 persons listed in the 2001 census. The South Australian portion of the region is characterised by substantially older median ages and high elderly dependency, and is more dependent on agriculture, fisheries and forestry industries with lower employment diversification outside regional centres (http://adl.brs.gov.au). The Australian Government reports that major marine industries associated in the area include commercial fishing, marine-based tourism, shipping, oil and gas exploration, boat

and ship-building, defence activities and aquaculture (Department of the Environment and Water Resources, 2007). Marine based tourism is not well developed in the area, and focuses on diving and fishing; there is however scope for future development. There is no current oil and gas production in the region, but exploration has identified two frontier basins with petroleum potential - the Naturaliste Plateau and Bight Basin.

Commercial fishing employment, including aquaculture, is largely concentrated across most of the Eyre Peninsula where almost all coastal towns have strong linkages to commercial fishing activities. For example, Port Lincoln has the largest number and proportion of people employed within the fishing sector of any coastal town in Australia (Bureau of Rural Sciences, 2006). In 2003, fishers active within Australian Government-managed fisheries in the LME caught around US$135 million worth of fish. In the WA and SA State-managed fisheries, rock lobster, abalone, scallop, shark, King George Whiting and prawn mostly caught in State waters, have a gross value of production nearing $385 million a year. More than 3,600 people are directly employed by the fishing industry in the area with a further 800 employed in the aquaculture sector. Of increasing economic importance is the developing mariculture industry which is primarily based in the coastal inlets and bays of Eyre Peninsula. Recreational fishing is particularly important in regional and local economies, especially in the towns on the far-west coast and on Yorke and Eyre Peninsulas. Recreational fishers are increasingly moving further offshore to target a range of deep-sea species. Despite the vastness of the South Australian coastline, human activities tend to be concentrated near centers of population and here most conflict or competition occurs. The region is becoming of increasing interest for general coastal and marine tourism and associated water based recreational activities, and this trend is likely to continue as the region continues to receive greater focus for its ecological values through marine conservation under State and Commonwealth instruments.

V. Governance

For a fuller overview of the history, current status and underpinning principles of respective Commonwealth and Western Australia marine biodiversity conservation frameworks refer to the West-Central Australian Shelf LME section (this series).

Australia has a federal system of government with the States forming the Australian Commonwealth federation. The LME is bordered by the States of South Australia and Western Australia. The States are responsible for the marine environment for the first three nautical miles from the shore. Australia declared a 200 nautical-mile EEZ in 1978. Refer to the West-Central LME section for more details of the Commonwealth and State zones and responsibilities. The Australian State and Commonwealth governments identified a need to protect representative examples of the full range of marine ecosystems and habitats in marine protected areas. A spatial framework was established, the Integrated Marine and Coastal Regionalisation of Australia (IMCRA), for classifying Australia’s marine environment into bioregions that make sense ecologically and are at a scale useful for regional planning (Commonwealth of Australia, 2006). The Southwest Australian Shelf LME encompasses 8 IMCRA meso-scale bioregions. The Commonwealth’s IMCRA framework provides a platform for the development of a National Representative System of Marine Protected Areas (NRSMPA), which is a comprehensive, adequate and representative system of marine protected areas that will contribute to the long-term ecological viability of marine and estuarine systems, maintain ecological processes and systems and protect Australia's biological diversity at all levels.

The establishment of the Commonwealth’s MPA network is being progressed as part of the marine bioregional planning process being conducted by the Department of the Environment, Water, Heritage and the Arts under the *Environment Protection and*

Biodiversity Conservation Act 1999. IMCRA bioregions are pooled to form Marine Bioregional Planning Regions (www.environment.gov.au/coasts/mbp). These bioregions are large areas of ocean, considered to be ecologically similar, compared to other similarly sized areas. See the West-Central Australian Shelf LME section for more information on the bioregionalisation schemes developed in Australia and how these provide a framework for a representative system of marine reserves. The Commonwealth's South-west Marine Bioregion comprises 7 provincial bioregions, 5 of which fall into this LME. A Bioregional Profile identifying the important ecological, conservation and socio-economic values of the region for this region has been released (Commonwealth of Australia, 2007). Within this LME, the Western Australian and South Australian State-based marine conservation reserve frameworks are being progressed so as to be aligned and consistent with the federal framework.

Australian fisheries resources are managed under both Commonwealth and State/Territory legislation. The jurisdiction and responsibilities among these various governments has been agreed to under the Offshore Constitutional Settlement (OCS). Under OCS, the states and territories have jurisdiction over localised, inshore fisheries. The Commonwealth has jurisdiction over offshore fisheries, transboundary fisheries (extending to waters adjacent to more than one state or territory) and foreign fisheries. Each government has separate fisheries legislation and different objectives. An important goal is to ensure that the exploitation of fisheries resources is conducted in a manner consistent with the principles of ecologically sustainable development. This includes the need to assess the impact of fishing activities on non-target species and the long-term sustainability of the marine environment. For more information on the governance of Australia's fisheries, see the FAO website.

Coastal development proposals are presently regulated under various State and local Government planning legislation. In South Australia, coastal development is regulated by the Planning Commission and overseen by the Coast Protection Board; however coastal management is often uncoordinated, fragmented and prone to jurisdictional and administrative overlap. Human activities such as mining, fishing, shipping, or tourism, which may detrimentally affect marine or coastal habitats, are generally regulated through conditions on the permits or licenses issued under the respective controlling legislation.The marine tourism industry has produced a code of conduct that covers issues such as anchoring, dropping of rubbish, fish feeding and preservation of world heritage values.

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