Major findings of the State of the Marine Environment Report for Australia.

Our Sea, Our Future.

AUSTRALIA
Department of the ENVIRONMENT SPORT and TERRITORIES
Ocean Rescue 2000 Program

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Major Findings of the State of the Marine Environment Report for Australia

Compiled by Leon P. Zann

ISBN 0 642 17391 5.

E R R A T A

ABOUT THIS REPORT

Insert "... super script numbers) throughout the text."at the end of the last paragraph.

Page 7

Insert "Catchments in the tropical ... " at the beginning of the text.

Page 14 text should be replaced by:

General issues affecting Australia's coral reefs include effects of sediments and nutrients[42], effects of fishing and tourism[69], and the threats of oil spills[39]. Specific threats include elevated nutrients in the inner Great Barrier Reef[69]; outbreaks of crown-of-thorns starfish in the outer central and northern Great Barrier Reef and Tasman reefs[49,69]; damage from the passage of tropical cyclones; and outbreaks of coral-eating *Drupella* snails in Ningaloo Reef, Western Australia[50,70].

Coral reefs are relatively well represented in marine protected areas in Australia[12,67]. Significant areas are protected in all of the places where reefs are found, although management is often constrained by their great size and remoteness, and by lack of financial resources. Australia's coral reefs are relatively unaffected by human activities due to low to moderate levels of use and their remoteness, but elevated nutrients and sediments resulting from inland soil erosion are a threat in non-arid regions[42,69]. Because of the general decline in many of the world's coral reefs, the conservation and tourism values of Australia's reefs are of growing importance[12].

Our Sea, Our Future.

Major findings of the State of the Marine Environment Report for Australia

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Ocean Rescue 2000 program
Department of the Environment, Sport and Territories, Canberra

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Disclaimer:
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Foreword

The production of the first State of the Marine Environment Report (SOMER) is a milestone in the management of Australia's marine environment.

SOMER provides the first comprehensive scientific description of our marine environment and the baseline information included in the report will enable better management of this precious asset.

It is an information base that will allow us all to be better informed about the condition of the marine environment.

The information in the report will feed into the development of the Australian Marine Conservation Plan which will contain strategies and priorities for managing our marine environment. It will form a part of the overall national State of the Environment Report.

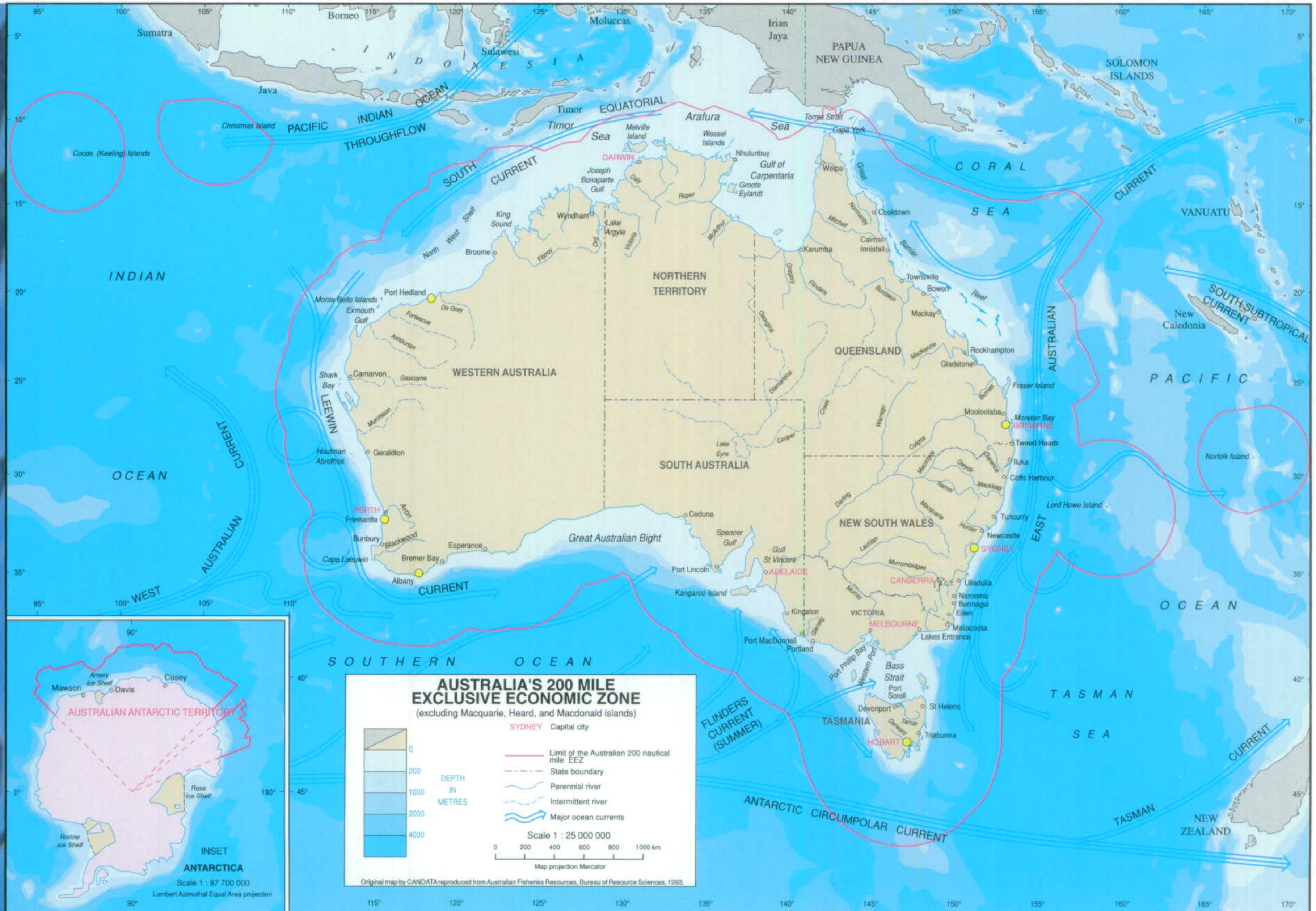
A quarter of Australia's population lives within three kilometres of the sea, and two-thirds reside in our coastal towns and cities.

Our marine environment is a national asset, in terms of the biodiversity it maintains, the important industries it supports and for its recreational values.

We have a responsibility to protect our marine environment for the benefit and enjoyment of all Australians.

Senator John Faulkner, Minister for the Environment, Sport and Territories

February 1995


AUSTRALIA'S 200 MILE
EXCLUSIVE ECONOMIC ZONE
(excluding Macquarie, Heard, and Macdonald islands)
SYDNEY Capital city
Limit of the Australian 200 nautical mile EEZ
State boundary
Perennial river
Intermittent river
Major ocean currents
DEPTH IN METRES
0
200
1000
2000
4000
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0 200 400 600 800 1000 km
Map projection Mercator
Original map by CANDATA reproduced from Australian Fisheries Resources, Bureau of Resource Sciences, 1993.
INSET
ANTARCTICA
Scale 1 : 87 700 000
Lambert Azimuthal Equal Area projection
AUSTRALIAN ANTARCTIC TERRITORY
Mawson
Davis
Casey
Amery Ice Shelf
Ross Ice Shelf
Ronne Ice Shelf
WESTERN AUSTRALIA
NORTHERN TERRITORY
SOUTH AUSTRALIA
QUEENSLAND
NEW SOUTH WALES
VICTORIA
TASMANIA
DARWIN
PERTH
ADELAIDE
MELBOURNE
CANBERRA
SYDNEY
BRISBANE
HOBART
INDIAN OCEAN
SOUTHERN OCEAN
PACIFIC OCEAN
TASMAN SEA
CORAL SEA
Arafura Sea
Timor Sea
Great Australian Bight
Gulf of Carpentaria
Bass Strait
PACIFIC INDIAN OCEAN THROUGHFLOW
EQUATORIAL
SOUTH CURRENT
LEEWIN CURRENT
WEST AUSTRALIAN CURRENT
EAST AUSTRALIAN CURRENT
FLINDERS CURRENT (SUMMER)
ANTARCTIC CIRCUMPOLAR CURRENT
TASMAN CURRENT
SOUTH SUBTROPICAL CURRENT
INDONESIA
PAPUA NEW GUINEA
Irian Jaya
SOLOMON ISLANDS
VANUATU
New Caledonia
NEW ZEALAND
Sumatra
Java
Borneo
Sulawesi
Moluccas
Timor
Christmas Island
Cocos (Keeling) Islands
Norfolk Island
Lord Howe Island

ABOUT THIS REPORT

The State of the Marine Environment Report for Australia (SOMER) is the first comprehensive description of Australia's marine environment, its uses and values, the issues and threats affecting it, and its management.

SOMER covers the marine environment of Australia and its external territories, from the estuaries and sea shores to the edge of the 200 mile Exclusive Economic Zone. It primarily concentrates on the coastal and continental shelf areas around the continent but it also covers issues within coastal catchments which affect the marine environment. Marine protected areas, a major reason for the establishment of the Ocean Rescue 2000 program, are discussed in some detail.

SOMER is an independent, scientific report and its production involved hundreds of marine experts. SOMER was a major challenge as Australia's marine environment is very large and covers a great range of climates, ecosystems, habitats and human influences. More significantly, Australia's marine environment is also very incompletely described. Long-term scientific information on the marine environment, which is essential to accurately assess its environmental condition, is very scattered, or lacking altogether in many areas.

A senior marine scientist, assisted by an expert Advisory Committee, was appointed to prepare SOMER. The topics to be covered in SOMER were initially identified by a workshop of experts from marine science, resource management and industry.

Some of Australia's leading marine experts were then commissioned to prepare reviews on these topics. These technical reviews were, in turn, subject to a process of 'scientific peer review' in which at least two other scientists expert in that area checked the review for its scientific accuracy. The 83 technical papers provided the source material for this report. Two volumes of 30 papers are published as 'The State of the Marine Environment Report for Australia: Technical Annexes 1 and 2'.

Because the technical papers were long (several thousand pages) and technical, they were simplified and summarised to produce the SOMER Technical Summary. This report is written in a semi-technical style for marine environmental managers, environmental scientists, conservationists, teachers and other specialists interested in the marine environment.

This booklet is an overview of the major findings of SOMER, written in a non-technical style for the general reader. It attempts to simplify often highly technical subjects, and makes assessments from often limited or sketchy information. Information sources, which mainly come from the SOMER Technical Summary, are referenced (as

SOMER process

topics identified by workshop

expert scientists commissioned to produce technical papers

papers peer reviewed

Selected papers published:
SOMER Technical Annexes 1 & 2

technical papers, condensed & management implications identified

reviewed by authors, SOMER Advisory Committee and relevant govt agencies

combined to produce technical report:
SOMER Technical Summary

major findings and issues identified & collated

reviewed by SOMER Advisory Committee and relevant govt agencies

published as non-technical report:
Our Sea, Our Future. Major findings of SOMER

major findings summarised in brochure:
Our Sea, Our Future. Summary of SOMER

applications of SOMER:

- ***Australian Marine Conservation Plan***
- ***National Marine Education Program***
- ***Marine Environment Conference (Uni Queensland, 1995)***
- ***National State of the Environment Report (1995)***

Acknowledgments

SOMER is the result of the effort of 134 scientists and technical experts, 14 members of the Advisory Committee, and around 160 external reviewers.

SOMER Advisory Committee members were: Dr Don Kinsey (Committee Chair), former Executive Officer of the Great Barrier Reef Marine Park Authority, Townsville, Qld; Associate Professor Paul Adam, School of Biological Science, University of New South Wales, Sydney, NSW; Dr Joe Baker, Senior AIMS Fellow, Australian Institute of Marine Science, Townsville, Qld; Dr Eric Bird, Geostudies, Black Rock, Vic; Professor Ben Boer, Law Faculty, University of Sydney, NSW; Dr Des Connell, Director, Government Chemical Laboratory, Brisbane, Qld; Dr Pam Eiser, Australian Committee IUCN, Sydney, NSW; Dr Laurie Hammond, CEO Foundation for Research, Science and Technology, Wellington, NZ, (retired); Dr Tor Hundloe, Industry Commission, Canberra, ACT; Professor Arthur McComb, Environmental Science, Murdoch University, Murdoch, WA (retired); Professor Jason Middleton, Chairman, Centre for Marine Science, University of New South Wales, Sydney, NSW; Dr Russell Reichelt, Director, Fisheries Resources Branch, Bureau of Resource Sciences, Canberra, ACT; Dr Graham Ross, Series Manager, Fauna of Australia, ABRS, Canberra, ACT; Professor Graeme Kelleher (ex-officio), former Chairman, Great Barrier Reef Marine Park Authority, Canberra, ACT.

The technical contributors are listed in the 'Information sources'.

Contents

Australia's 200 nautical mile Exclusive Economic Zone (EEZ), proclaimed in August 1994, is over 11 million square kilometres in area. Its area has not yet been precisely estimated but it is likely to be one of the largest EEZs in the world.

Australia's 200 nautical mile Fishing Zone, which excludes the Australian Antarctic Territory, is 8.94 million square kilometres in area and is the third largest in the world. The total area of the continental shelf around Australia, as defined by the 1982 United Nations Convention on the Law of the Sea, is 14.8 million square kilometres.(1,58)

Australian waters span almost 60 degrees in latitude from Torres Strait in the north, to Antarctica in the south, and 72 degrees in longitude from Norfolk Island in the east to Cocos (Keeling) Island in the west. They include a great range of geographic, geologic and oceanographic features, and around 12,000 islands. The length of the coastline of the mainland and that of the larger islands is estimated to be 69,630 kilometres at a 0.1 kilometre scale, or 30,270 kilometres at a 10 kilometre scale.(1)

But sea boundaries exist only on maps. Australia's marine domain is essentially a part of the interconnected world ocean which covers 71% of our planet. Many marine species are migratory, travelling across many nations' boundaries. Currents may carry marine organisms and pollutants great distances through the sea, necessitating a regional, national and international approach to marine environmental management.(2,93,95,96)

THE OCEAN

The waters surrounding Australia and its external territories are part of three large, interconnected ocean basins of the Southern Hemisphere: the Pacific, Indian and Southern Oceans.

Oceanography

Australia's seas encompass all five of the world's ocean temperature zones: tropical (25 to 31°C); subtropical (15 to 27°C); temperate (10 to 25°C); subpolar (5 to 10°C); and polar (-2 to 5°C). The main ocean currents affecting the marine environment around the continent are the East Australian Current which brings warm equatorial and Coral Sea water down the east coast, and the Leeuwin Current bringing warm, low salinity water down the west coast. These are not major currents by world standards. Other major ocean features are the

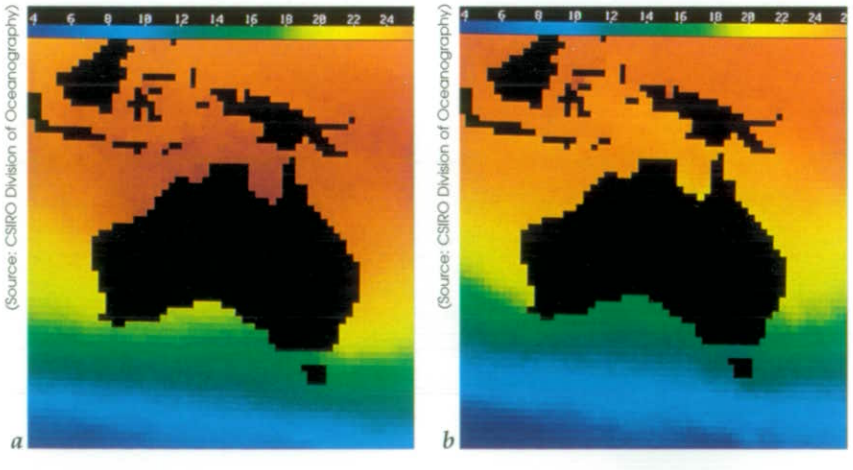
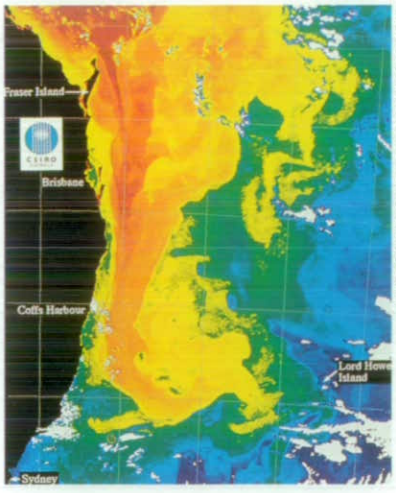
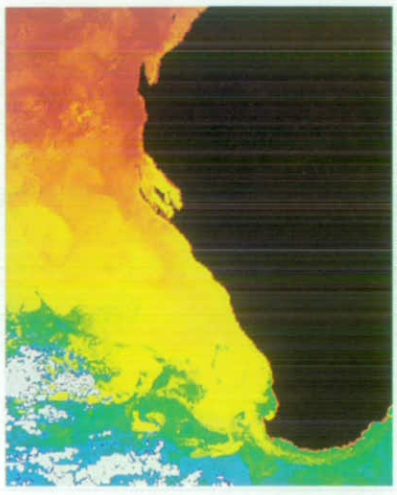


Figure 3: Australia's waters encompass all five of the ocean's climate zones. *These images, produced from satellite data, show average surface sea temperatures for summer (a) and winter (b) between 1982 and 1988.*



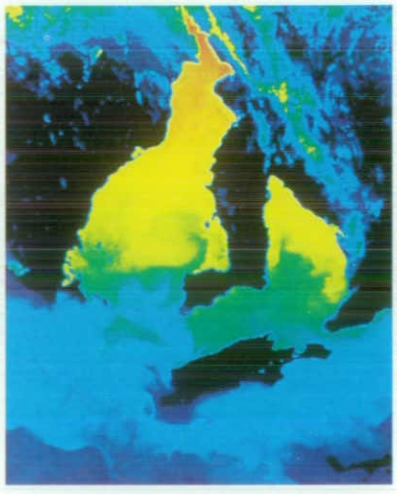
(Source: CSIRO Division of Oceanography)

Figure 4: Satellite image of eastern Australia showing the meandering East Australian Current. This current brings warm equatorial and Coral Sea water down Australia's eastern coast. Around the Sydney area it turns east into the Tasman Sea where it forms giant loops and eddies.



(Source: CSIRO Division of Oceanography)

Figure 5: Satellite image of Western Australia showing the Leeuwin Current. This current brings warm, low salinity water masses from the North West Shelf region down the western and south-western coasts. It sometimes reaches the Eyre Peninsula in South Australia.



(Source: CSIRO Division of Oceanography)

Figure 6: Satellite image of South Australia's gulfs showing marked changes in surface sea temperatures. The gulfs are 'reverse estuaries' which become warm and more salty in their upper reaches.

sub-tropical and antarctic convergences. The periodic influence of the El Nino/Southern Oscillation has a great effect on ocean temperature and biological productivity, and on Australia's terrestrial climate and agriculture.(2) Similarly there are the periodic influences of strong winds and storm surges associated with tropical cyclones and mid-latitude low pressure systems(84).

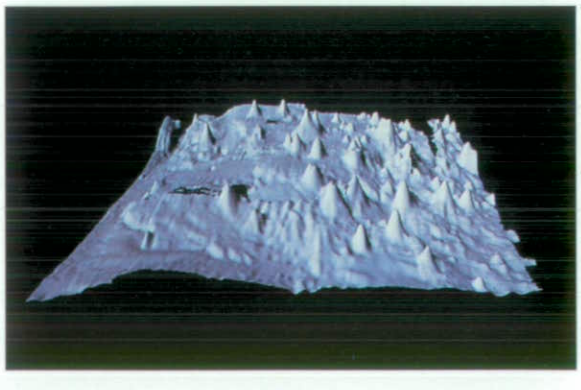
ocean nutrients and productivity

Australian waters are generally low in nutrients and therefore have a relatively low biological productivity. This is because they are largely dominated around the continent by low-nutrient tropical water masses; there are no major upwellings of nutrient-rich deep water in the region; and the run-off from our ancient, leached land is naturally low in nutrients. Paradoxically, some inshore areas tend to be dominated by highly productive mangroves, seagrass and coral communities which are adapted to low-nutrient waters. The generally low nutrient status also contributes to the relatively low fisheries production of Australian waters.(2,30)

sea floor

The mainland of Australia is surrounded by a continental shelf between 15 and 400 kilometres wide, and 2.5 million square kilometres in area. The shelf is connected to Papua New Guinea in the north, and to Tasmania in the south. With the exception of the complex Great Barrier Reef in the north-east, and the undersea cliffs and pinnacles off Tasmania, the sea floor is generally rather featureless but is broken by occasional reefs, terraces and plateaus.(3)

Figure 7: Spectacular volcanic cones recently discovered around 100 kilometres south of Tasmania. The cones which lie in 1,000 metres of water and average 200 metres in height, are the fishing grounds for Tasmania's lucrative orange roughy fishery. This image, which covers an area of around 35 kilometres square, was produced by multibeam sonar in 1994.

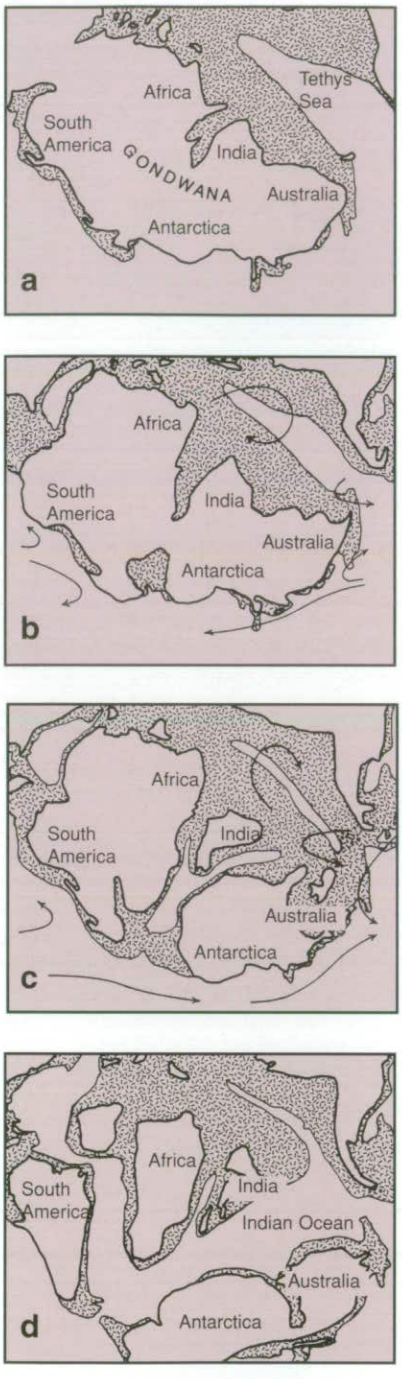


(Source: N. Exon, AGSO)

MARINE BIODIVERSITY

The ocean is the cradle of life on earth. Of the 33 major animal groups or phyla, 28 are found in the sea. Thirteen of these are exclusively marine[85]. Life forms, life histories and ecological processes are very different in the sea than on the land, often necessitating different approaches to marine environmental management[15]. The reproductive cycles of marine organisms are often closely linked with water movements and most species have spores or larval stages some of which are dispersed over very great distances. Because of the vagaries of currents and ocean conditions, their populations are subject to considerable year to year fluctuations. Marine species, bathed as they are in water, are particularly susceptible to water-borne pollutants.[15]

(Source: G. Poore[5])



Biogeography and origins of Australia's marine biodiversity

Australia's coastal sea life, although less well known than our unique land life, is also notable for its high proportion of endemic species (species found only in a particular area). There are two distinct biogeographic regions or provinces in Australia: the temperate south, and the tropical north, which overlap on the western and eastern coastlines.[5]

In the south, which has been geographically and climatically isolated for around 40 million years, about 80-90% of species of most marine groups are endemic, or restricted to this area. In the north, which is connected by currents to the Indian and Pacific Ocean tropics, only around 10% of most groups are endemic.[5]

The number of distinct 'bioregions' in Australian waters has not been agreed upon. A classification for the Council of Conservation Ministers in 1985 produced 32 bioregions (p. 81)[86], but this has not been widely recognised.[5] A new classification is currently being developed as a basis for the National Representative System of Marine Protected Areas in the Ocean Rescue 2000 program.

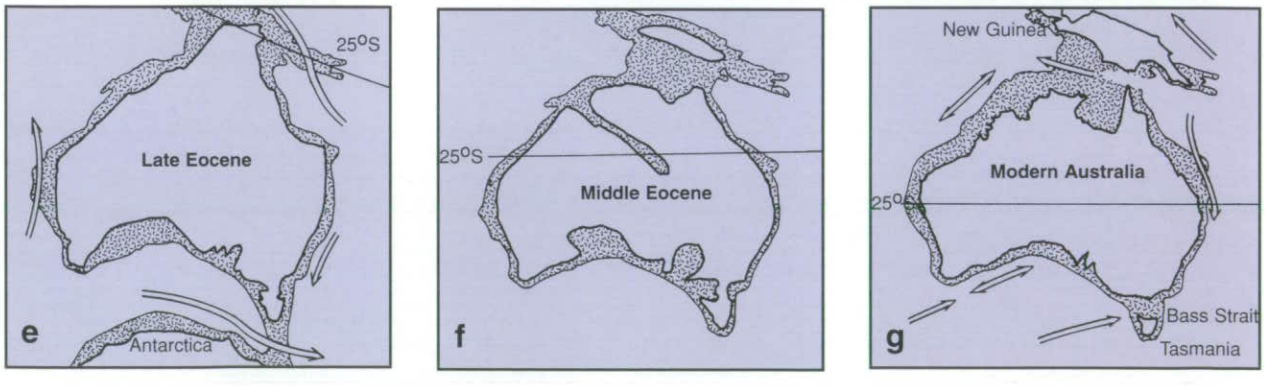


Figure 8: The origin of Australia's coastline and marine life. *Australia-Antarctica separated from Gondwana around 100 million years ago and drifted away to the east, carrying coastal fauna and flora with it (a - d). After the split from Antarctica, Australia drifted northwards, colliding with South-East Asia forming Papua New Guinea, linking the two regions' marine life (e - g). As a result, marine life in northern Australia is mainly tropical Indo-Pacific in orgin. Marine life in the climatically i solated temperate south is ancient Tethyan and Palaeoaustral in origin, and has a very high proportion of endemic species.*

STATUS OF MAJOR MARINE HABITATS AND ECOSYSTEMS

Australia's marine environment extends from the shores and wetlands along the coastline to the abyssal deeps, and from the coral reefs of Torres Strait in the north to the pack ice of the antarctic continent in the south.(1) The following section describes the main types of marine and coastal habitats and ecosystems in Australia, the major issues and threats affecting them, and assesses their environmental health or status.

Estuaries: critical habitats under threat

Estuaries are the meeting place of fresh and salt waters. Naturally rich in nutrients, estuaries are ecologically highly productive, and are important fish habitats. In Australia, estuaries and sheltered bays have also been the focus of urban and industrial development, and are important for recreation.(6)

Australia has 783 major estuaries: 415 in the tropics; 170 in the subtropics; and 198 in temperate areas. The long arid coastlines in the south-west and west have few estuaries.(6)

(Source: Saenger(6))

Table 1: Distribution and areas (sq km) of estuarine habitat types(6)

	Open water*	Intertidal flats**	Mangroves	Seagrass	Saltmarsh	Total
NSW	1 323	na	107	153	57	1 487
Vic	2 682	444	41	364	125	3 292
Qld	4 093	1 574	3 424	68	5 322	14 413
WA	17 825	2 891	1 561	11	2 965	25 241
SA	760	219	111	na	84	1 173
Tas	1 825	274	na	na	37	2 136
NT	5 187	821	2 952	23	5 005	13 966
Total	33 694	6 223	8 195	6 001	13 595	61 707

* includes subtidal seagrass beds

** includes intertidal seagrass beds

Most river catchments in eastern and southern Australia have been extensively cleared. This has resulted in land erosion, sedimentation of rivers and increased sedimentation and levels of nutrients downstream in estuaries, bays and adjacent coastal waters. High sediment levels in the water reduce light penetration which affects rates of photosynthesis. When sediments settle they can also smother seabed organisms. Sedimentation of estuaries and shipping channels causes shoaling and alters currents. Sedimentation is a major problem in ports and shipping channels, necessitating regular dredging. This resuspends sediments, creating further environmental problems.(6,42)

The flows of many of Australia's rivers have also been significantly altered by dams and barriers, reclamation of wetlands, irrigation schemes and flood mitigation schemes, affecting the hydrodynamics or flushing characteristics of estuaries.[1,6,40]

Elevated nutrients may cause eutrophication, the excessive growth of algae which may smother other organisms and deplete oxygen levels.[6,42]

(Source: Saenger[6])

Table 2: Overview of Australia's estuaries (% of estuaries with ...)[6]

	Uncleared catchments	Excellent water quality	High fisheries value	High conservation value	Threats to conservation value	Adequate state of knowledge
NSW	24.7	0.0	24.7	16.0	21.0	100.0
Vic	22.9	14.3	14.3	48.6	22.9	31.4
Qld	55.4	48.5	18.9	21.8	2.3	11.1
WA	86.2	83.4	7.6	7.6	2.8	7.6
SA	0.0	0.0	6.7	20.0	6.7	13.3
Tas	27.0	25.4	0.0	6.3	4.8	6.3
NT	99.3	97.1	17.5	22.6	0.7	5.1
Total	60.8	54.2	15.2	18.6	5.2	19.2

Where rivers drain disturbed acid soils, such as in northern New South Wales and southern Queensland, estuaries may become periodically acidic. This increases levels of dissolved aluminium and iron which form compounds very toxic to fish. As a result fish diseases such as 'red-spot' disease and fish kills are increasingly common in estuaries.[52]

Of the estuaries which have been studied, 64% in New South Wales and 22% in Victoria are considered to have poor water quality.

Figure 9: Threatened estuaries and enclosed marine waters of high conservation or fisheries value.

(Source: Saenger[6])

north are less affected by human activities but may carry heavy sediment loads resulting from soil erosion.(6)

Unnaturally elevated sediments and nutrients have led to an alarming decline in seagrass beds in temperate Australia(10). Poor water quality and loss of habitat have also caused a decline in estuarine fisheries. For example, fisheries are thought to be threatened in 21% of estuaries in New South Wales and 23% in Victoria(6). However, eutrophication of some estuaries has enhanced their value for oyster aquaculture(30).

coastal lakes and lagoons under threat

Of great concern in south-eastern and south-western Australia is the declining water quality and eutrophication of coastal lakes and lagoons, particularly those which are insufficiently flushed by the sea, for example, Tuggerah Lakes and Lake Macquarie (NSW), Gippsland Lakes (Vic) and the Peel-Harvey system (WA)(42,52,53,56). As coastal lakes are largely restricted to the densely inhabited south-eastern coastal strip, a significant proportion of the nation's coastal lakes has been degraded.

Coastlines and shore communities: heavily used and potentially vulnerable

The intertidal shores are the meeting place of the land and sea. Shores are periodically immersed by sea and exposed to air, and subject to extremes in salinity. They are often enriched by land nutrients and have a high biological productivity. Shores have a high diversity of very specialised animals and plants, and may require special conservation measures. Australia's shores include open coasts with rocky headlands, cliffs and sandy beaches; and sheltered coasts, bays and estuaries with muddy and sandy tidal flats.(1,9)

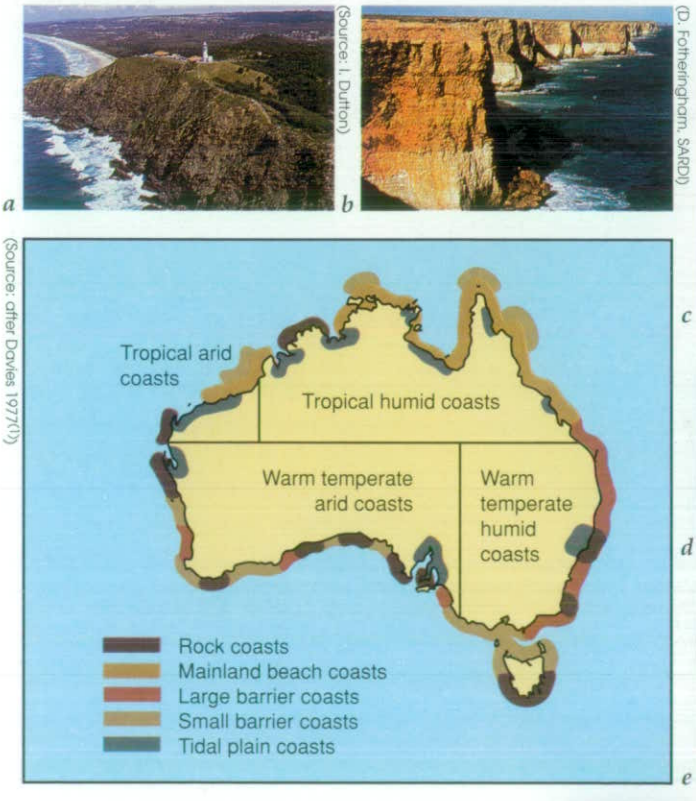


Figure 10: Australian shores are varied and picturesque.
(a) Warm-temperate humid coastlines in the south-east are noted for their rocky headlands and long sandy beaches. Cape Byron (NSW). (b) Warm-temperate arid coastline. The spectacular Nullarbor Cliffs stretch unbroken for around 180 kilometres of the Great Australian Bight (SA). (c) Arid Shark Bay coast (WA). (d) Tropical arid coastline. Fringing coral reefs off Ningaloo (WA). (e) Tropical humid coastline. The wide, macrotidal shore near Hope Islet (NT).

Table 3: Areas of major coastal landforms (sq km) and % of total coastline[1]

Landform	Qld	NSW	Vic	Tas	SA	WA	NT	Total
Dunes, beaches etc	5 109	1 236	1 653	984	5 613	12 057	1 242	27 897
(%)	18.8	16.3	28.0	13.8	53.4	33.4	5.5	23.8%
Low rocky terrain	1 407	1938	724	1 974	969	2 832	390	10 234
(%)	5.5	25.6	12.3	27.7	9.2	7.8	1.7	8.7%
High rocky terrain	2 198	1 365	432	2 247	279	5 142	552	12 215
(%)	8.1	18.0	7.3	31.5	2.7	14.2	2.4	10.4%
Tertiary sand, laterite	1 212	144	939	414	129	2 076	5 271	10 185
(%)	4.4	1.9	15.9	5.8	1.2	5.7	23.3	8.7%
Intertidal mud	4 527	117	150	33	459	5 643	5 742	16 671
(%)	16.6	1.5	2.5	0.5	4.4	15.6	25.4	14.2
Supratidal mud*	8 522	117	198	57	558	4 218	6 675	20 345
Alluvium*	2 652	1 518	1 203	714	99	1 977	1 581	10 638
Water (estuaries etc)	1 596	1 128	597	705	1 503	2 187	1 146	8 862
(%)	5.9	14.9	10.1	9.9	144.3	6.0	5.2	7.6%
Cliffs >2 m (km)	4 875	565	465	664	1 023	1 950	548	
(% of coastline)	8.0	33.0	27.0	27.0	29.0	18.0	10.0	
Length of coastlines (km)	6 080	1 740	1 720	2 230	3 270	10 100	5 030	

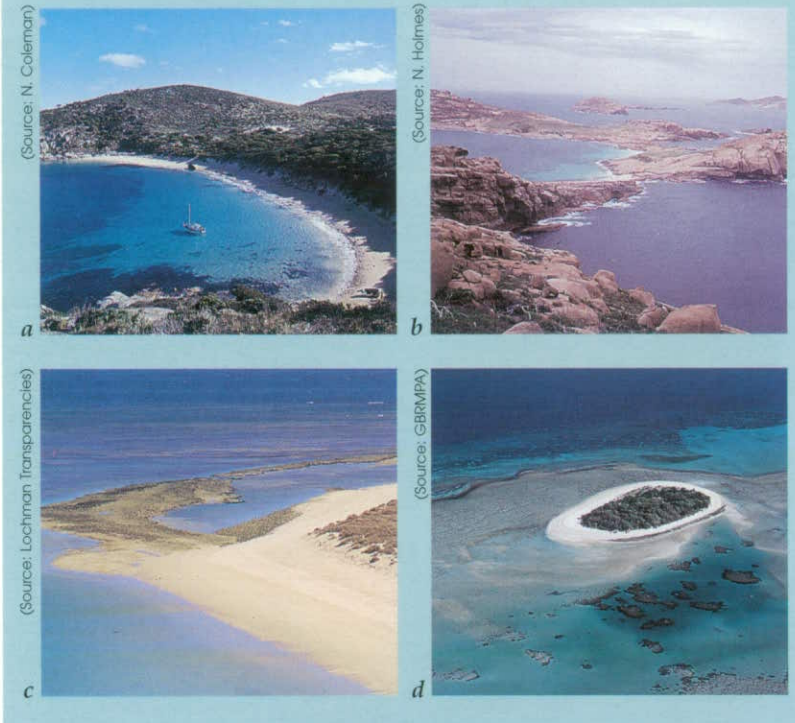


Figure 11: Over 12,000 islands lie off Australia's coast. *(a) Erith Island, Bass Strait. (b) Pearson Island (SA) . (c) Barrow Island, Western Australia. (d) Bushy Island, Great Barrier Reef.*

Australian shores are also the meeting place for people. Beaches are the most popular areas for outdoor recreation in Australia, and are popular for recreational fishing, swimming and surfing.[23,28,29]

Intertidal rocky shore habitats are often limited in area. They are also potentially vulnerable to human impacts. Threats to shore communities include over -harvesting of molluscs, crustaceans and sea urchins for food and bait, trampling by fishers and other visitors[34], oil slicks and other pollutants which float on the sea surface[39], and loss of habitat[40]. In the more populous south-east, south and south-west of Australia, significant areas of shores around coastal cities and towns have been reclaimed or alienated by seawalls, port development, industry, housing and tourism and recreational facilities[40,51-54].

Despite their great ecological and recreational values, shores are often not well protected. On some coasts they are protected through terrestrial conservation reserves which extend to the low water mark. Management of intertidal areas may be confused by overlapping responsibilities, and lack of coordination amongst management agencies. Effects of human uses are also not well understood or monitored.(9,67)

Because of serious concerns on the over-harvesting of intertidal invertebrates, in 1993 New South Wales introduced a management plan for its shores which included an extensive system of Intertidal Protected Areas, controls on tools used in collecting, and strict bag limits.(6,52,77)

Coastal saltmarshes: undervalued and locally threatened

Coastal saltmarshes, the intertidal plant communities dominated by herbs and low shrubs, are often associated with estuaries. Saltmarshes are highly productive, key habitats which support many other organisms. They are a critical habitat for many migratory species and for rare species such as the orange bellied parrot in Victoria.(7)

It is estimated that Australia has 13,595 square kilometres of saltmarshes (Queensland 5,322; New South Wales 57; Victoria 125; Tasmania 37; South Australia 84; Western Australia 2,965; and Northern Territory 5,005 square kilometres).(7)

A major threat to saltmarshes in developed areas is land reclamation and extensive areas have been filled for ports, marinas, canal estates and urban and industrial sites. Other threats include degradation by rubbish dumps, off-road vehicles, invasion by weeds (particularly by introduced cord grass, pampas grass, para grass, and rushes), periodic surges associated with low pressure systems and drainage for mosquito and sandfly control. Although the total loss of saltmarshes has not been great in Australia, most has been concentrated in the south-east where the initial area was small, and where biodiversity and endemism is highest. Losses are therefore considered to be significant both regionally and nationally. A sea level rise resulting from an enhanced greenhouse effect could cause significant contractions in saltmarshes.(7,84)

Mangroves: vital coastal ecosystems

Mangroves are tree and shrub species which are adapted to the periodically inundated and salty conditions between the tides. Mangrove forests are very productive ecosystems and are of major ecological and economic importance. They provide habitats and nurseries for many fish, form a buffer for estuaries from sediments and for coastlines from storm waves, are natural nutrient filters, and are critical habitats for many birds and other wildlife. Australia has the third largest area of mangroves in the world, and has some of the most diverse communities.(8)

(Source: GBRMPA)

Figure 12: Mangroves are highly productive communities, are important nurseries for fish, and protect the coastline during storms. *These mangroves are off eastern Cape York (Qld).*

(Source: N. Coleman)

Figure 13: Significant areas of mangroves have been cleared or killed around metropolitan areas of Australia. *About 20% of the mangroves in Moreton Bay near Brisbane have been cleared.*

Overall losses of mangroves in Australia are small compared with those from other countries. However, locally significant losses have occurred around Australian coastal cities and towns, for example 20% has been cleared in Moreton Bay near Brisbane[8,51], and there has been significant die-back of mangroves near Adelaide[55]. Major threats are continued local clearing and development and effects of catchment alterations. Only 8% of Australia's mangrove communities are in protected areas[8].

(Source: Robinson and Alongi[89])

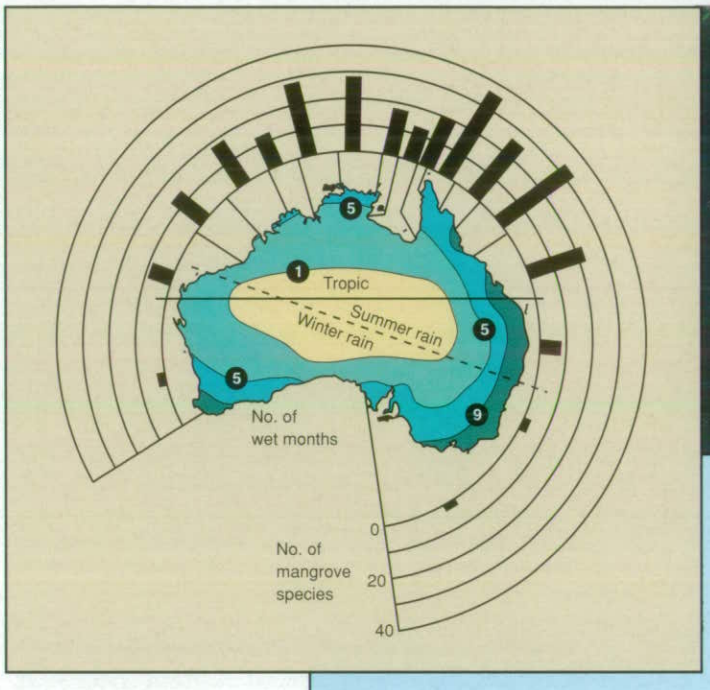


Figure 14: Mangrove plant richness around Australia. There are far more species in the wet tropics. The aridity (shown here as the number of wet months) affects species richness in north-western Australia.

(Source: GBRMPA)

Table 4: Area (sq km) of mangrove forests in Australian States and the Northern Territory, the number of reserves, the area reserved and the % of mangroves in each State which are reserved.

	area	no. reserves	area reserved	% reserved
Queensland	4 602	54	600	13
tropics	4 117			
subtropics	485			
New South Wales	99	8	5	5
Victoria	12	2	3	23
Tasmania	0	0	0	
South Australia	211	7	113	56
Western Australia	2 517	*	*	*
tropics	2 507			
subtropics	10			
Northern Territory	4 119	2	282	7
TOTAL	11 558	73	1 003	

*Western Australia protects all mangroves.

Seagrass beds: major declines in temperate areas

Seagrass beds are also ecologically important because of their high productivity, their ability to trap and stabilise sediments, their importance as fisheries habitats, and as the habitat for important species such as dugongs and turtles[10,18]. Australia has the highest biodiversity of seagrasses in the world, the largest areas of temperate seagrass and one of the largest areas of tropical seagrass[10].

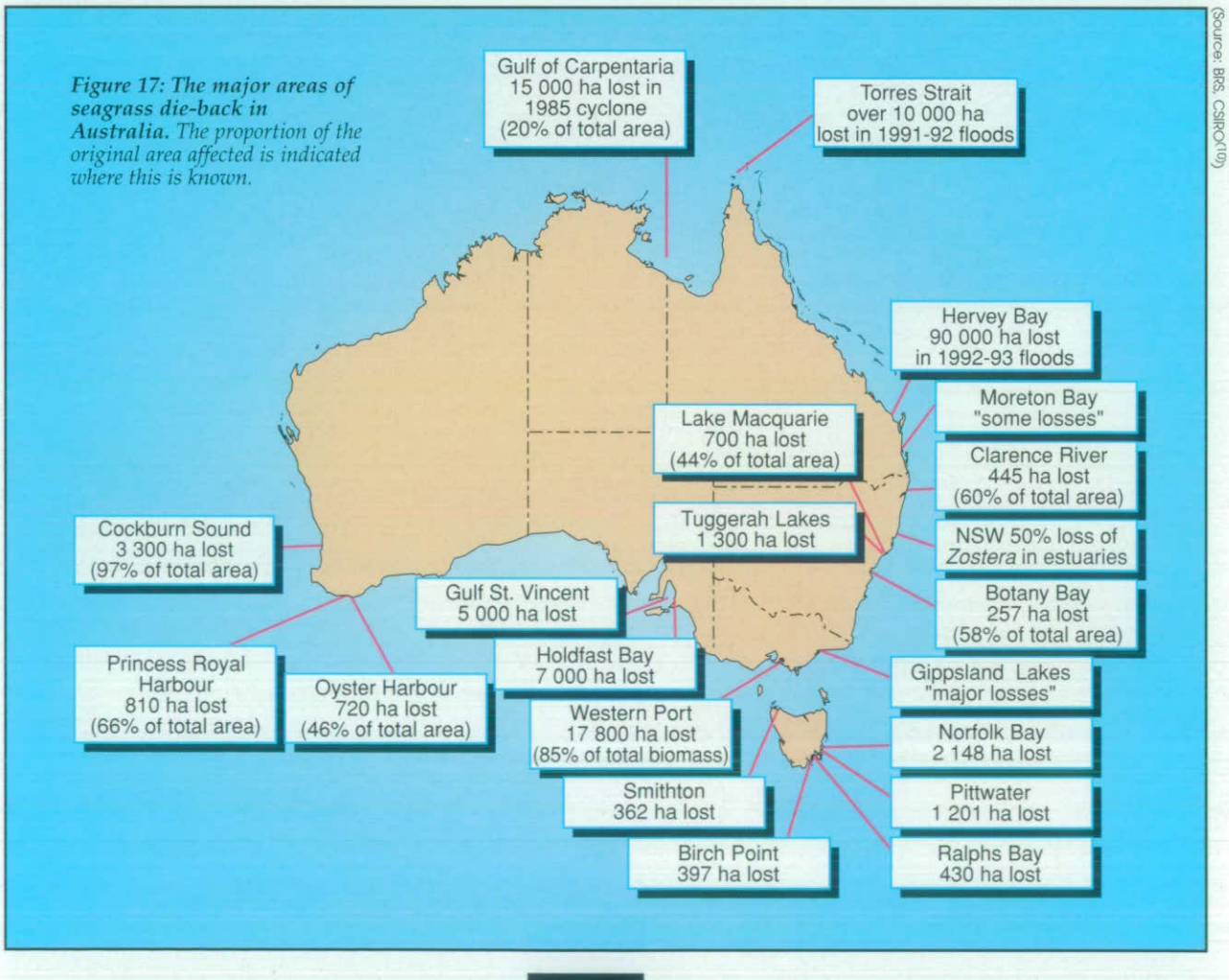
(Source: N. Holmes)

Figure 15: Australia has the largest area and highest diversity of temperate seagrass in the world. *Seagrass are highly productive communities, are important nurseries for fish, and protect shores during storms. This diver is surveying beds in South Australia where large areas have suffered die-back.*

(Source: A. Dalgetty, SARDI)

Figure 16: Die-back of seagrass beds is one of the most serious issues affecting Australia's marine environment. *Blooms of epiphytic algae, thought to be caused by elevated nutrients from sewage and stormwater discharges, are smothering blades of this* Posidonia *seagrass off metropolitan Adelaide.*

Australia's unique temperate seagrass beds appear to be under particular threat. Increased sedimentation and nutrients from catchments have been linked with massive die-back of seagrasses in many areas. New South Wales has lost half of the *Zostera* seagrass in its estuaries[10,52]. In Victoria around 85% of the total biomass of seagrass in Western Port has been lost[10]. In Tasmania there have also been declines in the Hobart and D'Entrecasteaux region, Triabunna



(Source: BRS, CSIRO[10])

Figure 17: The major areas of seagrass die-back in Australia. *The proportion of the original area affected is indicated where this is known.*

and St. Helens on the east coast, and Tamar, Port Sorell and Duck Bay on the north-west[54]. In South Australia's Gulf St Vincent around 5,000 hectares of seagrasses has been lost[10,55]. In Western Australia around 97% of seagrass in Cockburn Sound have been lost[10,56]. A serious loss of tropical seagrasses has occurred in Hervey Bay in Queensland, causing major mortality of dugongs[10,18].

Once lost, seagrasses do not readily recover[10]. The decline in temperate seagrass is one of the most serious issues in Australia's marine environment.

Temperate reefs: unique, poorly known and under-protected

While the submerged rocky reefs in temperate Australia may lack the glamour and accessibility of their tropical equivalents, they do have a very high species diversity and a high proportion of endemic species[5,11]. Australia's southern coastline has the world's highest diversity of red and brown algae (around 1,155 species), bryozoans (lace corals), crustaceans and ascidians (sea squirts). Long isolated in geological time and by climatic barriers, this region has a distinctive fauna and flora, with around 80% to 90% of species in most groups being endemic[11]. Temperate reefs are also important for commercial and recreational fisheries such as abalone, rock lobster, snapper[11,31], and for recreational diving[28].

Figure 18: Australia's temperate reefs have a very high species diversity of algae and invertebrates, and a very high proportion of endemic species. *(a) Australian fur seals on reef, Sir Joseph Banks Group (SA). (b) The kelps are common canopy plants and important primary producers on temperate reefs (SA). (c) Temperate reefs have a very high diversity of ascidians and other invertebrates (SA).*

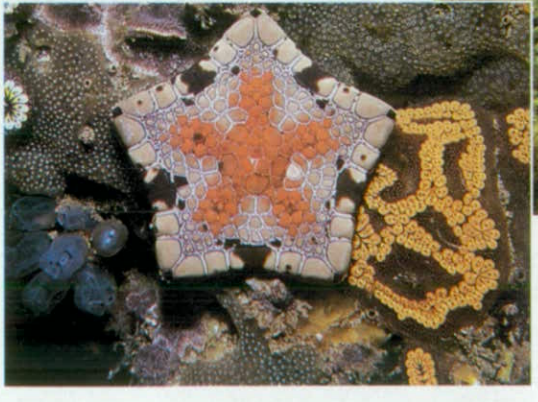
(Source: SARDI)

b

(Source: N. Holmes)

a

(Source: N. Holmes)



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Despite their high conservation and economic values, Australia's temperate reefs are inadequately studied scientifically[11], and relatively few are protected[67]. Very little is known of the effects of human activities on temperate reefs but it is assumed that outside metropolitan and industrial areas, they are relatively unaffected[11].

Table 5: Biogeography of Australia's macroalgae

Southern Australia is the outstanding region of the world for richness of benthic algae[102]. The 5,500 km coastline from the south-west part of Western Australia to the NSW/Victorian border has around 427 genera and 1,155 species of benthic macroalgae. It is rich in Phaeophyta, and is particularly rich in Rhodophyta. Some genera and many species are endemic.

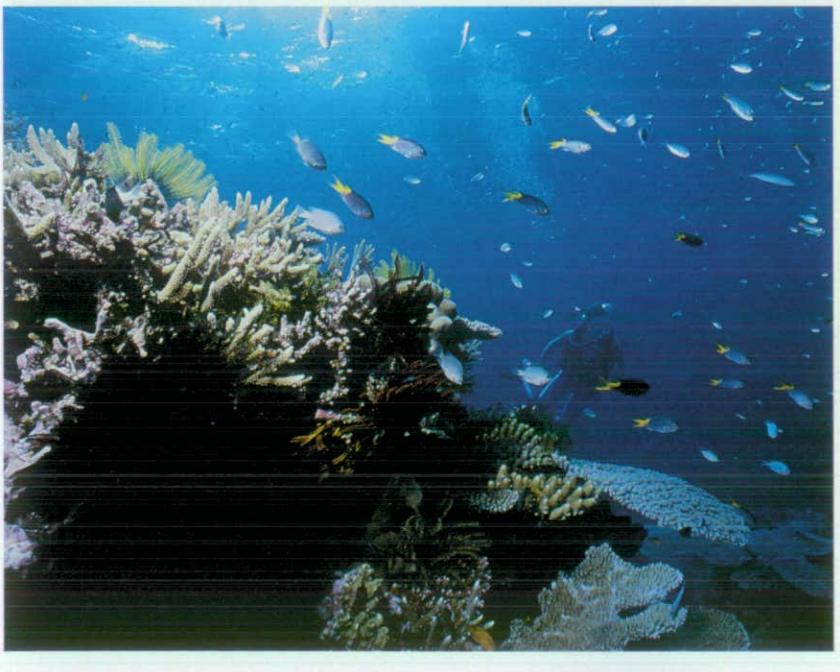
	total genera	no. endemic (% total)	total species	no. endemic (% total)
Chlorophyta (green algae)	39	2 (5%)	124	43 (30%)
Phaeophyta (brown algae)	104	20 (19%)	231	131 (57%)
Rhodophyta (red algae)	284	72 (30%)	800?	538 (75%)
Total	427	94 (22%)	1155	712 (62%)

Coral reefs: under global threat

Coral reefs are among the most productive, diverse and complex ecosystems in the world. They are also under global threat. It has been estimated that around 70% of all the world's coral reefs are degraded in some way, and there are fears that the survival of coral reefs in some areas is threatened[12].

Australia has the largest area of coral reefs of any nation and the largest coral reef complex, the Great Barrier Reef. Major areas of coral reefs are also present in Torres Strait, the Coral Sea Territories, and central and northern Western Australia. The Tasman Sea reefs (Elizabeth and Middleton Reefs and Lord Howe Island fringing reef) are the highest in latitude in the world, and thrive in conditions otherwise marginal for coral growth.[12]

Figure 19: Coral reefs are one of the most diverse and productive ecosystems in the world. *(a) Coral reef, Great Barrier Reef. (b) On coral reefs, corals are the main canopy formers and primary producers because of their symbiotic algae, the zooxanthellae. (c) Coral reefs support many thousands of other species.*



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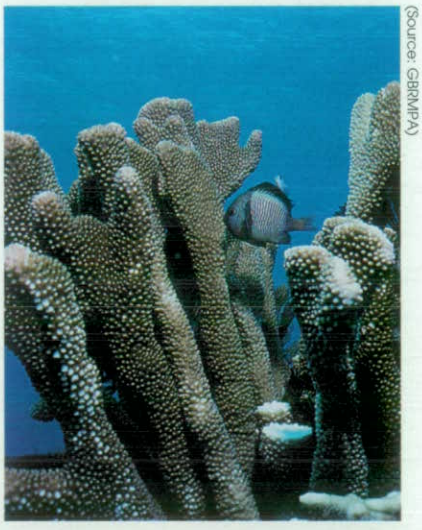

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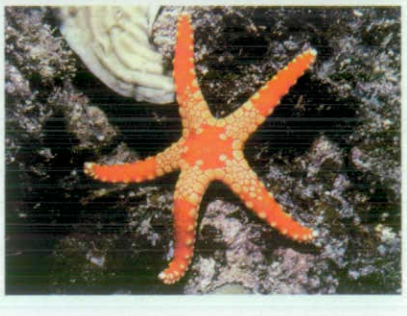

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(Source: GBRMPA)

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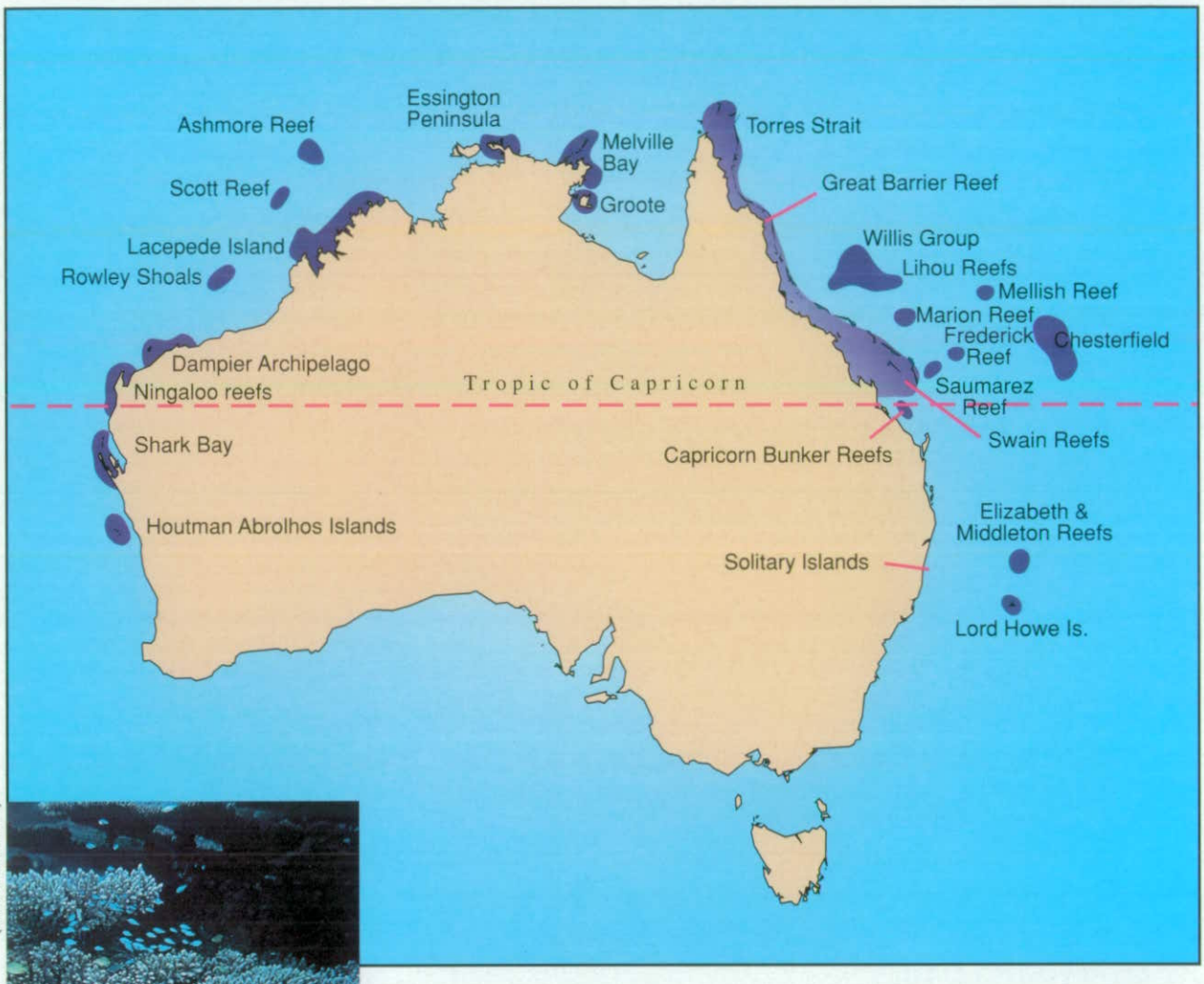
(Source: Veron[12])



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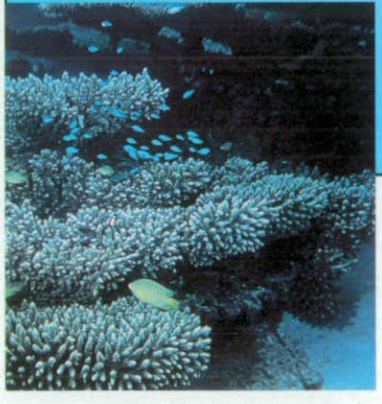


Figure 20: Australia has the largest area of coral reefs (purple) of any nation. (Inset) Acropora *corals on Ningaloo Reef.*

General issues affecting Australia's coral reefs include effects of sediments and nutrients[42], effects of fishing and tourism[69], and the threats of oil spills[39]. Specific threats include elevated nutrients in the

Sea floor communities: out of sight, out of mind and little known to science

Continental Australia has around 2.5 million square kilometres of geomorphic continental shelf, half of which is less than 50 metres deep. The continental slope which drops from a depth of 150 metres to 4,000 metres, is at least 2 million square kilometres in area. The total area of the continental shelf around Australia, as defined by the 1982 United Nations Convention on the Law of the Sea, is 14.8 million square kilometres. Under the Convention definition, the Continental Shelf can extend beyond the 200 nautical mile EEZ, and in Australia's case it does so in various places.[1,58]

The communities on the deeper areas of sea floor are almost completely unknown to science[13]. Only three qualitative studies have ever been made on Australia's shelf, and only two areas of the slope have ever been visited by scientists. Sites examined on shelves and slopes on the Great Barrier Reef, Bass Strait and North West Shelf had very high biodiversity, and very high proportions of species previously unknown to science[13].

(Source: B. Russell, NT Museum)

Figure 21: Dredging and trawling may have significant impacts on sea floor communities. *Trawling on the North West Shelf has removed large numbers of sponges and other attached organisms from the sea floor.*

Little is known of human impacts on sea floor communities. The rate of sedimentation on the sea floor has greatly increased since European colonisation of Australia by factors of 10 to 100, and even more in some areas[3]. Some shelf and slope fish species have been severely overfished, and trawl nets may dislodge attached species such as sponges and modify the habitat and food chains[32]. Dredging and dumping of wastes may also cause localised disturbances around ports[36].

Most of Australia's sea floor is not actively managed[13,67]. However, trawling is prohibited in some areas (e.g. in parts of the Great Barrier Reef Marine Park[69]), and dumping of wastes on the sea floor is controlled under international conventions (e.g. London Convention) and various Commonwealth and State/Territory legislation[36].

Phytoplankton, the pastures of the sea: growing concerns about toxic marine algae

Phytoplankton, the minute algae which make up the floating pastures of the sea, is the food base of the oceans.

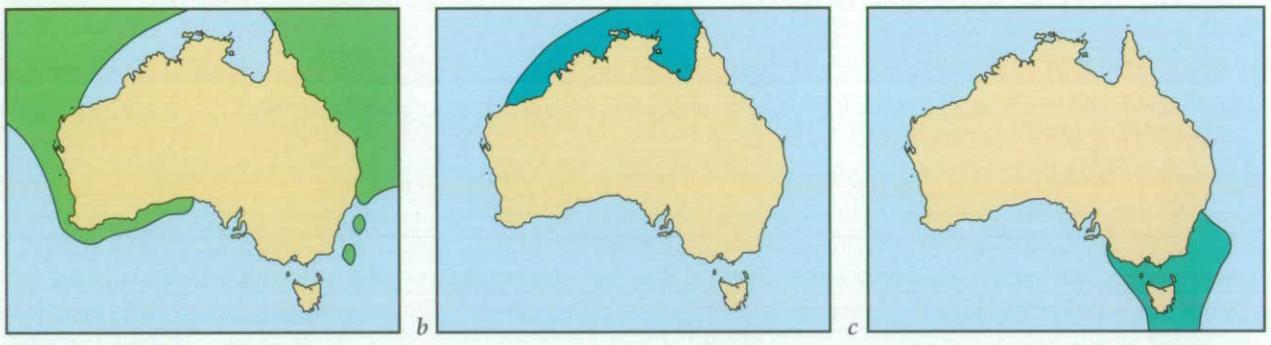
Most rivers, estuaries and coastal waters near Australia's large population centres show signs of eutrophication. Blooms of toxic plankton are increasingly common in areas such as the Hawkesbury River and Tuggerah Lakes (NSW), Gippsland Lakes and Port Phillip Bay (Vic), Huon and Derwent Rivers (Tas), Port River (SA) and Cockburn Sound (WA).[14, 42]

Blooms of toxic marine algae, which are thought to have been introduced from other countries in ships' ballast waters[14,42,48], are now periodic, serious problems in parts of Tasmania[54] and Victoria[53] where they kill marine life and cause the closures of shellfish farms.

Management to limit nutrient discharges from farmlands and sewage into inland and coastal waterways is the only way of controlling harmful algal blooms in the long-term.[14,42]

Figure 22: The distribution of three distinct marine phytoplankton communities in Australian waters: *(a) tropical oceanic species; (b) tropical neritic species; and (c) temperate neritic species. These assemblages support different marine food chains and are likely to have different sensitivities towards nutrient and pollutant stress.*

(Source: (Hallegraeff[149]))



a b c

STATUS OF MARINE GROUPS

Little is known of the conservation status of most of Australia's marine species[15]. Scientific interest to date has largely centred on the higher vertebrates such as turtles, seabirds, seals, dugongs and whales. Micro-organisms, algae, invertebrates and fish have been generally neglected[85].

Considerations in the management of marine species

Much of the effort in conservation of terrestrial biodiversity has centred around the protection of rare and endangered species. However, it is difficult to apply the endangered species concept to marine animals other than mammals, seabirds and some reptiles. Management strategies for conserving terrestrial species are often not suitable because of the interconnectivity in the marine environment.[15]

Many marine species are naturally rare by terrestrial standards but are not necessarily endangered. Species extinctions appear to be infrequent in the marine environment but local extinctions are more common. If these occur in ecologically important species in specific communities, they may have a major impact on marine ecosystems.[15]

We know very little of marine biodiversity. Many marine species remain undescribed and relatively little is known about most of the described species. An enormous taxonomic and monitoring effort would be required in Australia to describe all species and to determine their status.[15]

Given this lack of knowledge, precautionary management strategies are important in the conservation of marine biodiversity. These strategies might include establishing protected areas for endemic species with small geographic ranges or restricted breeding sites; protecting long-lived, large and wide-ranging species; and enhancing populations of excessively exploited species.[15]

Networks of marine protected areas are an important 'catch all' strategy for protecting the majority of species of unknown status and significance, particularly invertebrates.[15]

Plants

The seas around Australia contain thousands of different types of microscopic marine algae, fungi and bacteria. Australia's marine phytoplankton includes representatives of all 13 algal classes, including diatoms (5,000 species) and dinoflagellates (2,000 species)[14]. Australia is also very rich in macroalgae or seaweeds. Southern Australia has over 1,150 species. This is over 50% more than any comparable region in the world[88].

The angiosperms (flowering plants) are also very well represented. Australia has 11 of the world's 12 genera of seagrass, and over half the total number of species. Australia has 16 of the world's 20 families of mangroves, and 40 of the world's 55 species of mangroves.[88]

Invertebrates

The number of marine invertebrate species in Australia is unknown but is probably in the order of tens of thousands. The conservation status of very few invertebrate species is known. A number appear vulnerable because they are rare and have quite restricted habitats[15]. Examples include a number of species of volute shells; cowries such as the Western Australian *Zoila* species and the Queensland *Cymbiola* species; and the live-bearing starfish *Patiriella vivipara* and *P. parvivipara* which are restricted to Tasmania and South Australia, respectively[84,89].

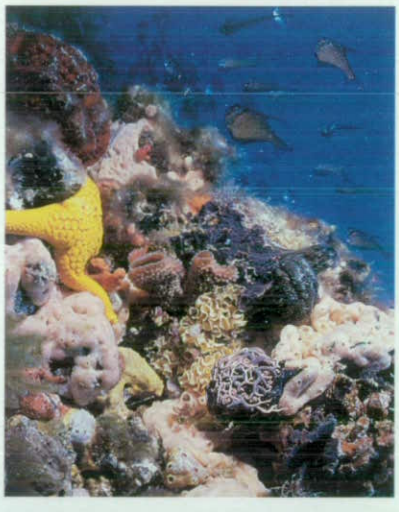
Because there is insufficient information on the status of invertebrate species, none are listed in the *Commonwealth Endangered Species Protection Act* 1992. Some, mainly the commercially fished species, are covered by the *Wildlife Protection (Regulations of Exports and Imports) Act* 1982. All hard corals (Scleractinia) are listed on Appendix 2 of the Convention on International Trade in Endangered Species (CITES) because of problems in controlling trade in other countries. It is expected that as scientific knowledge increases, the vulnerable invertebrates will be progressively incorporated into the legal and administrative framework used to conserve vertebrates[16,60]. Habitat protection is considered to be the most useful approach to conserving invertebrates[15].

Fish

Australia has an estimated 4,000 to 4,500 species of fish, of which around 3,600 have been described. Around one-quarter of the species are endemic, most of which are found in the south[5,90]. While regulations governing many of the fished species have long existed in this country, marine fish conservation is a relatively new field and the conservation status of most species is poorly known[16].

Potentially vulnerable fish include the sharks, which are slow growing, have a low reproduction rate, are highly migratory, and school during the mating season. Threats are commercial and sports fisheries, and shark meshing of surfing beaches. Also vulnerable are fish species with restricted distributions which may be threatened by loss of habitat.[16]

Figure 23: Many thousands of species of invertebrates are found in Australian waters. *The status of very few is known. (a) A large range of invertebrates present under a rocky ledge at Marmion Marine Park in Western Australia. (b) Invertebrates dominate a reef edge of the Great Barrier Reef.*



(Source: E. Boogaard, Lochman Transparencies)

a

(Source: GBRMPA)

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(Source: SARDI)

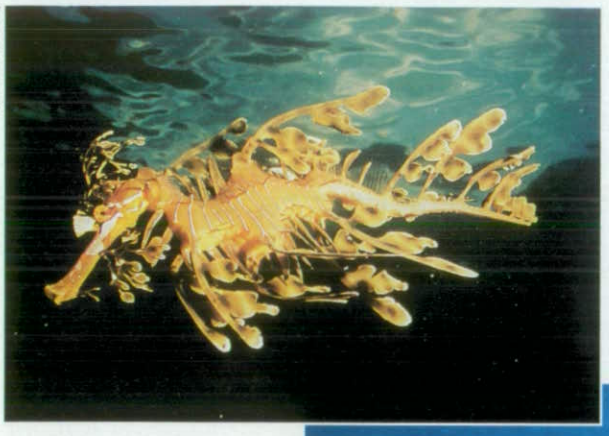


Figure 24: The unique leafy sea dragon is camouflaged to resemble a piece of drifting seaweed. Because of concerns that populations were declining from over-collecting, effects of trawling and loss of habitat, it is protected in South Australia.

Recent concern has focused on the status of the tropical rays known as sawfish, and the endemic handfish family in southern Tasmania. The handfish *Brachionichthys hirsutus is* the first marine fish to be listed nationally as endangered.(16)

No marine fish in Australia is listed as 'Endangered' by the IUCN (International Union for the Conservation of Nature - World Conservation Union). One, the whale shark, is listed as

(Source: G Taylor, Lochman Transparencies)

Figure 25: The giant whale shark is protected in Ningaloo Marine Park in Western Australia where it is the focus of a growing dive-tourism industry.

'Indeterminate'. The status of the great white shark and several others is insufficiently known. Other species have been considered for national conservation listings, for example Herbst's shark, black cod and southern bluefin tuna(16).

The grey nurse sharks, harmless fish-eaters despite their fearsome reputation, are protected in New South Wales because populations were seriously depleted by spear fishing. Whale sharks are protected in Ningaloo Marine Park in Western Australia. The leafy sea dragon is protected in South Australia because of concerns that populations were declining, possibly due to trawling, collecting and loss of habitat. The blue groper is protected in parts of South Australia. The black cod, a large species targeted by spear and line fishing, is protected in New South Wales and through the establishment of the National Marine Nature Reserve at Elizabeth and Middleton Reefs in the Tasman Sea(16).

(Source: SARDI)

Figure 26: There are growing concerns on the status of the great white shark in South Australia.

(Source: GBRMPA)

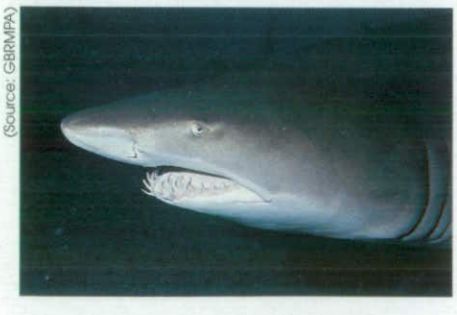


Figure 27: The grey-nurse is protected in New South Wales because populations have been depleted by spear fishing.

Reptiles

sea snakes

Australia has about 30 of the world's 50 species of sea snakes, around half of which are endemic. The family of aipysurids live in coral reef waters and the family of hydrophiids live in inter-reefal waters of Australia's tropics. Sea snakes bear live young and have a relatively short lifespan; they reach sexual maturity in around three years, and live for some 10 years. The greatest human impact is from prawn trawling. Sea snakes are quite fragile animals and it has been estimated that between 10 and 40% taken in trawls die once released. For the past 20 years trawled sea snakes have been used in a small leather industry. Licences currently limit the take of sea snakes for leather to 20,000 per year.(18)

Figure 28: Loggerhead turtles mating on the Great Barrier Reef. Although Australian populations are secure, turtles are considered to be seriously threatened worldwide.

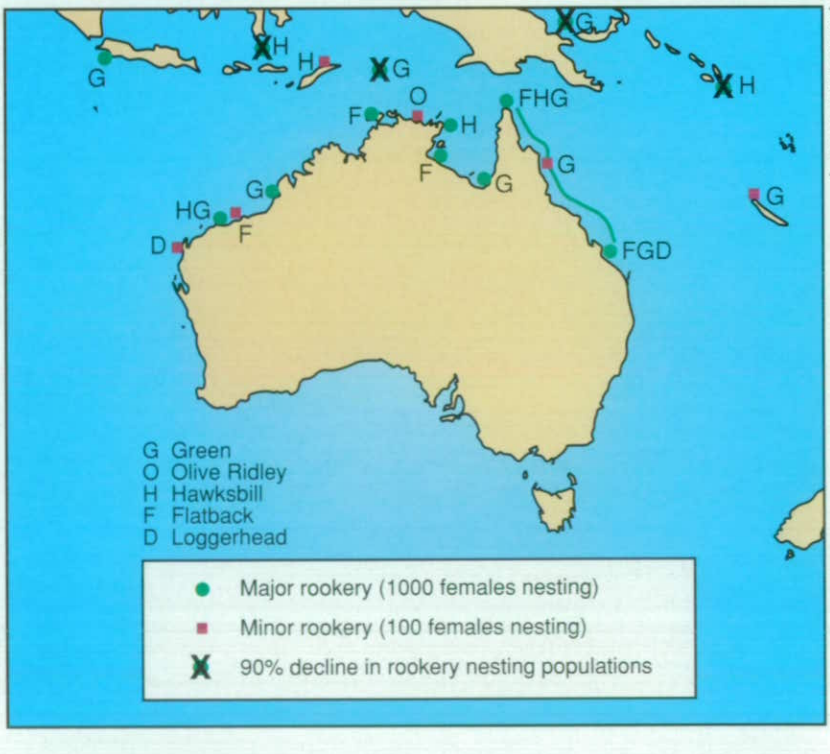
(Source: GBRMPA)

turtles

Turtles are large and exceptionally long-lived reptiles. They are slow to reach maturity; for example it takes about 35 years for green turtles to mature. Turtles may breed only around five times in their lives, making them extremely vulnerable to over-exploitation. Six of the seven world turtle species occur in Australian waters. One, the flatback turtle, is endemic. Breeding migrations may cover hundreds to thousands of kilometres and many turtles breeding in Australia may live around the islands of Papua New Guinea, the south-western Pacific Islands, and Indonesia, making species management difficult.(18)

The major human impacts on Australian breeding turtles while in neighbouring countries are from subsistence and commercial hunting for meat, shells and leather. The main human impacts occurring while turtles are in Australian waters are: mortality of adults in prawn trawls, shark nets and gill nets, and in collisions with speedboats; subsistence hunting by indigenous communities; habitat degradation; and predation on eggs by feral animals.(18)

Figure 29: Status of turtle rookeries in northern Australia and adjacent islands. Some major declines have occurred in populations to the north.



(Source: Marsh et al.(18))

Turtles are seriously threatened worldwide. The leatherback, green, hawksbill and olive ridley are listed as 'Endangered' by the IUCN; the loggerhead is listed as 'Vulnerable'; and the flatback as 'Potentially Vulnerable'. Despite their apparent abundance in this country, populations of green, loggerhead, and hawksbill are declining in Australia, Indonesia/Malaysia and Oceania. Because some species are highly migratory, a regional approach to the management of turtles is important.(18)

Table 6. Estimates of numbers of breeding pairs of Australian seabirds along the Australian coast and Coral Sea (range of estimates)[17]

Little penguin (C)	149 130	249 900
Shy albatross (C)	6 900	8 500
Great-winged petrel (C)	33 050	84 100
Herald petrel (T)	3	3
Black-winged petrel (T)	3	3
Gould's petrel (T)	250	500
Fairy prion	1 055 060	1 682 000
Wedge-tailed shearwater(T)	1 301 150	1 344 400
Flesh-footed shearwater (C)	104 540	310 600
Sooty shearwater (C)	300	1 210
Short-tailed shearwater (C)	12 787 070	16 059 700
Little shearwater (C)	27 060	61 600
White-faced storm-petrel (C)	370 180	396 600
Common diving-petrel (C)	127 220	184 000
Australasian pelican	1 030	1 680
Australasian gannet (C)	5 560	6 140
Masked booby (T)	3 750	4 270
Red-footed booby (T)	1 380	4 990
Brown booby (T)	59 940	73 900
Pied cormorant (T)	13 080	19 120
Little pied cormorant	140	200
Black-faced cormorant (C)	7 740	8 110
Great frigatebird (T)	1 610	1 610
Lesser frigatebird (T)	18 680	19 430
Red-tailed tropic bird (T)	290	380
White-tailed tropic bird (T)	2	2
Silver gull	133 890	163 620
Pacific gull (C)	1 900	1 950
Kelp gull (C)	315	315
Caspian tern	1 160	1 410
Roseate tern (T)	7 220	13 370
White-fronted tern (C)	44	44
Black-naped tern	1 710	2 080
Sooty tern (T)	328 760	383 750
Bridled tern (T)	20 040	57 870
Little tern (T)	560	570
Fairy tern	2 420	2 990
Crested tern	74 350	89 940
Lesser crested tern (T)	4 710	8 170
Common noddy (T)	174 480	214 130
Lesser noddy (T)	79 500	79 500
Black noddy (T)	119 340	130 840

(T) denotes tropical species

(C) denotes Southern Ocean species

Seabirds

There are about 110 species of seabirds belonging to 12 families found in Australia and its external territories. Of these, 76 species breed and spend their entire lives in the region, and the remaining 34 species are regular or occasional visitors.[17]

The conservation status of most species breeding in the region appears to be satisfactory. In cases where seabirds were formerly exploited, for example for oil, food and bait, most populations have recovered satisfactorily[17]. The only remaining industry, the harvesting of short-tailed shearwaters, is sustainably managed[84].

Some 14 species or subspecies of Australia's seabirds (13% of the total) are considered by ornithologists to be threatened, largely because their colonies on oceanic islands are few in number and are vulnerable to harvesting and natural disasters. The wandering albatross on Macquarie Island, Abbot's booby on Christmas Island, and the Australian sub-species of the little tern are classified as 'Endangered' under IUCN criteria. Lord

(C. Totterdill, Australian Nature Conservation Agency)

a

(Source: P. Goh)

b

Figure 30: The status of seabirds with isolated oceanic rookeries is of concern. *(a) Christmas Island frigatebird. (b) Abbot's booby on Christmas Island.*

Howe's Kermadec petrel and white-bellied storm-petrel, and Christmas Island's Christmas frigatebird are considered 'Vulnerable'.(17)

Problems for sea birds include illegal poaching of adults, chicks and eggs; mortality from bushfires and feral animals; incidental capture of albatrosses and other seabirds by longline fishing; clearing of habitats; and disturbances of nesting colonies by humans and low-flying aircraft. Possibly half of Australia's nesting islands are subject to one or more of these direct human threats.(17)

(Source: G. Robinson, Antarctic Division)

Figure 31: Populations of the wandering albatross (here nesting on Macquarie Island) are declining because of high mortalities on fishing long-lines.

Treaties on the protection of migratory shorebirds have been signed with Japan and China, and are planned with Russia, Thailand, Indonesia and Papua New Guinea. International management of migratory seabirds is likewise important.(17)

Marine mammals

dugongs (sea cows)

The tropical dugong is the only fully herbivorous marine mammal and the only Sirenian (sea cow) to occur in Australia. It is extinct or near extinct in most of its former range which extended from East Africa to South East Asia and the Western Pacific. Northern Australia has the last significant populations (estimated to be over 80,000) in the world. Large, long-lived mammals, dugongs become sexually mature at around 10 years and calve every three to five years, making them vulnerable to overhunting.(18)

Figure 32: Australia has the world's last major populations of the dugong or sea cow. Populations are threatened elsewhere in the Indo-Pacific. This Western Australian dugong is accompanied by suckerfish.

(Source: G. Taylor, Lochman Transparencies)

Major concerns are possible overhunting of Torres Strait populations, mortalities in fish gillnets and shark nets, and loss of seagrass habitat. A major mortality occurred in Hervey Bay (Qld) in 1992 following die-off of seagrasses. The dugong is listed by the IUCN as 'Vulnerable to extinction' but it is not listed under the *Commonwealth Endangered Species Protection Act*.(18)

pinnipeds (seals and sea lions)

Three species of eared seals breed in mainland Australian waters: the endemic Australian sea lion, Australian fur seal and New Zealand fur seal(18). The Australian sea lion has recently been listed as 'Rare' by the IUCN(84). Five species of true seals and two other species of fur seals breed in Australia's subantarctic islands and the Antarctic Territories(18).

Figure 33: Although once heavily hunted, Australia's seal populations appear to be recovering. The endemic Australian sea lion, pictured here with a pup in Western Australia, is listed as 'Rare' by IUCN.

(Source: J. Lochman, Lochman Transparencies)

Australia's seals were seriously overhunted last century. They are now fully protected and some populations appear to be increasing. Major human threats include entanglement in fishing nets and ocean litter, oil pollution, and disturbances by visitors. Fur seals are still occasionally illegally killed for lobster bait, and around fish farms for 'stealing' fish. Development of predator-resistant cages has reduced the latter problem.(18)

(Source: G. Abraham)

Figure 34: Visitors may threaten seal colonies by disturbing them.

Entanglement in nets and plastic box straps remains a major problem. About 2% of seals at haul out or resting sites in Tasmania are entangled in net fragments and other plastic litter at any time[18,53,54]. It is thought that a significant number of more badly tangled seals must drown before reaching haul out sites. In 1990 an oil spill in Western Australia affected a number of New Zealand fur seal pups[39].

cetaceans (whales and dolphins)

Eight species of baleen whales and 35 species of toothed whales, porpoises and dolphins are found in Australian waters, although none are endemic. This is almost 60% of the world's total cetacean species.[18]

All whales and dolphins are large, to extremely large mammals. Because they are slow to mature and calve at intervals of several years, they have slow rates of natural population increase and are highly vulnerable to overexploitation.[18]

(Source: GBRMPA)

Figure 35: Humpback whale and calf on the Great Barrier Reef. *Populations were seriously depleted by overhunting by 1963. They are now protected and numbers are steadily increasing.*

Until recently, hunting was the major impact on whales and several species were driven to near extinction. Australian breeding populations of southern right whales were depleted by 1845. Their population has slowly increased from small remnants totalling a hundred or so, to between 500 and 800. Australian breeding populations of humpback whales were depleted by 1963. Numbers are now recovering and there are now thought to be up to 4,000 breeding in Australian waters. In the Antarctic, overhunting has endangered the blue whale, perhaps the largest animal which has ever existed, and severely depleted other baleen species.[18]

Gillnets, shark nets set off bathing beaches, discarded fishing nets, and ingestion of plastic litter are considered threats to cetaceans within Australia. It is estimated that during the 1980s almost 14,000 dolphins

(Source: Marsh et al. [18])

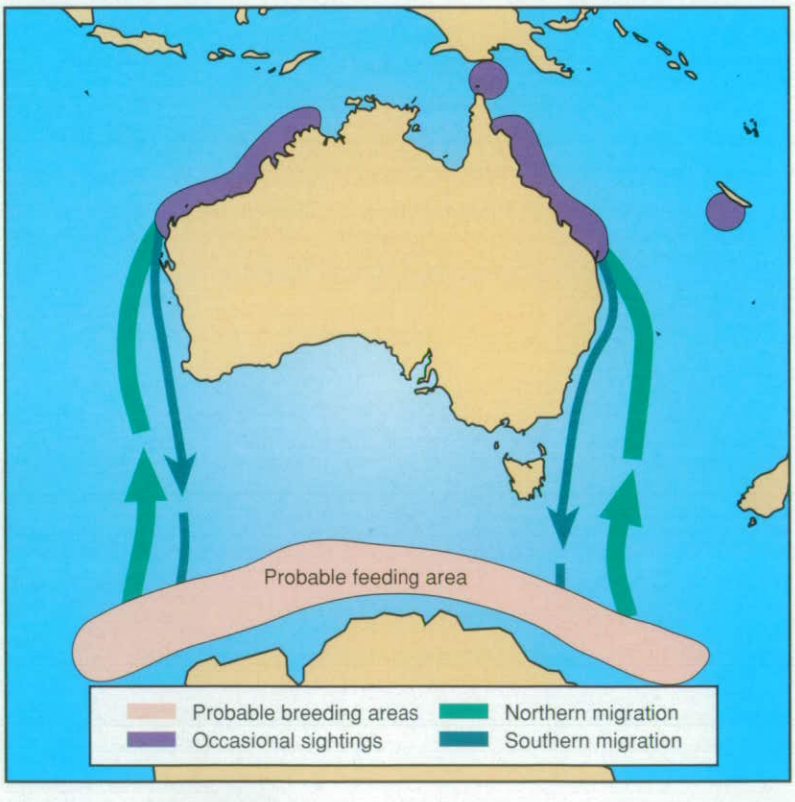


Figure 36: The humpback whale migrates northwards in winter to calve. *It feeds in Antarctic waters.*

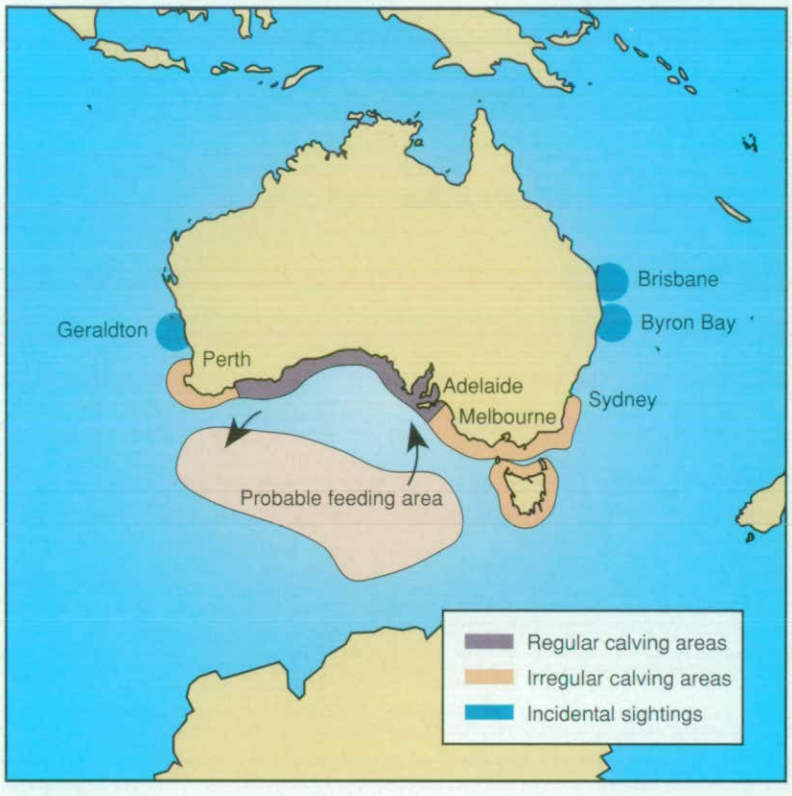


Figure 37: The southern right whale migrates northwards to southern Australia to calve.

(Source: Marsh et al. (18))

were drowned in Taiwanese shark gillnets off northern Australia but this fishery is now closed[18]. The use of long driftnets (sometimes referred to as the 'walls of death') which caused substantial mortalities of cetaceans is now banned under the Convention for the Prohibition of Fishing with Long Driftnets in the South Pacific and the UN global moratorium on their use[84]. However, considerable numbers of cetaceans are still caught in protective shark nets off bathing beaches. For example around 520 dolphins were caught in shark nets in Queensland between 1967 and 1988. Contamination of cetaceans by organochlorine pesticides and poly-chlorinated biphenyls (PCBs) is regarded as a significant worldwide threat.[18,75]

(Source: SARDI)

Figure 38: Southern right whales and calf at the Head of the Bight, South Australia. *This species was very seriously depleted by whaling by 1845 but is now slowly recovering.*

Whaling has been replaced by the new industry of 'whale watching'. Because of concerns that boats, aircraft and divers may affect whale behaviour, regulations govern the distances that observers may approach whales.[18]

The southern right whale, humpback whale and blue whale are listed as endangered species under the *Commonwealth Endangered Species Protection Act*. Internationally, Australia has been very active in whale management through the International Whaling Commission and the recent establishment of the Southern Ocean Sanctuary.[18,60]

Report Card

Subject: State of Australia's marine environment

How the SOMER Report Cards were prepared

The state of various aspects of the marine environment is simplified and summarised in the form of report cards, rather like a school report. (Like a school report, 'As' are very good, and 'Ds' are poor). **Note that the scores are broad and descriptive and are intended only as rough assessments of the scale of the problems**.

Because of the great difference in the state of the marine environment in remote, little developed and undeveloped areas away from human population centres and those near the highly developed coastal cities, industrial centres and intensively farmed areas, '**developed**' and '**undeveloped**' areas are generally rated separately. If they were assessed proportionately to their areas, the vast undeveloped areas of the 'remote' north and west would average out the concentrated and often very disturbed areas off urban and intensively farmed rural areas. Geographically, the 'undeveloped' areas lie largely along the far north-eastern, northern, and western coastlines, the Great Australian Bight, the Southern Ocean and the External Territories. 'Developed' areas lie largely along the south-eastern, and parts of the southern and the south-western coasts.

Report Card

Subject: State of major coastal ecosystems and habitats

(A: excellent, to D: poor)*

Ecosystem	Pressures,Sources	State
Estuaries, coastal lakes (developed)	Serious eutrophication and pollution from elevated nutrients and contaminants from poor inland waterquality, developed run-off,sewage, industrial and shipping discharges.	C-D
Estuaries, coastal lakes (undeveloped)	Localised eutrophication and pollution from increased sedimentation and elevated nutrients from catchments, erosion, fertilisers, animal wastes and sewage. Most severe in cultivated catchments. (6,42)	A-C
Saltmarsh (developed)	Locally serious losses from reclamations, drainage, stormwater, weeds, dumps.	C
Saltmarsh(undeveloped)	Localised losses from draining, grazing, weeds etc.(7)	A-B
Mangroves (developed)	Locally serious losses from reclamations, alteration of estuaries, dumps.	C
Mangroves(undeveloped)	Localised losses from reclamations, ports.(8)	A-
Seagrasses(developed)	Widespread, serious die-back of temperate seagrasses from elevated nutrients and sediments.	C-D
Seagrasses(undeveloped)	Locally serious die-back of temperate seagrasses in many areas; locally serious die-back of tropical seagrass in several areas.(10,42)	A-C
Shores (rocky, soft) (developed)	Widespread serious overfishing and collecting in metropolitan areas; local pollution.	C
Shores (rocky, soft) (undeveloped)	Localised overfishing and collecting.(9,34,39)	A-B
Beaches (open, sandy) (developed)	Widespread serious littering; localised sewage pollution and poor bathing water quality.	C-D
Beaches (open, sandy) (undeveloped)	Widespread, light ocean and fishing litter; localised moderate to heavy beach litter in heavily visited areas.(40,47,101)	A-B
Coral reefs(undeveloped)	Significant losses of coral from crown-of-thorns starfish (Great Barrier Reef) and snails (Ningaloo) threats from elevated nutrients, overfishing, tourism, oil spills.(12,69,70,73)	A-B
Temperate reefs(developed)	Locally serious overfishing and collecting; introduced species; pollution. Status not well known.	B-C
Temperate reefs(undeveloped)	Localised overfishing and collecting. Status not well known.(11,31,48)	A-B?
Shelf seafloor communities (developed)	Overfishing of some species; effects of trawling; increased sedimentation rates; localised sea dumping.Status poorly known.	B-C
Shelf seafloor communities (undeveloped)	As above. Status poorly known.(3,13)	A-B?

*Scores
A: EXCELLENT (no obvious effects of human activities)
B: GOOD (general slight effects, or few sites with moderate effects)
C: FAIR (general moderate effects, or some sites with serious effects)
D: POOR (general serious effects, or some very serious effects)
? : UNCERTAIN STATUS (insufficient knowledge)

2

The social value of the coastal and marine environment to Australians

The sea is of particular importance to the recreation, culture and spirit of Australians, both indigenous and non-indigenous. It is also economically important for fisheries, oil and minerals, shipping and tourism.

IMPORTANCE TO AUSTRALIA'S INDIGENOUS PEOPLES

Coastal Aboriginal communities

The coastal Aboriginal peoples have been users and custodians of Australia's marine environment for 40,000 to 50,000 years. For coastal communities 'salt water country' was, and in many communities still remains, an indistinguishable part of the clan estate and culture. Aboriginal shell middens as old as the present coastline (around 5,000 years) are found in many coastal areas around Australia.(19)

The cultural associations and concerns of coastal Aboriginal peoples for the sea and its resources remain strong, even in areas where they have been historically dispossessed. However, this has not been adequately documented and is little understood by non-indigenous Australians.(20,21)

Major issues and concerns of coastal Aboriginal peoples today centre around their dispossession from their traditional land/sea estates; the threats, desecration and injury to sites of cultural significance; the loss of ancient fishing and hunting rights; their lack of commercial fishing opportunities; and their general lack of participation in coastal environmental planning and management.(20,21)

(Source: M. Hartcher, GBRMPA)

Figure 39: The sea is traditionally important for the culture and sustenance of coastal Aboriginal people. The arrival of Europeans, depicted in this rock painting on Stanley Island in the Flinders Group (Qld), resulted in the dispossession of Aboriginal people from their land and sea estates.

(Source: N. Coleman)

Figure 40: Many coastal Aboriginal communities still fish and hunt for subsistence. Hunter cutting up a turtle at Cape Levique (WA).

Legislation protecting Aboriginal rights in the sea exists in the Northern Territory. Here, 84% of the coastline to the low tide mark is Aboriginal land. Beyond the low tide mark, Territory legislation provides for the closure of waters up to two kilometres offshore for Aboriginal usage[82]. In the Torres Strait, indigenous fisheries are specifically protected under the Torres Strait Treaty [22,74].

Sea rights and interests may yet be found to persist in southern Australia. However, the establishment of indigenous rights over an area may not necessarily be followed by closure to other parties since rights and interests may co-exist[84].

While native title in the sea was not tested in the historic 'Mabo decision' of the High Court in 1992, claims regarding sea title are currently before the High Court and State Supreme Courts.[20]

The Law Reform Commission (1986) and the Resource Assessment Commission (1993) strongly recommended that indigenous interests in environmental management be accommodated[20]. The full implications of the recognition of the persistence of indigenous common law rights and interests is yet to be determined, and implications for indigenous management of resources or other interests in the marine environment is yet to be resolved[20]. The special rights of indigenous peoples, including recognising their traditional rights relating to environmental management, have been recognised under international agreements[20].

(Source: Lochman Transparencies)

Figure 41: Netting at Birany Birany, Arnhem Land (NT).

(Source: K. McClymont)

Figure 42: Koori community beach seining, Jervis Bay (NSW).

Torres Strait Islanders

The Torres Strait Islanders, a maritime people of mainly Melanesian origin, have long been dependent on the reefs and marine resources of Torres Strait. While they face many of the problems of the Aboriginal peopleson the mainland, they were generally not dispossessed from their estates and continue to identify strongly with the sea.[22]

Today there are 14,500 Torres Strait Islanders in Queensland, of whom around 5,200 live in Torres Strait. Many of the islands are relatively small and infertile, and the Torres Strait Islanders continue to rely heavily on seafood in their diet, particularly green turtle. The Islanders are some of the greatest consumers of seafood in the world, and take around 2,400 turtles and 1,000 dugongs each year.[22]

Land and sea title are important issues. The historic 'Mabo decision' resulted from a legal challenge by three Murray Islanders. While it did not include customary sea tenure, by tradition clan territories comprise both land and sea. Sea territories include home reefs adjacent to their lands, and an extended sea tenure over waters, submerged reefs and sand banks beyond the home reef. Islanders continue to claim home reefs under custom, if not law.[22]

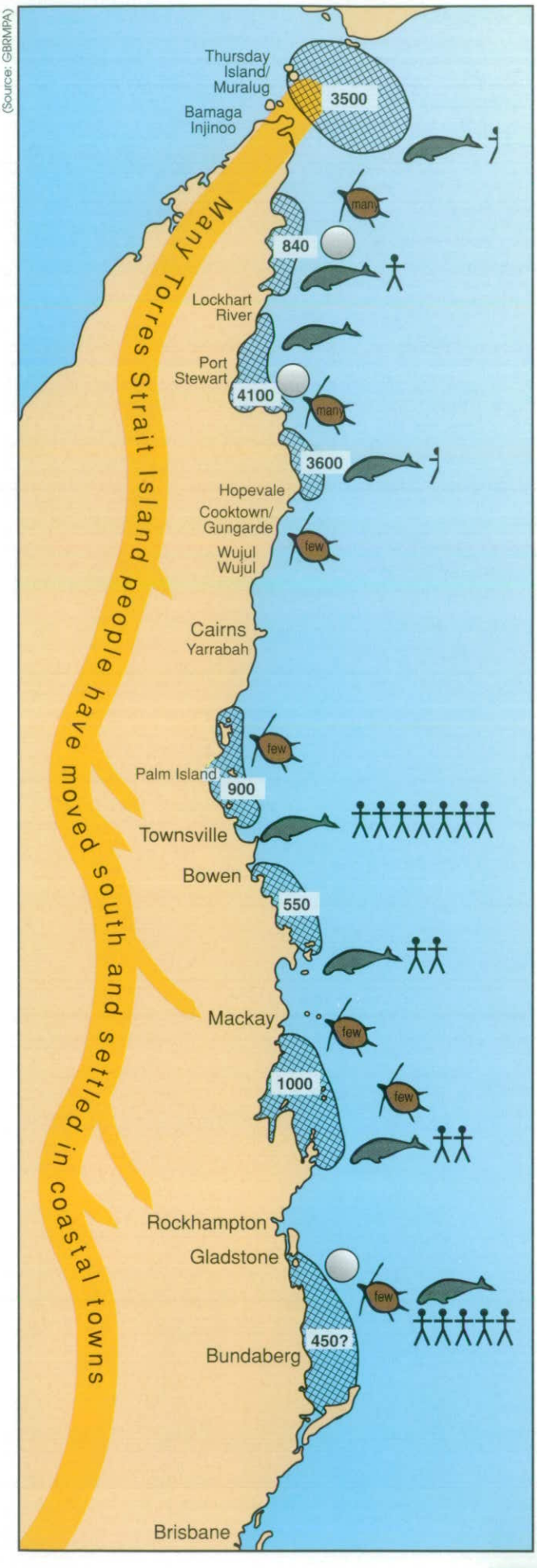
Figure 43: Torres Strait Islanders have maintained a strong maritime culture. (a) Outrigger canoes, traded from Papua, are used for fishing and travel. (b) Much of Torres Strait Islander art and culture draws inspiration from the sea.

(Source: W. Gladstone, GBRMPA)

a

(Source: L. Zann)

b



Major environmental and management issues in the Torres Strait include the high levels of heavy metals in seafood; threats of enhanced greenhouse effect sea level rise on coastal erosion and water tables; threats of oil spills from pipelines and shipping in Papua New Guinea; effects of prawn trawling on the sea floor communities and on fisheries; the lack of access of Islanders to commercial fisheries; possible overhunting of dugongs and turtles; and conflicts in resource sharing with Papua New Guinea.(22,74)

Indigenous rights recognised as important in Ocean Rescue 2000 program

Marine conservation and management plans in the Ocean Rescue 2000 program recognise the special interests of the coastal Aboriginal peoples and Torres Strait Islanders and seek to involve them in all aspects of planning and management. The program is currently funding projects to develop marine conservation strategies for the Wessel Islands in the Northern Territory and for Torres Strait.

Figure 44: Changing patterns of dugong and turtle hunting in Queensland's indigenous communities. This is modified from a poster prepared to help explain to communities why hunting may need to be managed.

HUNTING CHANGES

Many Aboriginal and Torres Strait Islander people moved south after World War II, and are still hunting. There have always been fewer dugong and turtles in the south. This means there are now greater numbers of people hunting fewer dugong and turtles in the south.

- few — Traditional hunters' observations and knowledge of green turtle numbers.
- Main green turtle breeding sites.
- 450 — The number refers to the number of dugong based on scientific information in the area.
- ? — Numbers have dropped due to seagrass die-back.
- Ratio of dugong to people.

IMPORTANCE TO AUSTRALIA'S GENERAL COMMUNITY

Australia is today a complex, dynamic multicultural society of mainly coastal peoples. Over a quarter of Australians live within three kilometres of the sea, three-quarters live within 50 kilometres of the coast, and Australians are increasingly moving to live along the seashores. The coast and sea are very important to the culture, lifestyle and social values and perceptions of Australians.(1, 23)

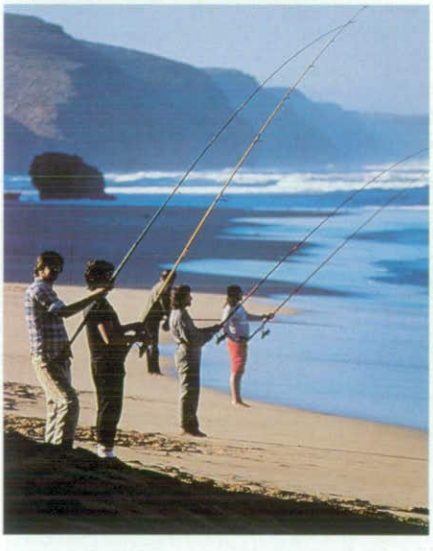
(Source: CALM)

a

Social and cultural values of the marine environment

The beach and the marine environment are socially and culturally important to Australians. Australians live and play by the sea. The beach is one of our national icons and Australia has developed a characteristic beach sub-culture. The beach has become a cherished place and is entwined in the rites of passage of many Australians. The beach is the major centre for outdoor activities such as bathing, surfing, fishing, boating, exercising and just relaxing. The sea provides inspiration for Australian artists, writers and musicians, sailors and adventurers, and 'average Australians'.(23)

(Source: SA Tourism)



b

The 'average Australian' is increasingly concerned about the marine environment. Three-quarters of people polled in a recent public opinion poll said they were concerned about the environment in general. Their single most serious concern was the pollution of rivers, beaches, harbours and the sea. Recreational and commercial fishers, surfers and local residents have formed lobby groups to combat what they consider to be inappropriate coastal development and marine pollution(23). Young Australians in the Surfrider Foundation recently undertook their own independent survey of the state of over 400 surfing beaches around the country (p. 64)(47).

(Source: Coffs Harbour Visitors Bureau)

c

Despite the great importance of the coast and sea to Australians, social and cultural values and perceptions of the coast and sea are remarkably little documented, and are often not adequately considered in management plans and environmental impact studies.(23)

(Source: Tas Dept. Tourism, Sport and Recreation)

d

Figure 45: The sea is a focus for recreation in Australia.
(a) Windsurfing (WA). (b) Beach fishing (SA). (c) Surfing (NSW). (d) Sailing (Tas). (e) Diving (Qld).

(Source: GBRMPA)

e

(Source: Australian Picture Library)

Figure 46: Bondi Beach is an Australian icon. *'The beach' is the centre for outdoors recreation during summer.*

(Source: Bondi Surf Bathers Life Saving Club, Australian National Maritime Museum)

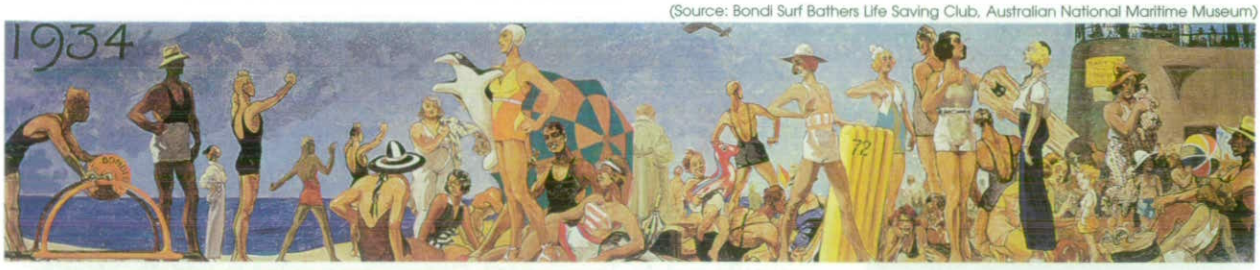


Figure 47: Australia's beach culture had emerged by the 1930s. *Bondi Beach, from a mural by commercial artist and surf life saver D.H. Souter.*

Heritage values

The coast and sea are important to the heritage of Australians. The natural beauty of seascapes, wild and remote coastlines and islands, Aboriginal dreaming sites, the landfalls of explorers, early settlements, historic buildings, holiday beaches and surfing meccas are important to our heritage. Under the sea lies another world: spectacular natural gems such as the Great Barrier Reef and Ningaloo Reef; Aboriginal dreaming sites, camp sites and other sites of cultural importance; and the remains of many shipwrecks.(24,25)

shipwrecks

Over 6,000 shipwrecks have occurred in Australian waters over the past four centuries. Many of these shipwrecks are of great historical and archaeological value. The seventeenth and eighteenth century Dutch ships in the west, the *Pandora* on the northern Great Barrier Reef, the *Cato* and *Porpoise* in the Coral sea, the German raider *Emden* on Cocos Island, and war wrecks such as the Japanese submarine *I-124* in the Northern Territory trace the story of European exploration, settlement and defence of Australia.(24)

Because of widespread looting of historic shipwrecks by scuba divers, wrecks are now strictly protected by Commonwealth and State legislation. Australia is considered a world leader in underwater archaeology and the protection of shipwrecks. However, concern has now shifted away from protecting shipwrecks to the preservation of important portable items of our maritime heritage such as ship's journals, paintings, fishing equipment and vessels.(24)

(Source: P. Gesner, Queensland Museum)

Figure 48: Australia has a rich maritime heritage. *There are around 6,000 shipwrecks lying beneath Australia's seas, many of which are of great historical and archaeological value. The wreck of the HMS* Pandora, *being excavated here, lies in 35 metres of water off Pandora Entrance on the Northern Great Barrier Reef. It is regarded as one of the most significant wrecks in the Pacific because of its historic context (it was dispatched to arrest the infamous* Bounty *mutineers) and its good state of preservation. It also contains a range of South Pacific Islander artefacts and a complete refit set for the* Bounty.

coastal heritage

Australia's coastal strip also contains many places of maritime cultural heritage. These include sites of Aboriginal traditional, historic and archaeological significance. Important to non-indigenous Australians are the landfalls of early explorers; sites of first settlements; lighthouses and defence facilities; wharves, customs houses and other early buildings; national landmarks such as Sydney Harbour Bridge and the Opera House; and social and recreational icons such as Bondi Beach, the Gold Coast and the surfers' mecca of Bell's Beach (Vic).(25)

As has been the case in the past, natural processes threaten some heritage sites: Aboriginal middens and European settlement sites may be washed away in high seas, and historic buildings deteriorate in salty environments. However, disturbances by humans are far more serious. Coastal ribbon development has destroyed many Aboriginal

(Australian Nat. Maritime Museum)

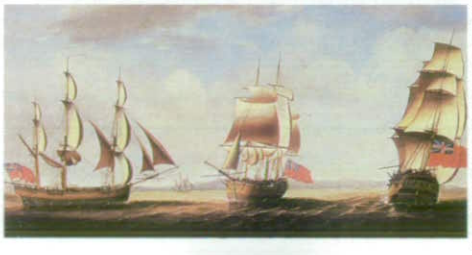


Figure 49: Australia's portable maritime heritage is less protected than its wrecks. *Three views of the* Borrowdale, *a merchant ship from the First Fleet, by Francis Holman around 1787.*

Australians knowing about the marine environment and its importance, recognising the threats to it, wanting to care for it, and learning the skills to look after it.(65, 66)

Formal marine education

Many factors influence people's values (family, friends, media and personal experience) but it is education at schools, colleges and universities that gives people most of the formal knowledge and skills to make informed decisions, and the ability to act on them. Education also provides training for the scientists, engineers, planners, educators and other professionals and technicians needed to manage our marine environment.(65)

Figure 54: Marine education is being undertaken in a growing number of schools in Australia.

(Source: GBRMPA)

marine education in schools

Australia has around three million school students, 10,000 schools and 200,000 full-time school teachers. During their formal education, every Australian student learns something about the sea in a variety of subjects, from art to biology.(65)

School curricula are developed by education departments in each State and Territory, but details of content are at the discretion of individual schools and teachers. In recent years, an interdisciplinary approach to curricula and the growing community concern about the environment has led to an increase in environmental topics in general subjects such as science and geography. However, topics are generally biased towards the terrestrial environment. Reasons include the community's greater familiarity with terrestrial issues, a lack of training for teachers in marine subjects, the scarcity of teaching materials on the marine environment, and the logistical difficulties and cost of marine excursions. While the establishment of coastal field centres has alleviated logistical problems in some places, these remain limited in number.(65)

Several States have developed specialist marine education subjects at upper secondary level (Years 11 and 12). These combine practical marine skills such as sailing and diving with marine environmental education. While comprehensive marine education programs do exist, the quantity and quality of marine education in most schools remains very limited. Most Australians leave school with little more than a basic understanding of the sea, and the important issues affecting the marine environment.(65)

'Seaweek' focuses awareness on marine issues

Many schools, particularly primary, base their marine studies on Seaweek, the yearly national awareness week organised by the Marine Education Society of Australasia (MESA). Special class or school-wide activities are developed in most States and the Northern Territory. Seaweek is a good way to promote marine education to teachers and provide them with teaching ideas.(65)

marine education in TAFE colleges

Around one million students are enrolled in Technical and Further Education (TAFE) courses. These are primarily technical in nature and are designed to meet industry requirements. Marine courses concentrate on maritime skills for master mariners, deckhands and engineers. Marine elements are offered within other courses such as applied biology, resource management, recreation, aquaculture, engineering, and tourism.(65)

marine education in universities

The number of specialised marine courses offered by universities has greatly increased over the past decade. Most universities offer courses with some marine content and many offer specialised courses on certain aspects of the marine environment, including management. University marine studies generally have a greater emphasis on basic science than applied science. Subject specialisations mostly reflect historic and geographic factors, and the academic interests of staff. For example, Curtin University of Technology (WA) offers marine archaeology, the University of Sydney has long specialised in shore ecology, and James Cook University of North Queensland specialises in coral reef science. The Australian Maritime College in Launceston (Tas) is a national centre for applied studies in fisheries.(65)

(Source: N. Coleman)

Figure 55: A mangrove class, Moreton Bay (Qld).

Community marine education

Marine environmental education not only occurs formally in schools and universities but also informally in the community for people of all ages and walks of life. Particular attention is now being given to marine education of user groups, decision makers, indigenous communities, non-English-speaking Australians and other special groups. However, while some excellent examples of community marine education programs exist, most Australians are reached superficially, if at all.(66)

education for recreational fishers

State and Commonwealth fisheries managers have only recently recognised the importance of managing the approximately five million recreational fishers in Australia. Most States have now embarked on programs of community consultation and education with recreational fishers. The Draft National Policy for Recreational Fishing stresses the importance of developing strong fishing conservation ethics and community awareness programs to encourage a positive change in community attitudes and values. Established fishing clubs have a key role to play in this education process. Sportfish tagging programs have grown rapidly in recent years. The tags provide not only valuable information on fish breeding, growth and movements to researchers and managers, but help foster a conservation ethic.(33,66)

Figure 56: Marine education programs are being developed for commercial fishers.

(Source: GBRMPA)

education for commercial fishers

Habitat destruction and declining water quality are unifying issues amongst commercial and recreational fishers, environmentalists, scientists and the general community. Commercial fishers are beginning to recognise the importance of fisheries habitat and water quality, that fisheries resources are not inexhaustible, and that ecologically sustainable development equates with a decent living in the long-term and the chance to pass on the business to future generations. Full-time environmental officers have been appointed in professional fishing industry groups in Queensland, New South Wales, South Australia and Western Australia. Most government fisheries management agencies have only recently extended from the research and enforcement mould, into education.(66)

(Source: GBRMPA)

Figure 57: Aboriginal liaison officers are employed by the Great Barrier Reef Marine Park Authority to work with Aboriginal communities.

education for indigenous communities

The involvement of indigenous communities in marine environmental management requires culturally appropriate education. For example, the Great Barrier Reef Marine Park Authority has used art, role play and stories to explain its management programs to Aboriginal communities, and employs indigenous people in its community extension programs.[20,66,69]

education for marine protected area users

Various education programs have been developed for commercial and recreational groups who use marine protected areas. These range from simple signage to special courses for particular user-groups. Rather than rely on controls through permits, regulations and fines, governments are increasingly encouraging user-groups to develop their own 'codes of practice'. These have been effective in generating community support and 'ownership' for a marine protected area, for shaping appropriate behaviour by users, and for solving particular management issues. 'Codes of practice' have been developed in various places for island camping, waste disposal, whale watching, minimal impact diving, anchor damage, marine litter, motorised water sports, and sport fishing.[66,69]

education for divers

Skin- and scuba-diving are popular pastimes in Australia. It is estimated that each year around 1.9 million scuba dives are undertaken in Australian waters, including 1.4 million in Queensland. There has been a marked change in divers' perceptions over the past 20 years: emphasis has gradually shifted from spearfishing and wreck-pillaging, to underwater photography and marine life viewing. Scuba courses may include an introduction to marine biology. Divers are often well travelled and environmentally aware, and even sharks are now perceived in a more positive light[66].

Figure 58: Many marine aquaria in Australia offer special classes for school children and other groups on marine subjects.

(Source: GBRMPA)

Recreational divers also learn about marine environmental management through involvement with scientific projects. For example, the Great Barrier Reef Marine Park Authority relies heavily on divers to track crown-of-thorns starfish outbreaks and to report on giant clam diseases[49].

Marine aquaria education programs

The community's interest in the sea is reflected in the growth of large aquaria to provide 'real life' underwater experiences to young and old alike. Most aquaria now include strong education messages about

marine life, the importance of our seas for commercial and recreational purposes, and the need for marine conservation. Most aquaria employ interpretive staff and operate school programs. It is estimated that there were 12 million visitors to the major aquaria in Australia between 1987-92. Around 20% of those who visit are school children.[66]

The role of the media in marine education

According to a National Attitude Research Analysis poll, the main source of information about the environment in Australia today is television. News and current affairs programs, nature features, and science shows are the major influence. Other, less important sources were newspapers, radio and magazines.[26,66]

The Ocean Rescue 2000 national marine education program

A long-term national marine education program has been established by Ocean Rescue 2000 to provide the community with:

- an awareness, appreciation and understanding of the marine environment and of the need for its conservation;
- environmentally responsible attitudes; a commitment to work for change; a wide range of skills and behaviour for successfully tackling coastal environmental problems;
- the ability to actively contribute to the planning and management processes; and
- a high level of commitment to future management programs.

3

Major uses of the marine environment and their impacts

This chapter briefly describes the importance of our coastal and marine industries and some of the environmental impacts resulting from them.

Australia's marine environment is economically very important. The value of Australia's marine resources, according to CSIRO estimates, is around $17 billion per year. Offshore oil and gas are valued at around $5.5 billion per year[37]. The tourist industry, largely based on the coast and sea, contributes over 5% of the gross domestic product (GDP) and employs 5.8% of the workforce[28]. Commercial fisheries production is worth around $1.3 billion each year[30] and recreational fishers spend over $2 billion each year on their activities[33]. Marine transport is essential for our island continent and Australia ranks fifth in the world in terms of frequency and volume of shipping[36].

RECREATION AND TOURISM

The coast and sea are important natural tourist and recreational resources in Australia. Most of Australia's population live in the coastal zone and most international visitors stay on the coast. Visitors to the seashore swim, surf, fish, dive, and cruise or sail in boats.[28]

(Source: QTTC)

***Figure 59:** **Coastal and marine tourism in Australia is valued at over $10 billion per year.** The Gold Coast, Australia's tourist mecca.*

(Source: Australian Picture Library)

Figure 60: There are over half a million private motor craft in Australia. Sydney's fleet welcomes the Bicentenary Tall Ships.

Value and importance

Domestic use of the coastal environment has increased rapidly in the last thirty years. The non-metropolitan coastal population of Australia has doubled since 1970 and has the fastest rate of growth in the nation. The resulting increasing recreational pressure on the coastal strip was the major focus of concern of the Resource Assessment Commission's Coastal Zone Inquiry in 1993.(28,91)

Australia's natural environment is a major drawcard for overseas visitors. The international tourist industry, most of which is based on the coast, is economically significant to Australia, contributing over 5% of the GDP. In 1991 there were more than 2.3 million overseas visitors. Around half participated in some sport or outdoor activity: 700,000 surfed or swam, 300,000 snorkelled or scuba dived and over 100,000 went fishing or sailing. During 1991 Australians made 49 million trips as domestic tourists, and spent 215 million visitor nights away from home, mostly in coastal areas.(28)

The beach is a centre for outdoor activities in Australia, particularly during hot summer months. At mid-summer weekends, individual Sydney beaches attract crowds of up to 50,000, and in Melbourne, Port Phillip Bay beaches attract up to 300,000 bathers. The Gold Coast, Australia's premier holiday mecca, attracts over nine million visitors each year.(28)

Marine ecotourism

Marine ecotourism is a fast growing industry in Australia. Interpretive talks and guided activities are now routinely provided for visitors to the Great Barrier Reef, and many specialised rainforest and reef educational packages are available. Whale watching is a growth industry from the Whitsunday Islands (Qld) to Albany (WA).

Table 7: Australia's top 15 domestic tourist destinations
(visitor nights per year)

(Source: Drirnl)

(1) Sydney (12,978,000)
(2) Brisbane (10,711,000)
(3) Melbourne (9,526,000)
(4) Gold Coast (9,335,000)
(5) Sunshine Coast, Qld (7,325,000)
(6) Adelaide (6,444,000)
(7) Perth (5,719,000)
(8) Illawarra, NSW (5,096,000)
(9) Hunter, NSW (5,052,000)
(10) South Coast, NSW (4,493,000)
(11) Far North Queensland (4,033,000)
(12) Lower North Coast, NSW (4,296,000)
(13) Upper North Coast NSW (4,152,000)
(14) Outer Sydney (3,950,000)
(15) Fitzroy, Qld (3,735,000)

Figure 61: Marine ecotourism is a growing industry in Australia.
(a) The famous dolphins of Monkey Mia (WA) attract many thousands of visitors each year to this remote area. (b) The giant cod in the Great Barrier Reef's famous 'Codhole' are visited by thousands of scuba divers each year.

(Source: GBRMPA)

b

a

(Source: J. Lochman, Lochman Transparencies)

The dolphins of Monkey Mia (WA) have achieved national and international fame. The whale sharks at Ningaloo Reef (WA) and even great white sharks at Port Lincoln (SA) are the focus of dive tourism industries. As the quality of the marine environment deteriorates elsewhere in the world, Australia's significant areas of undisturbed coasts, seas and reefs will assume even greater importance for international ecotourism.(28)

Figure 62: The Great Barrier Reef region receives around two million visitors each year.

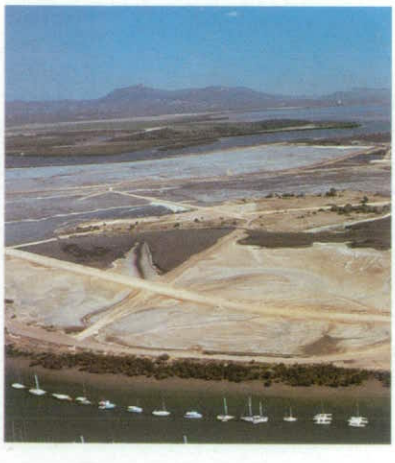
(Source: GBRMPA)

Environmental impacts of tourism and recreation

Although tourism and recreation are generally considered to be 'clean' industries, they have had significant negative impacts on many parts of Australia's coastal strip. Tourist facilities, accommodation, transport and other service infrastructure are typically placed on or close to the particular attraction, such as a picturesque and secluded beach, inlet or island. These facilities frequently affect the natural and cultural environment and reduce the scenic values which provided the initial attraction.(29)

Figure 63: Construction of recreational and tourist facilities on the shore may result in loss of coastal habitat.

(Source: L. Zann, GBRMPA)



Negative environmental effects of tourist and recreational facilities may include beach and dune erosion, loss of habitat, declines in wildlife and fisheries, and loss of water quality. Adverse socio-economic impacts may include destruction of cultural heritage sites, loss of amenity values, altered quality of life for established communities, increased cost of living, increased crime and traffic, and building congestion. The dilemmas facing coastal tourism are the erosion of the natural and cultural values of sites (which necessitates continuous demand for new areas) and its uncontrolled and unpredictable growth.(29)

FISHERIES

In Australia, fisheries are important for local consumption, export and recreation. Although Australians are primarily consumers of red meats, fish provides a relatively significant - and healthy - part of the diet. The average consumption of seafood in Australia is around 12 kilograms per person per year.(30)

Fishing is a major extractive use of the marine environment. Although fish are a renewable resource, fisheries production of a growing number of species has been declining since the late 1980s.(31)

Commercial fisheries and aquaculture

The Australian Fishing Zone has an area of nearly nine million square kilometres and is the third largest in the world. Despite this, Australia's fish catches are relatively low at about 200,000 tonnes each year, and only rank around 50th in the world. This is the result of the generally low productivity of our waters because of naturally limited run-off of nutrients from land, a relatively small area of continental shelf, and the absence of major upwellings of nutrient-rich deep waters. However, Australia has a number of high value export fisheries such as abalone, rock lobsters and prawns, and a large cultured pearl industry. Annual exports of marine products were valued at $1.1 billion in 1992-93.(30)

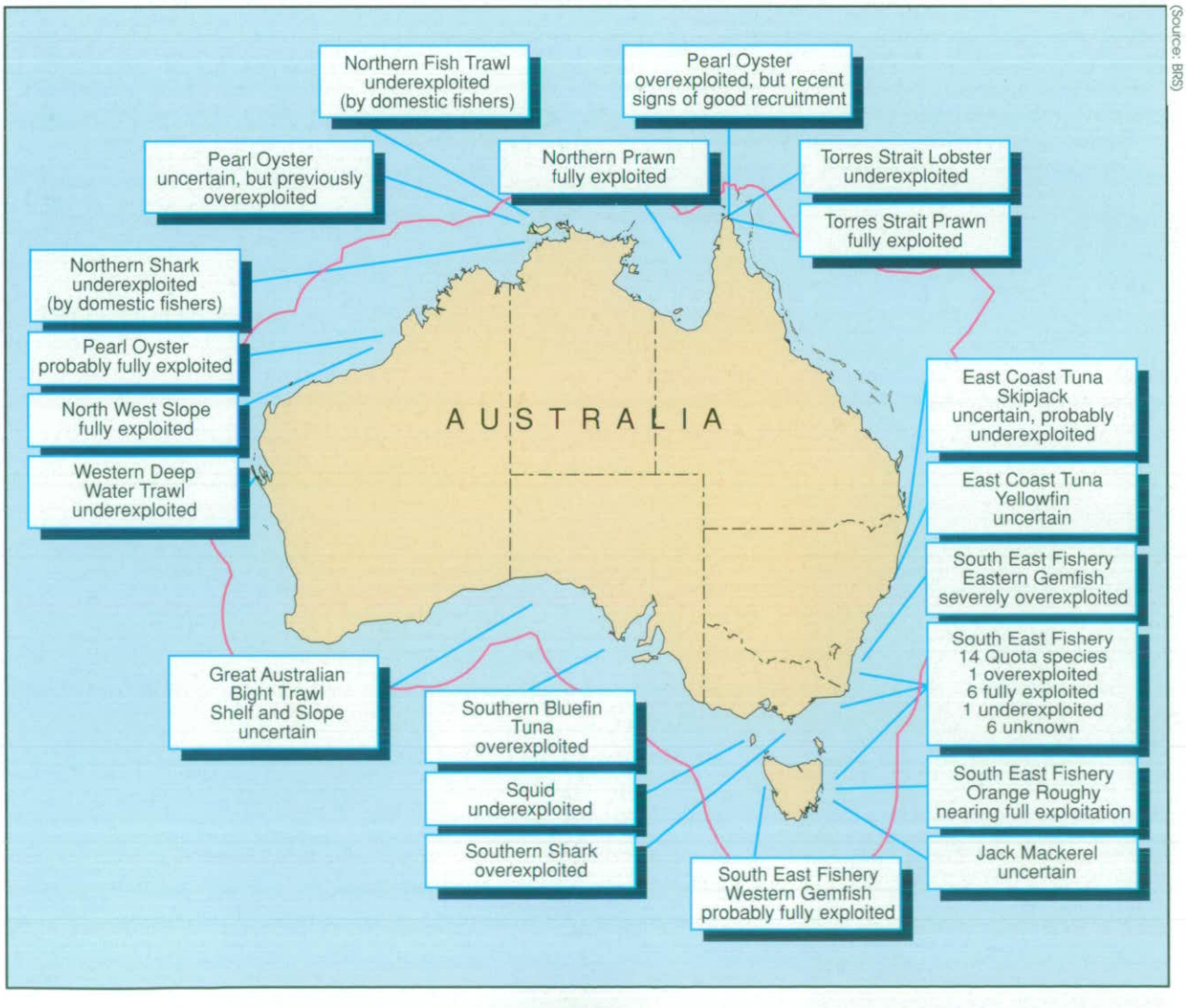
(Source: GBRMPA)

Figure 64: Commercial fishing is a major extractive use of Australia's marine environment. Australia's annual catch is around 200,000 tonnes per year.

status of commercial fisheries

Australia's commercial fishing fleet consists of almost 10,000 vessels. Some 200 different species of fish, 60 species of crustaceans and 30 species of molluscs are fished.(30,87)

Figure 65: The status of Commonwealth (or jointly-managed) commercial fisheries resources in Australia.



(Source: BRS)

Figure 66: A catch of orange roughy from the Great Australian Bight. *There are serious concerns that catches of these slow-growing, long-lived fish cannot be sustained.*

(Source: K. Gowlett-Holmes)

Australia has experienced declines in some commercial fisheries, particularly southern bluefin tuna, southern sharks and gemfish. There are also now serious concerns that the high catches of the long-lived, deep-sea orange roughy cannot be sustained.(30)

Of the 100 fisheries described in 'Australian fisheries resources' (87), nine are considered to be overfished, 23 are fully or heavily fished, nine are underfished, and 59 are of unknown status.

(Source: E. Boogaard, Lochman Transparencies)

Figure 67: Western Australian rock lobster pot. *This fishery is one of the world's major rock lobster fisheries. Annual catches of around 10,000 tonnes (worth in excess of $300 million) have been sustained through tight controls on the number of boats and pots, and through seasonal closures. The fishery is extensively researched and is closely monitored.*

Reasons for declines in some fisheries include overfishing, use of non-selective fishing gear, loss of habitat, pollution and Australia's marine jurisdictional complexity which hinders management of a fish stock or population. While it is considered that many of Australia's fisheries have not been managed in a conservative manner in the past(31), fisheries managers are now focusing more on fisheries ecosystem management(84).

aquaculture

Aquaculture is an important and logical development from the capture fisheries, just as agriculture was a monumental step from hunting and gathering. Although Australia has long had oyster and pearl farms, we have generally lagged in other areas of aquaculture. However, aquaculture began to grow rapidly in the mid 1980s, and has increased in value from around $50 million in 1985, to $260 million in 1991-92. Sixty aquatic species, from seaweeds to crocodiles, are now farmed in Australia.(35)

Positive environmental consequences of aquaculture include the restocking of over exploited species, reduced fishing pressure on some wild stocks, and improved scientific understanding and management of wild stocks.(35)

Possible negative environmental results of aquaculture include:

- a high demand for coastal foreshores, estuaries, mangroves and saltmarshs for farms;
- alteration of these habitats;
- waste production, leading to local increases in nutrients and excessive algal growth;
- a high demand for wild capture fisheries (e.g. pilchards and anchovies) for aquaculture stock food;
- a loss of visual amenity because of unsightly rafts, cages and other equipment;
- conflicts with recreational use;
- the culling of natural predators such as seabirds and seals on farms;
- the use of chemicals and antibiotics to control diseases;
- a reduction of genetic diversity; and
- an increased risk of introducing exotic species and diseases.(35)

Figure 68: Aquaculture has grown rapidly in Australia over the past decade. *Prawn ponds in North Queensland.*

(Source: GBRMPA)

The National Strategy on Aquaculture in Australia, released in 1994, aims to make improvements in land and water use planning, the use of chemicals, the management of species introductions, disease and pest controls, and research and training.(35)

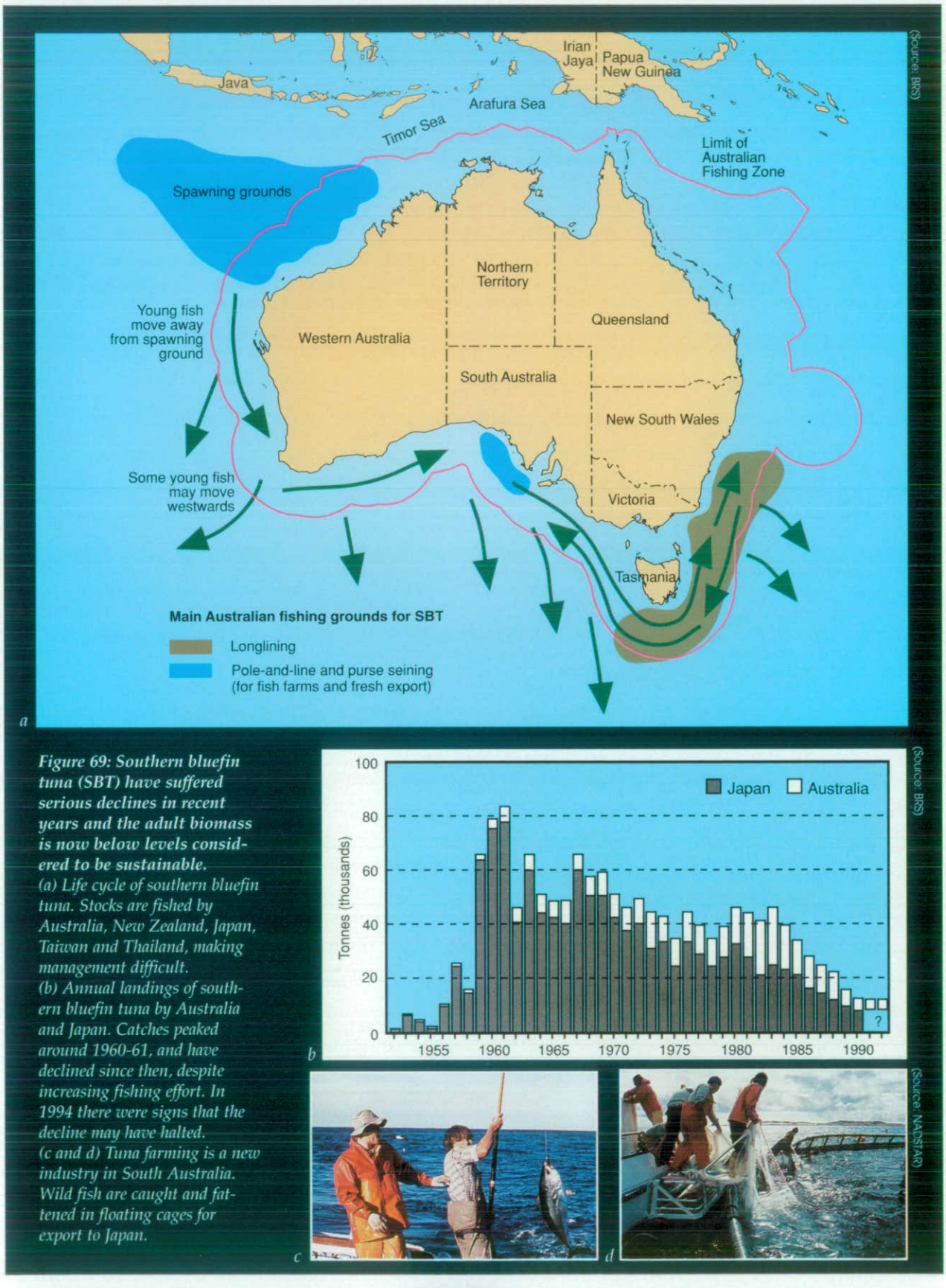


Figure 69: Southern bluefin tuna (SBT) have suffered serious declines in recent years and the adult biomass is now below levels considered to be sustainable.
(a) Life cycle of southern bluefin tuna. Stocks are fished by Australia, New Zealand, Japan, Taiwan and Thailand, making management difficult.
(b) Annual landings of southern bluefin tuna by Australia and Japan. Catches peaked around 1960-61, and have declined since then, despite increasing fishing effort. In 1994 there were signs that the decline may have halted.
(c and d) Tuna farming is a new industry in South Australia. Wild fish are caught and fattened in floating cages for export to Japan.

Recreational fisheries: an important pastime for Australians

'Wetting a line' is an important part of our Australian way of life. Each year one in three of us go fishing for recreation. However, the fishing authorities have only recently recognised the recreational fishing sector's significance - in terms of its large share of the coastal catch as well as its social importance - and the industry remains largely unmanaged.(33)

Figure 70: Fishing is a major recreational pastime in Australia. *In 1984 it was estimated that over 4.5 million Australians went fishing at least once each year and spent $2.2 billion on fishing activities. (a) Beach fishers at Scarborough (WA). (b) Light tackle anglers on the Great Barrier Reef. (c) Offshore catch, Evans Head (NSW).*

(Source: Lochman Transparencies)

a

Details on recreational fisheries remain sketchy. A 1984 survey estimated that over 4.5 million Australians went fishing at least once a year, and over 800,000 of these went fishing at least 20 times a year. Spending on fishing and related activities was estimated at $2.2 billion each year and later surveys suggest this figure is even higher. Some 100,000 people are directly employed in servicing Australia's huge recreational fishery.(33)

Recreational and sports fishing is a significant attraction for international tourists. It is estimated that in 1993 over 120,000 international tourists spent $210 million on fishing while in Australia.(33)

(Source: GBRMPA)

b

Australia's recreational fisheries are little managed although size limits (often imposed without adequate knowledge of the life history of the species) have existed for many years. Because of increasing pressure on stocks, bag limits have been imposed in recent years.(31,33)

In 1991 the Standing Committee on Fisheries which comprised all Commonwealth and State heads of fisheries departments found that a national policy on recreational fisheries was needed and a working group was formed to develop this. Recommendations in the draft national policy include the management of recreational fisheries as part of the total fisheries resources, the accommodation of conservation and non-exploitative uses, and the development of a strong conservation ethic amongst fishers.(33)

(Source: D. Schultz)

c

The major concerns of the Australian Recreational and Sports Fishing Confederation, which represents some 220,000 fishing club members around the nation, are the management of recreational fisheries, the decline in the marine environment, conflicts with the commercial sector, and diminishing stocks.(53)

the catch-sharing issue

Australian recreational and commercial fishing sectors are increasingly competing for the same, often dwindling stocks. General concerns of recreational fishers centre on commercial netting which they think is responsible for declining fish stocks, the effects of trawling, the need to protect fish habitats, growing fishing pressure from both sectors and perceptions of unequal regulations which favour the commercial sector.(33)

Conversely, concerns of the commercial sector centre on their own strict regulation as opposed to limited regulation of the recreational sector, the individually small but cumulatively large effects of the recreational sector, and widespread illegal sale or 'black marketing' of fish by some recreational fishers. Efforts are now being made by fisheries managers to address these conflicts and some successes have been achieved, but it is unlikely that they will ever be completely resolved.(33)

Effects of fishing on the marine environment

Fishing has direct and indirect effects on marine ecosystems. The target species, some of which are large, high level predators in the ecosystem, are taken in what is akin to hunting in the terrestrial environment. In some fisheries, particularly those using trawl and gill nets, large numbers of other species, termed the 'by-catch', are also taken. Often the by-catch is then discarded. The proportion of the by-catch to the target species in some fisheries, for example the northern prawn fishery, can be as high as 8 to 1.(32)

Fishing may also cause indirect and very poorly understood effects on marine ecosystems such as alterations to population structures and food chains(32). Fundamental changes in food chains referred to as 'ecosystem flips', have occurred in large marine areas overseas(92). In Australia it has been suggested that outbreaks of the coral-eating crown-of-thorns starfish on the Great Barrier Reef and of *Drupella* snails in Western Australia have been caused by overfishing of their natural predators, although unambiguous scientific evidence for this is lacking in both cases(49,50).

(Source: GBRMPA)

(Source: K. McLoughlin, BRS)

Figure 71: The effects of trawling on the marine environment is a major concern in Australia. *(a) A wide range of fish species from a Thai trawler in the Arafura Sea. (b) A range of small crustaceans and fish from a Queensland prawn trawler.*

effects of trawling

The effects of trawling on the marine environment are of major concern in fisheries and environmental management around Australia. Very little is known of the environmental impacts of trawling. Possible effects include the reduction of fished and non-fished species, removal of organisms attached to the sea floor, and changes in food webs, including increased populations of scavengers such as seabirds, fish and crabs. Management strategies include better use of the by-catch, development of more selective fishing gear to reduce the by-catch, and spatial and seasonal closures to trawling to maintain biodiversity. However, compared with some other fishing nations, Australia has lagged in developing selective fishing gear.(32)

The effects of trawling are one of the major issues in the Great Barrier Reef Marine Park. Zoning prohibits trawling on about 20% of the sea floor and a major research program is underway to assess its impacts on bottom communities.(69)

shoreline fishing and harvesting

The increasing pressure on our shores from recreational activities such as fishing and collecting is an important concern around Australia, particularly near coastal cities, towns and tourist centres. Very little is known about the impacts of these pressures. Direct effects include reductions in target species such as molluscs, sea urchins, sea squirts and fish. Indirect effects include the loss of habitats, alteration of populations and disturbance of food chains. Because of growing concerns about over-harvesting in intertidal areas, New South Wales has introduced controls on harvesting techniques and bag limits, and established networks of Intertidal Protected Areas.(34)

Figure 72: The increasing pressure of fishing and harvesting on shore communities is a growing concern, particularly near metropolitan areas. *Amateur abalone fishers on the opening day of the season, Search Reef near Perth (WA).*

(Source: D. Sarson, Lochman Transparencies)

Concerns of fisheries managers about the marine environment

Maintaining the habitat and good water quality are essential for fisheries. The overall goal for fisheries management in the National Strategy for Ecologically Sustainable Development (ESD) is for fisheries management agencies in Australia to adopt a fisheries ecosystem management framework which will provide a holistic and sustainable approach to the management of aquatic resources. Commonwealth and State/Territory fisheries agencies are now exploring how fisheries management can apply the concept of large marine ecosystems management and ESD.(30,61,84)

The major environmental concerns identified by Commonwealth and State fisheries managers in 1991 included impacts of point-source wastes, especially from industrial wastes; accumulation and effects of mercury, cadmium and other bio-accumulative substances, particularly in estuaries and coastal waters; effects of exotic species introduced via ships' ballast waters, particularly toxic phytoplankton and the Northern Pacific seastar; loss of fish habitats caused by coastal engineering works

such as ports, canal estates, marinas, and dredging; die-back of southern seagrass beds; and adverse effects on shellfish by tributyl tin used in antifouling paints.(30)

While elevated nutrients have had a generally harmful effect on Australia's marine environment, they have had a beneficial effect in some places by enhancing plankton production and thereby increasing the growth of aquacultured oysters.(30) (The negative side is that this water may also be polluted by faecal bacteria and be a danger to oyster consumers(47).) While there are a few anecdotal reports of increased fish production in eutrophic estuaries, the overall effects of lost fish habitat because of eutrophication must far outweigh any local gains(42).

MARINE TRANSPORT AND ENERGY

Ports, shipping and offshore petroleum industries may affect the marine environment through water pollution, particularly by hydrocarbons, and loss of habitat.

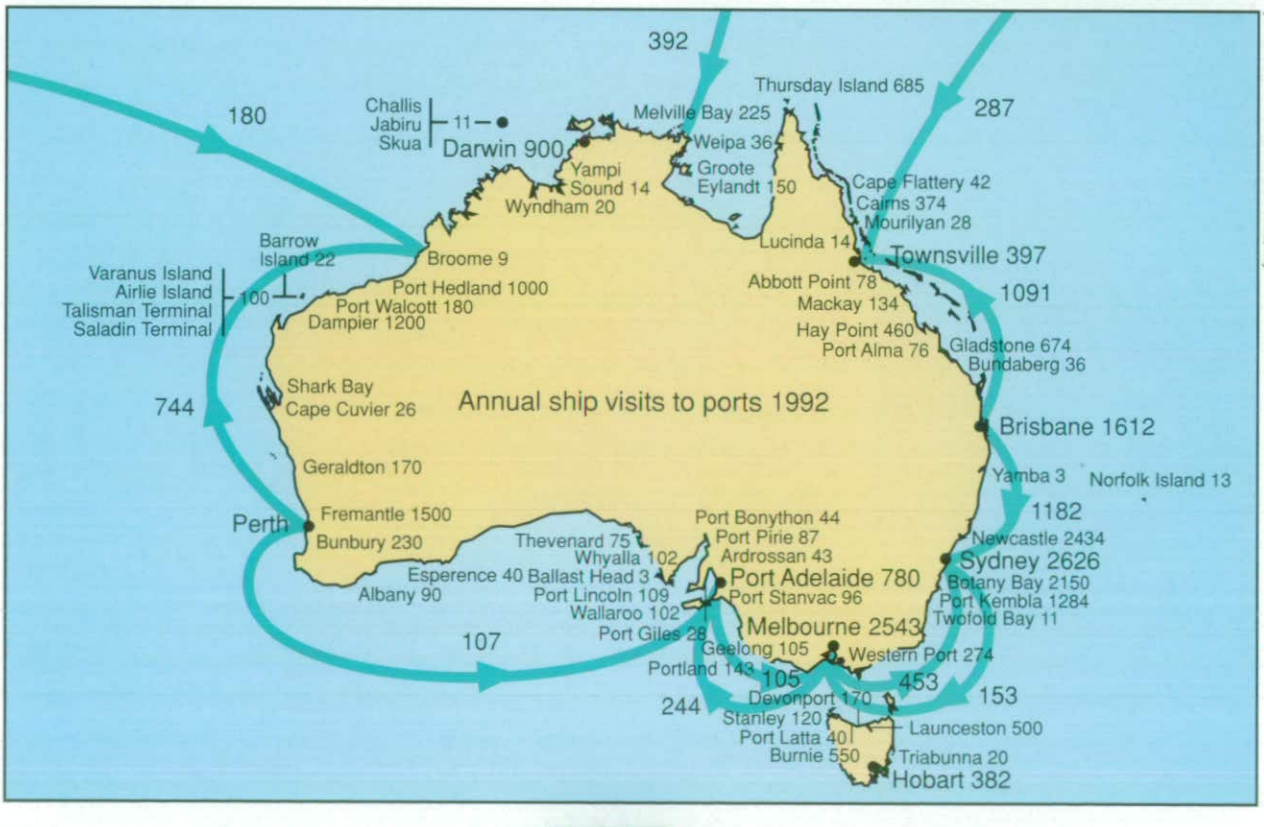
Marine transport

Australia is an isolated island continent with a long coastline and shipping is a major economic use of our seas, estuaries and coastlines. In terms of tonnage carried and distance travelled, Australia ranks as the fifth largest user of shipping in the world. Each year there are around 12,000 overseas shipping arrivals and almost 380 million tonnes of freight carried in Australian waters.(36)

Figure 73: Bulk carrier at sea.

(Source: GBRMPA)

Figure 74: Major ports around Australia. *The number of ship visits to the ports (1992) are indicated. Petroleum tanker routes (arrows, showing number of visits to each region)(1988) are also indicated.*



(Source: DTC and NATPLAN 1992/93)

(Source: G. Abraham)

Figure 75: Ships' antifouling paint is a source of pollution in ports and slipways.

Shipping and port operations produce a variety of environmental impacts such as pollution from oil, hazardous cargoes, tributyl tin from antifouling paints, litter and sewage; and introductions of exotic or foreign organisms in ships' ballast waters or attached to ships' hulls[36]. These are specifically examined in the next chapter.

port operations

Australia has 68 main ports. The impacts of ports include loss of habitat from reclamation and dredging; physical alteration of coastal environments; increased sediment from dredging; and pollution by oil, toxic chemicals, litter and antifouling paints. While ports are amongst the most disturbed marine environments in Australia, technical, engineering and management solutions do exist to prevent or minimise many of their environmental impacts.[36]

Figure 76: The stern section of the **Sanko Harvest**, *wrecked off Esperance (WA) in 1991.*

(Source: N. Holmes)

(Source: The West Australian)

Figure 77: Cormorant oiled by the **Sanko Harvest** *spill. Over 100 kilometres of coast were affected by the oil spill.*

spills from ships

The general effects of oil spills on the marine environment are well known through a long list of ecodisasters such as the *Exxon Valdez* in Alaska. So far Australia has been fortunate in that there have been only two large spills (over 1,000 tonnes), the *Oceanic Grandeur* in Torres Strait and the *Kirki* off Western Australia, but neither of these appeared to result in major environmental damage.[39]

The international nature of the shipping industry and its economic and strategic importance pose particular problems for the management of its environmental impacts. Australia has therefore adopted a number of international conventions covering marine pollution, for example the International Convention for the Prevention of Pollution from Ships (MARPOL), which deals with carriage and discharges of oil, noxious liquids, packaged harmful substances, sewage and garbage[39].

(Source: A. Dalgetty, SARDI)

Figure 78: Oiled mangroves from the **Era** *oil spill in Port Pirie (SA). Around 300 birds were killed and 100 hectares of mangroves were affected.*

recent oil spills in Australia

There have been several moderate but relatively destructive spills since 1991[39]:

- the *Sanko Harvest* spill off Esperance (WA) which oiled over 100 kilometres of coast and affected 200 fur seals (13 of which died);
- the *Arthur Phillip* spill off Cape Otway (Vic) which oiled 338 little penguins (273 died); and
- the *Era* spill in Spencer Gulf (SA) which oiled 300 birds, mostly cormorants (only five survived) and damaged 100 hectares of mangroves.

risk of major spill rated as high

The risk of a major spill from shipping around Australia is considered to be high. The Bureau of Transport and Communications Economics estimated in 1991 that the risk of a major spill from shipping was 49% in any five year period, and 84% in any 20 year period.(39,100)

oil spill management and controls

The Australian Maritime Safety Authority (AMSA) has the national responsibility for maritime oil spill issues. Because it has never been possible to control a major spill, the prevention of spills through safe operations and navigation of ships is the primary objective of management. For example, since the MARPOL Convention took effect, discharges from ships have been reduced by about 60% worldwide. Navigation technology has also greatly improved and the use of global satellite positioning systems has greatly reduced the risk of accidents. Tankers built after 1993 have double hulls for added protection against holing.(39)

Australia has been a leader in the control of pollution from shipping. For example, in 1990 the hazardous Great Barrier Reef passage was the first area in the world designated as a 'Particularly Sensitive Area' by the International Maritime Organisation. All ships using the passage which are over 70 metres in length, and all ships carrying oil or toxic cargoes must now carry Australian registered pilots.(39,69)

(Source: N. Coleman)

Figure 79: Oil spill, Botany Bay (NSW).

the National Plan

Despite best practice, oil spills are inevitable. Australia has a National Plan to Combat Pollution of the Sea by Oil which is managed by AMSA. This involves Commonwealth, State and Territory Governments, and the shipping, oil and exploration industries in order to maximise Australia's oil spill response capability. Pollution response equipment is stockpiled at strategic ports and oil terminals with a major industry stockpile in Geelong (Vic). The stockpile has the capability of controlling an oil spill of up to 10,000 tonnes. If necessary, additional equipment may be called upon from international stockpiles in Singapore and the United Kingdom. However, it is recognised that technology does not currently exist to prevent weather driven oil slicks from washing ashore or guarantee prevention of environmental damage and economic loss, except in favourable conditions.(39,84)

Offshore petroleum exploration and production

Offshore petroleum production is of great economic and strategic importance to Australia. Some 72% of our liquid fuels and natural gas comes from offshore wells in Bass Strait, the Timor Sea and the North West Shelf. Current production of oil is over 3.5 million barrels per year(37,84).

Over the past 30 years more than 1,100 wells have been drilled offshore and around 2,800 million barrels of oil have been extracted. The Australian offshore petroleum industry has a very good environmental record and only about 800 barrels of oil have been spilt since drilling began.(37,84)

Potential environmental impacts of offshore petroleum exploration and production include effects of seismic surveys on marine organisms that are within several metres of the trailing cables, and effects on the communications and behaviour of marine mammals over a wider area; the construction of platforms and laying of pipes, which affect the sea floor in the immediate vicinity; disposal of 'produced water', which is present with the oil and contains traces of hydrocarbons; contamination by drill fluids that are used to lubricate the drill bit, and which contain various chemicals; and effects of increased shipping activity.(37)

A scientific review of the environmental implications of the offshore petroleum industry by the Australian Petroleum Exploration Association (APEA) in 1993 found that the risk of oil spills by Australian explorers was minimal, and that environmental effects have been minimal. It considered that Australian producers are world leaders in 'produced water' treatment standards and technology.(37)

Figure 80: Offshore petroleum rigs supply the majority of Australia's oil and gas requirements. *Oil rig, Exmouth Gulf (WA).*

(Source: G. Taylor, Lochman Transparencies)

A statistical risk study by the Bureau of Transport and Communications Economics estimated that the theoretical probability of a major spill (that is, greater than 1,000 tonnes) from offshore petroleum sources was around 26% in any five year period, and the risk of a pipeline spill was around 17% for the same period. However, the industry strongly argues that these are highly pessimistic estimates as they are based on overseas data, and that offshore oil technology has greatly improved in recent years.(38)

Despite the clean environmental record of the Australian offshore petroleum industry, many conservationists still perceive the industry as a major threat because of overseas disasters such as the *Ixtoc 1* exploration well blow-out in the Gulf of Mexico. The offshore industry is, in turn, critical of the 'emotive' rather than scientific arguments of many conservationists and environmental managers.(38)

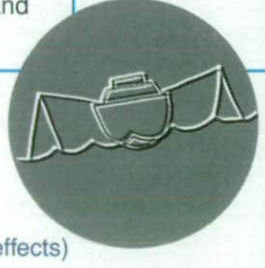
Oil drilling is prohibited in marine protected areas such as the Great Barrier Reef World Heritage Area and in Ningaloo Marine Park. In the Australian Antarctic Territory, any activity relating to mineral resources, other than scientific research, is prohibited. It is possible that the establishment of marine protected areas may affect oil exploration in those areas, and conversely, the issuing of offshore exploration leases may affect the future establishment of marine protected areas in lease areas.(38)

Report Card

Subject: Major uses of the marine environment and their effects

(A: no effect, to D: serious effect)*

Uses	Issues	Effects
Tourism and recreation (developed and undeveloped)	Coastal strip development; channel dredging and marinas; loss of habitat; shore and beach erosion; social impacts in communities; loss of amenity. (29)	A-C
Marine transport (developed)	Chronic spills of oil and hazardous chemicals; occasional large spills; introductions of foreign organisms in ballast waters; dredging of channels etc.	C-D
Marine transport (undeveloped)	Operational discharges; occasional oil spills and shipping accidents. (36)	A-B
Offshore oil (undeveloped)	Localised effects of exploration and operational discharges. Insignificant oil spills to date but some risk of significant spills exists. Leases may affect establishment of marine protected areas. (37,38)	A-B
Fisheries (developed and undeveloped)	Declines of significant stocks; declines in coastal catches; increasing conflicts between commercial and recreational sector in coastal fisheries; widespread serious concerns on effects of trawling on sea floor; concerns on waste of by-catch and effects on ecosystem. (30-35)	B-D



*Scores

A: NO APPARENT EFFECTS

B: SOME EFFECTS (general slight effects, or few sites with moderate effects)

C: MODERATE EFFECTS (general moderate effects, or some sites with serious effects)

D: SERIOUS EFFECTS (general serious effects, or many very serious effects)

4

General issues and pressures affecting Australia's marine environment

Australia's marine environment has been directly and indirectly affected by a range of human activities on the coast and sea, but also well inland in the catchments.

COASTAL MODIFICATIONS

The great majority of Australia's population is concentrated within the coastal zone of the east, south-east and south-west. Much of the coastline in these areas has been significantly altered by urban, industrial and port development, and by a variety of facilities for tourism and recreation.(1,40)

(Source: Vic Dept. Conservation and Natural Resources)

a

(Source: I. Dutton)

b

Figure 81: Significant parts of Australia's south-eastern and south-western coasts have been modified by human activities.
(a) The catchments and shores of much of Port Phillip Bay (Vic) are highly altered. This shows the Werribee sewage treatment ponds and the highly altered estuary of the Little River (below). (b) Typical of many coastal towns is Evans Head (NSW). The estuary (at right) has been modified by breakwaters, groynes, seawalls, a marina and urban development. The dunes (centre) have been mined for mineral sands while the dunes and heath (right) have been used as a bombing range for many years. Much of this area is now protected in the Bundjalung National Park.

Major coastal impacts include coastal engineering structures such as breakwaters and seawalls associated with ports, harbours, canal estates and marinas, and reclamations. Estuaries and the coastal lakes and lagoons in the south-east have been particularly affected by seawall construction and there have been significant local losses in saltmarsh, mangrove and seagrass habitats. Beach erosion, which has been occurring naturally in many parts of Australia in geologically recent times, is an increasing problem in many areas. Erosion is expected to accelerate in the following decades if sea level rises resulting from the enhanced greenhouse effect do eventuate(40,41). Sea level rises, erosion of shorelines in coastal lakes and estuaries, up-stream diversions of sediment (for example, through engineering works intended to remedy erosion) all pose significant threats to sites of cultural importance(84).

The coastal changes have been most extensive in the more populous south-east and south-west, but they have also occurred in other coastal towns, ports and resorts, and to a minor extent in rural areas. Although

they have affected a relatively small proportion of the continent's coastline, many have been in areas of particular ecological and fisheries importance and with particular aesthetic appeal. Around 70% of the coastline remains sparsely inhabited and most of Australia's coastline is still in a generally pristine condition[1,40].

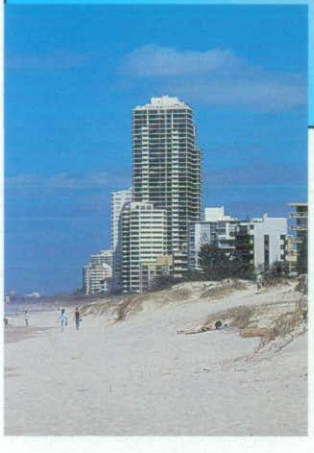
(Source: I. Dutton)

Figure 82: Coastal strip development is a major issue from Hervey Bay in Queensland, to southern Victoria. The Byron Shire coast (NSW) is rapidly being urbanised.

(Source: RAC)

Figure 83: Coastal growth has been rapid in non-metropolitan areas over the past 20 years. Growth rates in coastal growth regions, 1971-91 (excluding capital cities).

(Source: I. Dutton)



a

(Source: I. Dutton)

b

Figure 84: Foreshore development and beach erosion are serious issues in many places around Australia. (a) Beaches and dunes along Queensland's Gold Coast erode during heavy seas because breakwaters constructed 'upstream' on the Tweed River in New South Wales stop natural sand replenishment. (b) Residential beach front development near Perth.

COASTAL DYNAMICS AND SEA LEVEL CHANGE

Climate changes over geological and shorter time frames have greatly altered sea levels and coastlines. Only 18,000 years ago, at the end of the last Ice Age, the sea level was at least 130 metres lower than it is today, and it did not reach its present level until around 5,000 years ago. At one stage it may have risen at a rate of 45 millimetres per year! Geologically the present coastline is very young, and is very dynamic.[40,41]

(Source: C. Mitchell, CSIRO)

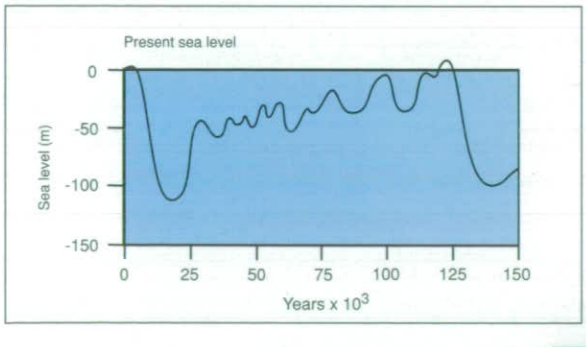


Figure 85: Sea level has varied greatly in the past 150,000 years. It has stood at its present level for only the past 5,000 years.

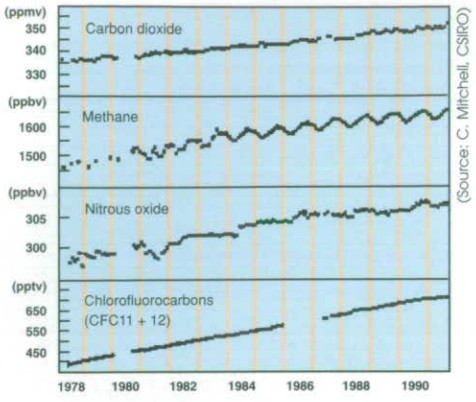


Figure 86: Trends in greenhouse gases observed over south-eastern Australia and at the Cape Grim monitoring station.

It is thought that increasing levels of greenhouse gases (mainly carbon dioxide, methane, and nitrous oxide) from industry and other sources may cause a warming of the atmosphere and climate changes. A rise in the mean sea level due to the thermal expansion of the ocean may occur in the next few decades. A doubling of carbon dioxide in the atmosphere from its pre-industrial level is predicted to increase the average global temperature by between 1.5 and 4.5°C. While the effects will probably not be as dramatic as feared a few years ago, it is possible that climate change and sea level rise will be major issues in coastal zone management in the 21st century.(41)

The Commonwealth Scientific and Industrial Research Organisation's (CSIRO's) recent scenarios, or possible outcomes, of Australia's warming by 2030 AD are between 0 and 1.5°C in the north, and between 0.5 and 2.0°C in the south. Based on 1990 sea levels, the resultant global rise in sea level by 2030 AD could be between 5 and 35 centimetres, and by 2100 AD could be between 15 and 120 centimetres. The lower estimates would cause minor problems; the higher estimates would result in inundation of low-lying areas and serious erosion of coastlines.(41)

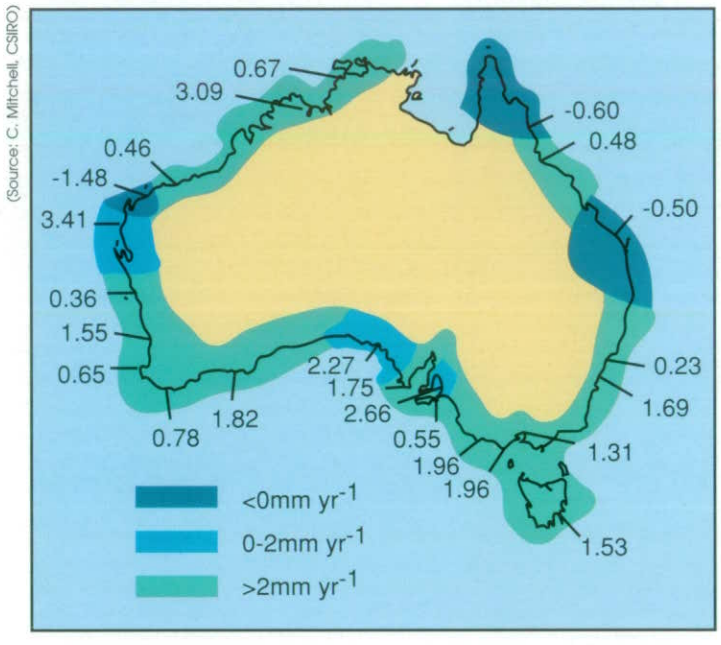


Figure 87: Recent trends in sea level changes between 1966 and 1984-85 show that these vary around the coast, with it rising in some places and falling in others. *Trends are not long enough to determine changes due to an enhanced greenhouse effect.*

Changes in patterns of rainfall and cyclones due to global warming may have a greater impact on coastal environments than sea level rise. Coastal saltmarshes and wetlands, beach processes, coral growth and fisheries productivity may also be affected.(41)

The threat of global climate change requires coordinated global and national efforts. Australia's Greenhouse Response Strategy is linked with the United Nations Framework Convention on Climate Change which was open for signing at the 1992 United Nations Conference on Environment and Development. Commitments of this Convention include preparing national inventories on greenhouse gas emissions and removals by carbon sinks, national programs to mitigate climate change, and promoting ecologically sustainable development.(41)

The Response Strategy provides a means for identifying response measures, including reducing greenhouse gases, scientific research, and planning for change. Major difficulties in planning include the extended time scales involved (spanning many decades: much longer than usually considered by planners), and the great uncertainty about the nature and extent of possible changes.(41)

Systematic monitoring of Australia's climate is undertaken by the Bureau of Meteorology. The composition of greenhouse gases in Australia is being monitored at the Cape Grim Baseline Air Pollution Station.(41)

MARINE POLLUTION

Marine organisms may be affected by a range of discharges and emissions including nutrients and sediments, heavy metals, organochlorines and litter. Most of these (in the order of 80% according to some commentators[84]) enter the sea from the land, from point-sources such as pipes and drains as well as from diffuse sources from catchments and from the atmosphere.

Elevated nutrients and sediments: significant threats to Australia's inshore marine environment

In recent years many of Australia's inland waterways have suffered catastrophic blooms of toxic blue-green algae because of high levels of nutrients from agricultural run-off and urban sewage. Eutrophication, an increase in algal growth because of elevated nutrients, also becomes a problem when polluted waters reach estuaries and enclosed bays. Coastal eutrophication is a growing worldwide problem, and is one of the most serious, large-scale threats to Australia's nearshore marine environment.[42]

Australian coastal ecosystems are particularly vulnerable to eutrophication and sedimentation as they evolved under very low nutrient and sediments regimes and are widely dominated by nutrient-sensitive corals in the north, and seagrass in the south. Estuaries and coastal lagoons whose upper river catchments have been cleared for intensive agriculture and whose lower reaches are subject to major urban and industrial developments are at particular risk.[42]

(Source: K. Edyvane)

a

b

Figure 88: Elevated nutrients in sewage have caused blooms of harmful algae in some estuaries and bays.
(a) Nutrients in sewage and stormwater have resulted in blooms of the macroalga Ulva *near metropolitan Adelaide, smothering mangroves. (b) Die-back of mangroves near the Bolivar sewage treatment works near Adelaide.*

sources of nutrients and sediments

Clearing of land, overgrazing and cropping have greatly increased soil erosion and, consequently, the amount of sediments entering the sea. Increased sedimentation is the major contributor of nutrients entering the sea. For example, it is estimated in Queensland that four times more sediments, nitrogen and phosphorus now enter the sea each year than in pre-European times.[42]

Fertilisers are a significant source of nutrients in agricultural areas. Because Australia's ancient leached soils are particularly low in phosphorus, superphosphate fertilisers are applied to crops and pastures. Superphosphate use has steadily increased since 1950, and is currently about 350,000 tonnes a year. Application of nitrogenous fertilisers has also steadily increased and is around 370,000 tonnes a year.[42]

Sewage and stormwater run-off are major sources of nutrients in urban areas. Most of Australia's sewage is only secondarily treated and remains high in nutrients. Each year around 10,000 tonnes of phosphorus and 100,000 tonnes of nitrogen are discharged through sewage, much of which finds its way into the marine environment. Tertiary treatment which removes nutrients is now being introduced in inland towns because of eutrophication of rivers. However, stormwater run-off from cities is also high in nutrients from animal and other wastes and may equal that generated from the city sewage.[42]

environmental impacts of nutrients

Many areas around Australia have experienced major changes to marine ecosystems through elevated nutrients. Very large areas of seagrass in southern Australia have suffered die-back from eutrophication and sedimentation[10] (Chapter 1). Nuisance and toxic blooms of seaweeds and phytoplankton are also now common in many southern bays and estuaries[14, 42]. Amongst the worst affected areas are the Peel-Harvey system and Cockburn Sound (WA)[42,56]; Holdfast Bay and Barker Inlet (SA)[42,55]; Gippsland Lakes and Port Phillip Bay (Vic)[42,53]; and Lake Illawarra, Lake Macquarie, Tuggerah Lakes, and Georges River (NSW)[42,52].

There is a growing concern that the Great Barrier Reef lagoon, the body of water between the Reef and mainland, is becoming eutrophic, and that corals on inner reefs may be declining[42]. It has also been suggested that elevated nutrients are responsible for outbreaks of crown-of-thorns starfish by increasing the survival rates of their larvae[49]. Major research programs are under way on these subjects[69].

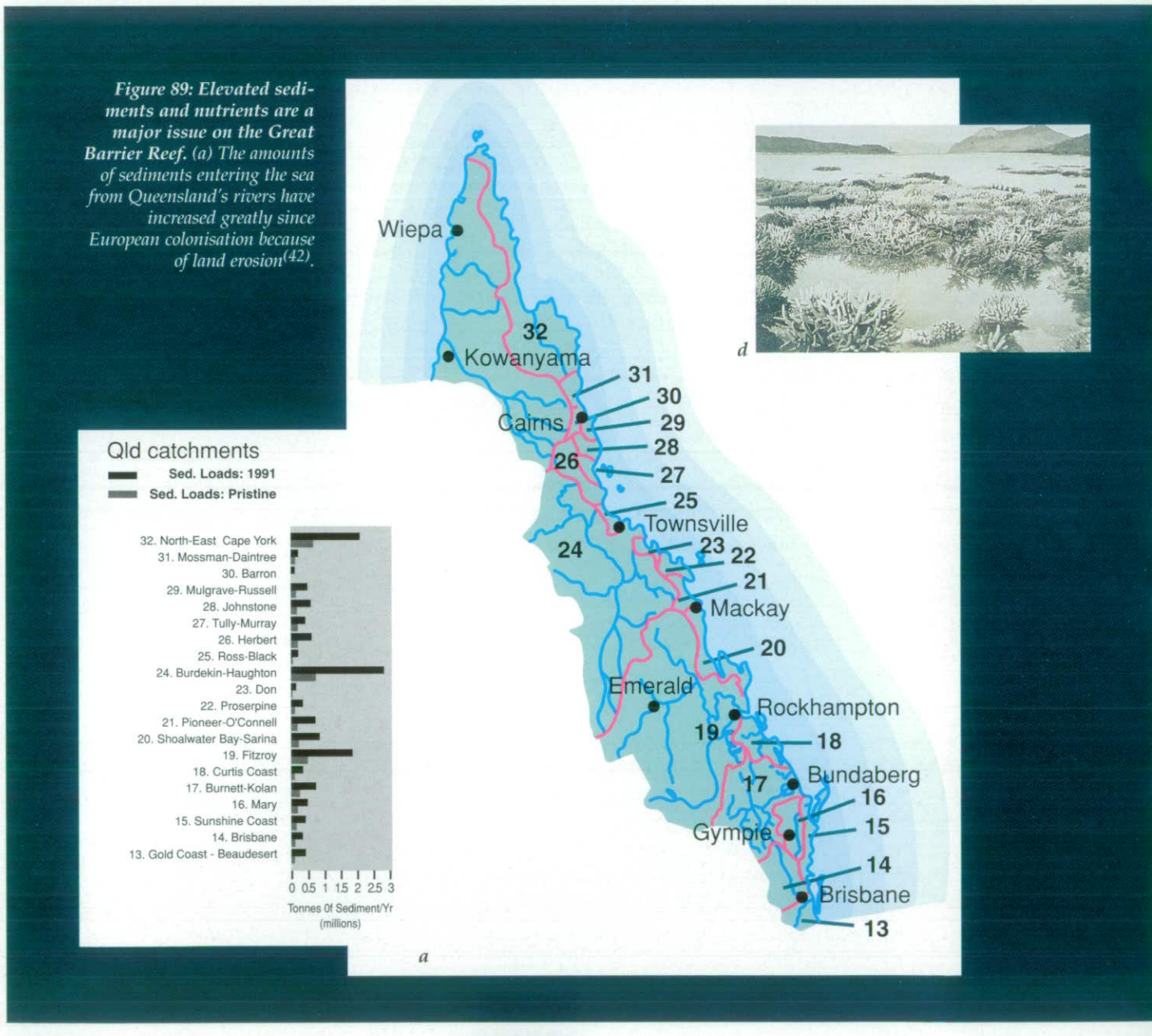


Figure 89: Elevated sediments and nutrients are a major issue on the Great Barrier Reef. *(a) The amounts of sediments entering the sea from Queensland's rivers have increased greatly since European colonisation because of land erosion[42].*

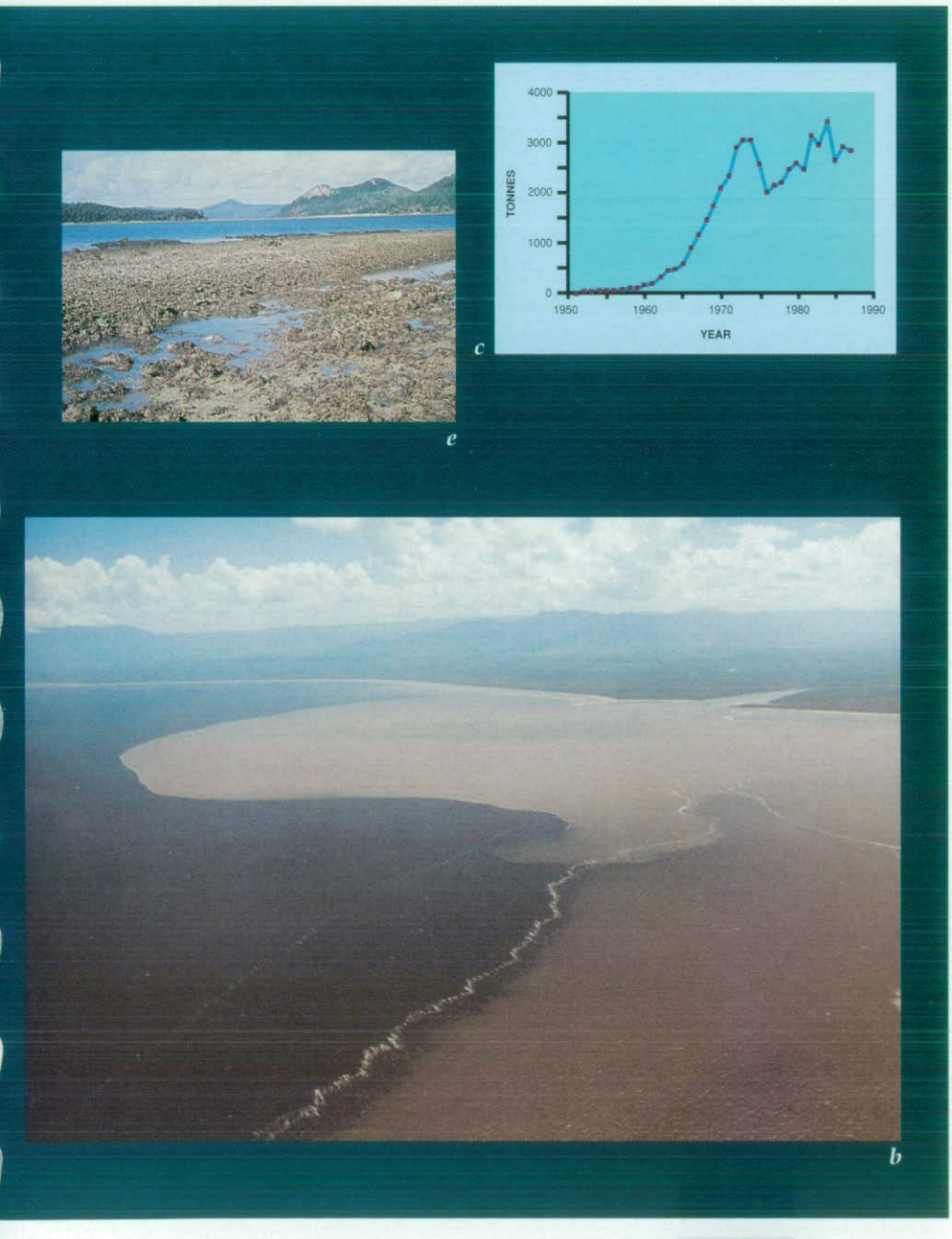
The economic costs of reducing eutrophic systems are great. For example, the engineering to reduce algal growth in Cockburn Sound (WA) cost $170 million, in the Peel-Harvey estuary (WA) cost $50 million, and in Tuggerah Lakes (NSW) cost $12 million. The estimated cost of the proposed Sydney Clean Waterways Program was $7.1 billion over 20 years[42].

management of eutrophic systems

Managing nutrients involves controlling point source discharges, rechannelling sewage into better flushed environments, sewage nutrient minimisation, and in extreme cases excavating artificial channels to increase flushing and mechanically removing algae. Management of diffuse sources of nutrients is undertaken in some areas through integrated catchment management to reduce soil erosion and improve fertiliser management. Integrated catchment management is one of the most important initiatives in the management of Australia's terrestrial - and its marine - environments[14, 42].

Figure 90: The Dawesville Channel which was opened in 1994 to increase ocean flushing of the highly eutrophic Peel-Harvey estuary (WA).

(Source: Lochman Transparencies).



(Source: J. Brodie, GBRMPA)

Figure 89 (cont.):
(b) A flood plume bringing sediments from the Tully-Murray Rivers into the Great Barrier Reef lagoon after cyclone Winifred in 1986. (c) Agricultural fertilisers may also be a significant source of nutrients entering the sea. Annual fertiliser use in the Atherton Shire since 1950(42). (d) and (e) There is growing evidence of a widespread die-back of reef top corals on inshore reefs. A Whitsunday reef around 1950 (d) and in 1994 (e).

Sources of oil pollution

While the large oil spills from ships[36] grab headlines (Chapter 3), far more oil actually enters the marine environment from industrial, sewage and stormwater discharges from land, and these have a chronic effect on coastal marine life.[43, 93]

It is estimated that globally, 36.3% of oil pollution enters the sea from terrestrial sources, 45.2% from shipping (of which 12.5% comes from tanker accidents), 9.2% from the atmosphere, 7.7% from natural sources and 1.5% from offshore oil exploration and production.[93]

In Australia the greatest sources of marine oil pollution are terrestrial outflows from sewage systems and drains, which are estimated at 16,000 tonnes a year, and operational discharges from shipping. The largest number of spills at sea result from accidents during fuelling of vessels in ports.[37, 43]

(Source: N. Coleman)

Figure 91: Shore crabs smothered by an oil spill, Cockburn Sound (WA).

Table 8: Occurrence of petroleum hydrocarbons in Australian waters and sediments[43]

Location	Concentration (microgram/litre)
Waters	
Great Barrier Reef	0.29 petroleum
Port Phillip Bay (Vic)	0.2-22.6 petroleum 0.25-0.7 total hydrocarbon
Western Port (Vic)	<0.1-7.1 petroleum
Yarra River (Vic)	0.05-0.41 PAHs
Parramatta River (NSW)	0.17-0.41 PAHs
Brisbane River (Qld)	0.10-0.28 PAHs
Sediments	
Great Barrier Reef	0.2-0.8 dry wt hydrocarbons
Brisbane River (Qld)	3.9-16.1 dry wt PAHs
Parramatta River (NSW)	0.1-13.6% grease
Mallacoota Inlet (Vic)	0.80-0.11 PAHs
Western Port (Vic)	2.3-5,271 dry wt hydrocarbons
Corio Bay (Vic)	0.49-3.0 PAHs
Corio/Geelong/ Port Phillip Bay (Vic)	6-1516 petroleum hydrocarbons
Yarra Estuary (Vic)	0.12-10.9 PAHs
Rowley Shelf (WA)	0.015-0.05 dry wt alkanes
Background	variable (<1 µg/l)

Hydrocarbon pollution

Crude oil and refined petroleum are complex substances made up of hundreds of different compounds of two types alkanes and aromatic hydrocarbons. The former have a low toxicity; the latter include environmentally harmful polycyclic aromatic hydrocarbons (PAHs) which are carcinogens and which have been implicated in a wide range of human health problems and diseases in aquatic organisms. PAHs also strongly accumulate in food chains and bind to organic material in sediments.[43]

Petroleum hydrocarbons are present at different concentrations in water, sediments and biota in the marine environment, but are normally at less than 1 microgram per litre concentrations. Background levels are difficult to establish as many organisms produce natural compounds similar to petroleum hydrocarbons. Waters from areas in Port Phillip Bay and Western Port (Vic), and the Brisbane (Qld), Parramatta (NSW) and Yarra Rivers (Vic) have been contaminated from urban run-off, sewage and petrochemical industries. Sediment concentrations similarly range from background levels in remote areas (e.g. on the Great Barrier Reef) to localised contamination in urban areas (e.g. in the Yarra River, parts of Western Port).

Heavy metals: significant gains in environmental management

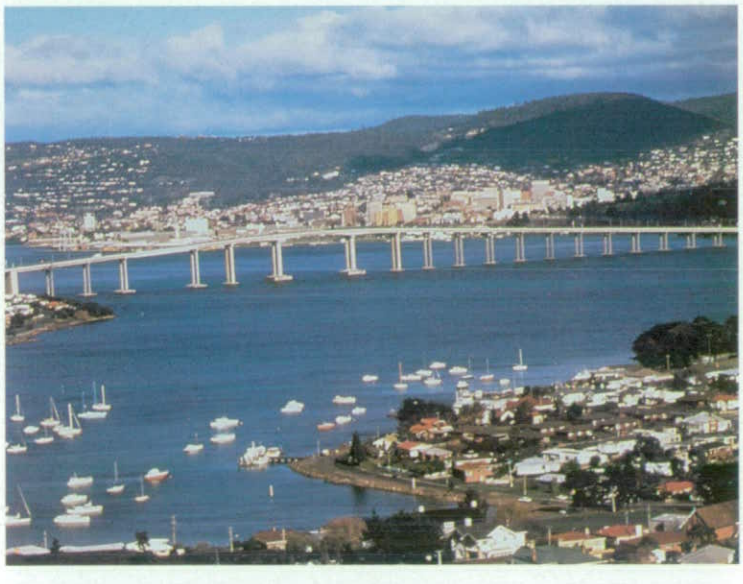
Heavy metals such as copper, lead, cadmium, zinc and mercury, as well as tributyl tin (TBT) from antifouling paints, have become serious contaminants in the world's estuaries and coastal waters in recent years. The heavy metals enter the marine environment via urban stormwater run-off, industrial effluents, sediments from mining operations, and atmospheric fall out. Tributyl tin comes from paint on boats' hulls and from slipway operations during repainting. Heavy metals tend to attach to suspended particles in the sea, and ultimately accumulate in bottom sediments.(44)

Heavy metals were identified as a major global pollution threat following a series of ecodisasters in the 1960s. The Derwent River in Tasmania was found to be particularly contaminated by metallurgical wastes, pulp mill effluents and partially treated sewage and was then regarded as one of the most polluted places in the world.(44)

Since then significant advances have been made in reducing the problem in Australia through implementation of water quality guidelines and effluent controls. Heavy metals now pose only localised problems, or potential problems, near some of the State capitals and industrial areas like Port Pirie (SA), Lake Macquarie (NSW), and the Derwent and other estuaries in Tasmania. However, concerns remain about the high levels in some sediments, and the long-term effects of moderate but sustained levels through bioaccumulation by fish, molluscs, algae and seagrass. Dredging of contaminated sediments in estuaries is also a problem. Standards for heavy metal levels in dredged sediments do not currently exist in Australia and levels frequently exceed those operating overseas. Australian guidelines are currently under development.(44)

Figure 92: Mine tailings at the entrance of the King River, Macquarie Harbour (Tas).

(Source: I. Dutton)



(Source: Tas. Dept. Tourism, Sport & Recreation)

Figure 93: The Derwent Estuary, Hobart.
The estuary has locally high levels of various heavy metals from refineries.

Table 9: Heavy metals in selected estuaries, coastal waters (micrograms per litre) and sediments (micrograms per gram) in south-eastern Australia [44]

Place	Cu	Pb	Cd	Zn	Hg	As	Co	Ni	Cr
ANZECC guidelines (μg/L)	5	5	2	50	0.1	50	-	15	50
Estuaries									
Mid Port Phillip Bay (Vic)	0.6	<0.8	<0.05	<2 .0	<0.002	2.8	-	-	-
Corio Bay (Vic)	1.1	<0.8	0.2	<2.0	<0.002	3.2-	-	-	-
Port Hacking (NSW)	0.5	0.4	0.2	-	-	-	-	-	-
N. Lake Macquarie (NSW)	1.5	1.61.9	5.2	-	-	-	-	-	-
S. Lake Macquarie (NSW)	1.2	0.1	0.2	1.0	-	-	-	-	-
Lake Munmorah (NSW)	1.5	0.2	0.1	2.7	0.02	1.7	-	-	2.1
Port Augusta (SA)	0.45	0.54	0.37	<10.0	-	-	-	-	-
Port Pirie (SA) offshore	0.25	5.1	0.32	47.0	-	-	-	-	-
Macquarie Harbour (Tas)	7	-	0.03	2.0	-	-	-	0.5	-
Derwent River (Tas)	1.2	0.23	0.05	3.4	0.034	<6	0.03	0.27	-
Coastal waters									
Pacific deep water	0.17	0.002	0.11	-	-	-	-	0.61	-
Bate Bay (NSW)	0.3	0.2	0.06	-	-	-	-	-	-
8 km E Port Jackson (NSW)	<0.2	0.04	0.01	0.1	0.02	1.4	-	-	0.1
off Maroubra (NSW)	0.09	0.03	0.01	0.2	0.01	1.0	0.04	0.2	0.3
Lizard Is (GBR)	0.13	<0.06	<0.01	0.10	< 0.002	-	-	-	-
Estuarine and marine sediments									
Corio Bay offshore	2-50	2-210	0.1-13	4-400					
Corio Bay mid	4-35	14-100	0.2-9	14-166					
Port Phillip Bay offshore	8	22	2	40					
Port Phillip Bay near shore	1.5	8	0.8	21					
Port Phillip Bay Werribee	<5-75	<20-140	<5	9-300					
Lake Munmorah*	70	40	-	150					
Tuggerah Lakes*	20	40	-	110					
Lake Macquarie north*	170	1200	160	2400					
Lake Macquarie south*	20	68	4	150					
Blackwattle Bay, Sydney**	180	520	3	1150					
Quibray Bay, Botany Bay**	3	10	0.5	25					
Port Kembla Harbour**	113	113	2	380					
Sydney coast (100m depth)	14	15	-	60					

(* 5 cm depth ** 10 cm depth)

(Source: N. Coleman)

Figure 94: Some mining and industrial effluents are sources of heavy metals.

Table 10: Tributyl tin levels* in selected waters in Australia[44]

Place	Level
Georges River (NSW)	8-40 (pre-ban) 1-11 (post-ban)
Kogarah Bay (NSW)	100 (pre-ban)
Port Phillip Bay (Vic)	3-23 (pre-ban)
Southport (Qld)	45 (pre-ban)

*(nanograms per litre)

tributyl tin

Tributyl tin (TBT) has been widely used in Australia as a poison in antifouling paints since the 1970s. During the 1980s TBT was found to affect the growth of oysters and other molluscs, and a ban was recommended on its use on vessels smaller than 25 metres.[44]

Prior to the ban on TBT, levels of concentration in Australian dockyards and marinas were frequently 50 times the guideline. Since the ban, levels have dropped appreciably, to below the guideline. Concentrations are now less in surface sediments than in older sediments below.[44]

Organochlorines: the problem of bioaccumulation in marine life

Around 60,000 different synthetic compounds have been produced for agricultural and industrial use over the past 50 years, and an additional 5,000 are now being produced each year. The persistence and toxicity of one group of synthetic chemicals, the organochlorine compounds, have made them very effective pesticides but has also made them potential environmental threats. Although organochlorines are present in very low concentrations in the sea, they are preferentially soluble in animal fats where they may reach 50,000 times the concentration in surrounding waters. They may also bioaccumulate in food chains and become most concentrated in predatory fish, seabirds, marine mammals and humans.(45)

A range of organochlorine compounds have been widely used in Australia as herbicides (2,4-D, 2,4,5-T), insecticides (DDT, lindane, chlordane), fungicides (hexachlorobenzene, chlorinated phenyls) and as insulating fluids (poly-chlorinated biphenyls, or PCBs). Organochlorines are also produced in chlorination processes such as chlorine pulp bleaching(45). These substances have a wide range of persistences; some break down quickly in sunlight and moisture but persist within fats(84).

Little is known of the levels of these in Australia's marine environment. Pesticides like DDT are thought to be widely present in marine life around Australia, but in very low concentrations away from urban and intensively farmed lands.(45)

In Queensland, organochlorines have been detected in very low concentrations on the Great Barrier Reef, and in higher concentrations in the Brisbane River. In New South Wales they were in very high levels near Sydney's sewage outfalls but have declined in these areas since the relocation of the outfalls offshore. In South Australia they were found to be widely present in fish sampled.(45)

Few surveys of PCBs have been undertaken in Australia. PCBs have been detected in offshore waters, with increasing levels towards the coast, but at lower levels than in equivalent Atlantic waters. PCBs have been detected in Queensland at low levels on the Great Barrier Reef and Brisbane River. In New South Wales they were high at the former Sydney ocean sewage outfalls but have declined since the relocation of the outfalls into deep water. In Port Phillip Bay levels remain high near Melbourne, but are declining in Corio Bay.(45)

(Source: Vic Dept. Conservation & Natural Resources)

Figure 95: Corio Bay near Geelong (Vic). *Industrial effluents, spills from ports, shipping discharges, and urban and agricultural run-off have resulted in locally high levels of heavy metals and organochlorines in the bay's sediments. Levels have been declining since controls on discharges came into force.*

Figure 96: Beach litter is highly conspicuous along shores near Australia's metropolitan areas but not even remote beaches are free from ocean litter. *(a) A heavily littered shore on Port Phillip Bay near Melbourne (Vic). Studies of litter near Australian cities show that the litter comes from city streets and dumps via stormwater drains and rivers, from visitors and from boats. (b) Studies of ocean litter on remote Australian beaches show that most of the litter there comes from fishing boats and foreign vessels. At Anxious Bay (SA) around 25 kilograms of ocean litter was found per kilometre of beach.*

(Source: Vic Dept. Conservation & Natural Resources)

a

(Source: N. Wace)

b

Dioxins, waste products related to organochlorines, are recognised as significant problems in Australia although again, very few studies have ever been undertaken. In Sydney they have been found in fish and sediments in Homebush Bay, and in Melbourne near sewage outfalls.(45)

management of organochlorines

Because of their harmful environmental effects, many organochlorines are now banned or controlled. From the scattered surveys undertaken, levels appear to be declining near urban sewage outfalls since their uses have been regulated, but more systematic nationwide monitoring programs for organochlorines are needed to determine their status.(45)

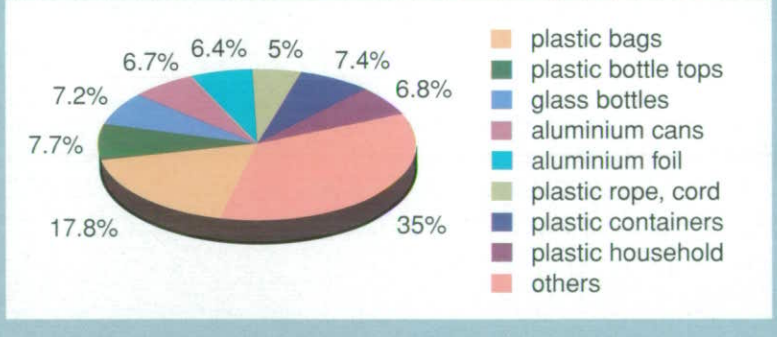
Ocean and beach litter: widespread, and more than unsightly

Australia's beaches are increasingly littered with plastic bottles, plastic bags, tangled fishing lines, nets and other rubbish. Litter comes from 'tourist trash' left by beach-goers or is washed there. The latter comes from land litter washed from catchments and stormwater drains, from ships' garbage, from discarded fishing gear from anglers and fishing boats, and from remote sources far across the ocean. Urban beaches are worst affected, but even the most remote coastal and island beaches are not free from litter.(46)

sources of beach litter

There is some debate on who is ultimately responsible for beach litter, and what can be done to reduce it. Recent scientific surveys of beaches near Brisbane, Sydney and Melbourne found that most litter came from streets and garbage dumps and reached beaches via streams and drains. Blame was attributed to littering practices of the general public and poor waste management by local authorities. However, Greenpeace argues that the core of the problem really lies with our consumer society, and targets the packaging industry.(46)

The fishing industry is also a major contributor of ocean litter. Greenpeace found 20% of items came from recreational and commercial fishers. Systematic surveys by Tasmanian authorities in the isolated south-west found fishing litter constituted as much as 80% of all beach litter.(46,54)



(Source: Greenpeace Australia)

Figure 97: Composition of beach litter (by number of items) collected in Greenpeace's 'Adopt-a-Beach' program.

Litter not only reduces the beauty of our beaches, but may also endanger marine life. Worldwide, many thousands of marine mammals, turtles and seabirds die each year from swallowing plastic bags and other objects, or get trapped in discarded fishing gear. Lost fishing nets and traps may also continue to catch fish (often referred to as 'ghost fishing'). In Australia the incidence of entanglement of fur seals in net fragments and other litter is alarmingly high. It is estimated that at any one time, around 500 seals in Tasmanian waters, and 45 seals at Victoria's Seal Rocks have 'collars' of plastic litter (Chapter 1).[18,46,54]


(Source: D. Pemberton)

Figure 98: Fishing litter such as net fragments, ropes and bait straps may entangle marine animals, strangling or drowning them. *In southern Australia, seals often get their necks entangled in lost or discarded fishing gear. This young Australian fur seal from Tasmania has a rope 'collar'.*

management of beach and ocean litter

Greenpeace Australia first focused public attention on the problem of beach pollution through the 'Adopt-a-Beach' program between 1990 and 1992. Some 123 beaches were 'adopted' by local groups and are now regularly cleaned. Greenpeace documented the composition of over 340,000 pieces of litter to determine the sources.[46] The 'Clean up Australia' campaign has continued the focus on the beach litter problem.

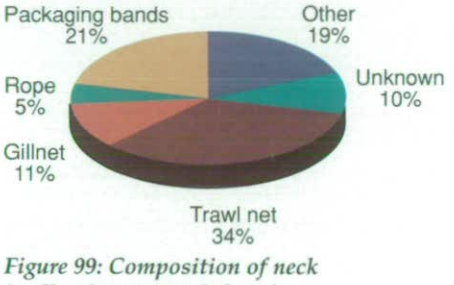


Figure 99: Composition of neck ' collars' on entangled seals. *(75 seals, 1989-91).* (Source: BRS)

There have been suggestions that the management of ocean and beach litter requires a coordinated national and international effort to reduce disposable packaging, an increase in the use of biodegradable packaging, a reduction in the littering practices of the public and fishermen, and improved waste management by local authorities. Stricter enforcement of MARPOL regulations on disposal of garbage from vessels is also required.[46]

Sewage, micro-organisms and human health risks

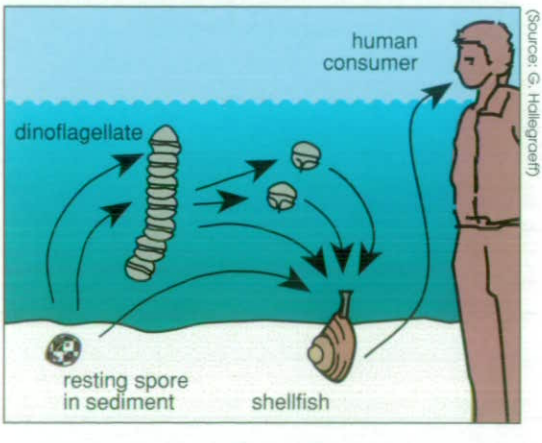
Over 80% of the Australian population reside in large coastal cities with aging and inadequate sewage treatment systems. Sewage outfalls, septic seepage and stormwater may carry disease-causing micro-organisms into the sea, endangering bathers and seafood consumers with illnesses such as gastroenteritis, hepatitis, conjunctivitis, and upper-respiratory tract and wound infections.[47]

Little is known of these disease-causing micro-organisms in the marine environment and how long they stay alive in seawater. Viruses are particularly poorly understood because of difficulties in culturing them, but diseases such as polio and hepatitis 'A' and those caused by 'E' viruses have been associated with swimming. Viruses may bioaccumulate in filter-feeding bivalves near sewage outfalls and may cause viral food poisoning in seafood consumers.[47]

Bacteria are also a problem in bathing waters. In Australia they are causes of common wound infections, particularly in fish handlers, and of 'swimmer's ear'. Parasitic protozoans may also be transmitted in seawater.[47]

There is also some risk that diseases such as cholera may be introduced from overseas via ships' ballast waters. Introduced species of dinoflagellates (single-celled algae) produce toxic red tides and paralytic shellfish poisoning (p.64).[47]

Figure 100: Blooms of introduced toxic dinoflagellates, microscopic single-celled algae, may contaminate shellfish and poison seafood consumers[14,48].



(Source: G. Hallegraeff)

Monitoring of disease-causing micro-organisms in the sea is difficult, as traditional bacteria indicators such as *E. coli* do not reliably reflect their presence. Standards for safe levels of viruses, parasitic protozoa and natural pathogens are lacking. Research is required to identify better indicators.[47]

State of Our Surf (SOS) survey

The Surfrider Foundation of Australia investigated the state of the environment of surfing beaches during 1992-93 using questionnaires[47, 101]. Of the 439 beaches investigated:

- 33% had some form of development on the dune system (around half was residential)
- 18% had some restriction on public access
- 34% had one or more stormwater drains discharging to the beach or associated lagoon
- 12% had an ocean sewage outfall (40% of these were primary treated only)
- 13% had been previously mined (mainly for mineral sands)
- 19% were subject to development proposals deemed by respondents to detract from beach quality
- 38% of 274 freshwater sources discharging at the beaches were considered by the respondents to have poor water quality.

While the SOS survey was not a scientific survey, it does provide a good indication of the environmental condition of Australia's surfing beaches.

INTRODUCED SPECIES

Introduced or exotic species of plants and animals have had a catastrophic effect on Australia's unique terrestrial environment. While impacts of exotic organisms on the marine environment appear to have been relatively minor in the past, there is now great concern about the threats posed by the introductions of exotic marine species via ships' ballast waters.[48]

Blooms of introduced toxic marine algae are a serious marine environmental and fisheries problem in Tasmania and Victoria, and may threaten other States. Outbreaks of the exotic Northern Pacific seastar are spreading along eastern Tasmania, threatening marine life, aquaculture farms and scallop and abalone fisheries. There is also the serious threat of the introduction of marine diseases to our growing aquaculture industry, and of diseases such as cholera to humans.[48]

At least 55 species of fish and invertebrates and a number of seaweeds have been introduced into Australia either intentionally, for aquaculture, or accidentally, in ships' fouling and ballast waters. Six species are regarded as pests. Principal organisms of concern are the

toxic alga *Gymnodinium catenatum*, which causes red tides, the seaweed *Undaria pinnatifida*, which smothers native kelps, the Northern Pacific seastar *Asterias amurensis*, and fish pathogens such as *Myxosoma cerebralis*.[48]

Introduced seastar a serious threat to Tasmania

The Northern Pacific seastar *(Asterias amurensis)* first recorded in Hobart in 1986, is now widely distributed along south-eastern Tasmania, and the larvae may be carried across Bass Strait to mainland Australia. The seastar is a voracious feeder on molluscs and other animals and is a pest on shellfish farms in its native Japan. Although many thousands have been removed by scuba divers so far, experience with the crown-of-thorns starfish on the Great Barrier Reef indicates that total eradication will not be possible.[48,49]

Figure 101: The introduced Northern Pacific seastar is a very serious threat to Tasmania's marine ecology and fisheries. Many thousands have already been removed by divers.

(Source: T. Bogue, Tasmanian Museum)

Australia, geographically isolated and traditionally free of agricultural diseases, is taking a leading international role in the management of exotic marine species. Management primarily focuses on the prevention of introductions. This includes the ocean exchange of ships' ballast waters on route, and by inspection and quarantine of imported organisms. Currently, ocean exchange is limited in some vessels by safety (stability) considerations and quarantine inspection is limited by delays in identification of organisms. Research is currently being conducted on both issues[84].

Past introductions of non-indigenous species onto islands, particularly those in the sub-antarctic, have had severe impacts on the islands' native fauna and flora.[48] These require special protection as their ecosystems are highly vulnerable to disturbance.[84]

POPULATION OUTBREAKS

Population explosions of certain native species have also been responsible for serious problems in the marine environment.

Crown-of-thorns starfish

Over the past 30 years outbreaks of the coral-eating crown-of-thorns starfish have caused considerable damage to Indo-Pacific reefs, including parts of the Great Barrier Reef and Australia's Tasman Sea reefs.[49]

(Source: L. Zann, GBRMPA)

Two episodes of outbreaks have affected parts of the Great Barrier Reef since 1960, and there are fears that numbers are building up towards a third. During the 1979 to 1990 episode around 17% of the 2,900 coral reefs were affected to some extent. Most of these were concentrated in the central one-third of the Reef.[49,69]

Monitoring studies indicate that the faster growing corals take 10-15 years to recover from an outbreak. The cause of outbreaks, particularly whether they are natural or the result of human activities, is still not known. One hypothesis is that elevated nutrients from terrestrial run-off increase the survival of larvae. Another is that overfishing or overcollection of natural predators increase survival of juveniles and adults. Many scientists now believe that there is no single, simple cause.[49]

The starfish outbreaks are regarded as one of the most serious management issues in the Great Barrier Reef Marine Park. Rather than attempt widespread, expensive and ineffectual eradication by diver programs, the Great Barrier Reef Marine Park Authority has channelled funds into long-term multi-disciplinary research programs to find the cause(s) of the outbreaks. Controls are undertaken on reefs only of special importance to tourism or scientific research.[49,69]

Figure 102: Outbreaks of the coral-eating crown-of-thorns starfish have killed large areas of coral reefs in the Indian and Pacific Oceans over the past 30 years. *The causes of the outbreaks remain unknown. On the Great Barrier Reef, small-scale or strategic controls of crown-of-thorns are undertaken on reefs of particular importance to tourism or scientific research.*

Drupella snails

In an alarming parallel with the crown-of-thorns outbreaks on the Great Barrier Reef, millions of small coral-eating *Drupella* snails have devastated approximately 100 kilometres of Ningaloo fringing reef in

(Source: AIMS and WA CALM)

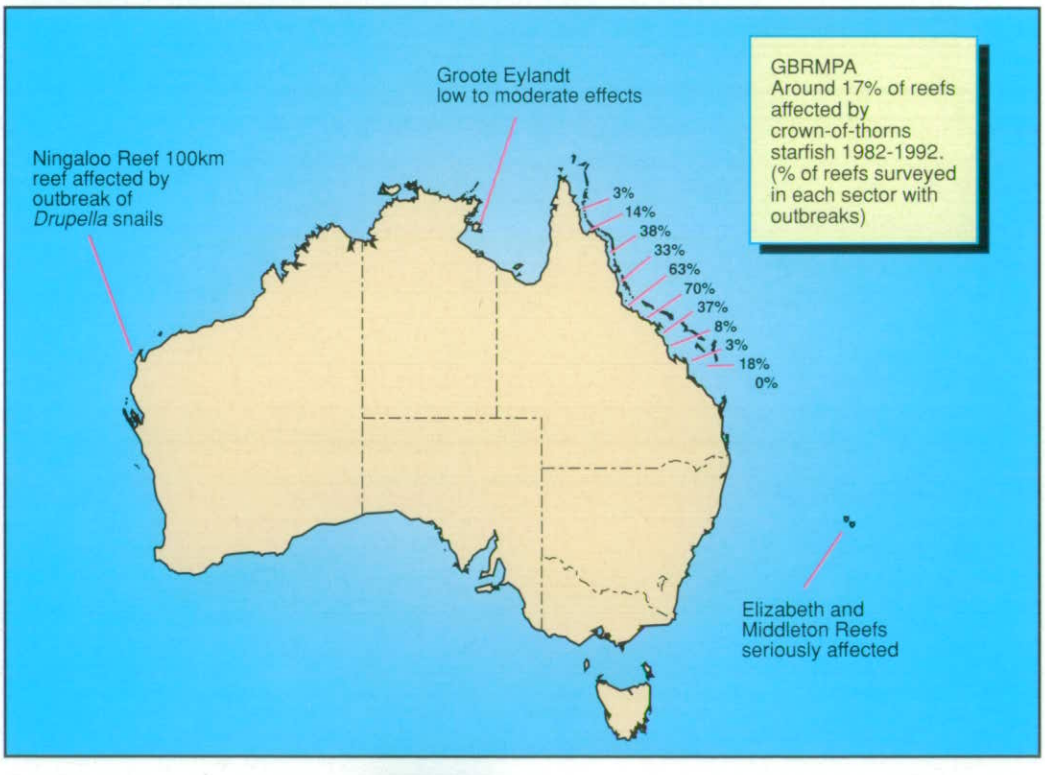


Figure 103: Areas affected by crown-of-thorns starfish and* Drupella *snails in Australia.

Western Australia. Similar concerns to the crown-of-thorns starfish have been raised on the causes of the outbreaks, possible human causes and on the feasibility of controls. Outbreaks have also occurred in Southern Japan and the Philippines. Some localised damage has occurred in the Cairns Section of the Great Barrier Reef Marine Park.(50,70)

Coral reefs are in a constant state of change and the snail outbreaks, like those of the crown-of-thorns, may be natural phenomena. Alternatively, it has been suggested that human influences such as overfishing of natural fish predators, such as sweetlips and wrasses, may be responsible. As with the crown-of-thorns starfish, further research on the biology and ecology of *Drupella* is necessary.(50,70)

(Source: Lochman Transparencies)

Figure 104: Outbreaks of the coral-eating snail **Drupella** *have killed over 100 kilometres of Ningaloo Reef (WA). Like the crown-of-thorns starfish, the causes of the outbreaks remain unknown.*

What do we know about Australia's marine environment? A review of marine scientific knowledge and its contribution to environmental management

The State of the Marine Environment Report is a testimony to the state of marine environmental knowledge in this country(63). A major finding of this report is that there are serious gaps in scientific knowledge and understanding of the marine environment in Australia, both geographically and by issue. In particular, there is a serious lack of long-term data on water quality(42-47), environmental health(6-14) and human uses(28-39) which could be used for quantitative 'state of the environment' reporting(94).

One explanation for this is the vast length of coastline and area of our seas, the large proportion of which is uninhabited or sparsely inhabited(1), and our relatively small scientific population(63). Australia's marine science has grown very rapidly over the past 20 years, and we have achieved pre-eminence in areas of tropical ecology, especially coral reefs and their management. Australia is now amongst the world's top ten nations in marine research effort and output(63).

There is widespread agreement amongst scientists and environmental managers that the lack of a clear national policy on marine science has been a serious impediment to its development(63). The Resource Assessment Commission's Coastal Zone Inquiry was highly critical of the lack of emphasis on applied research, for example the production of coastal zone inventories and long-term monitoring programs. It also noted that access to information by local council environmental managers is generally poor(91). However, various scientists contributing to SOMER argued that more basic research was needed as we must understand the functioning of marine communities before we can manage human impacts(7-14).

SOMER found that a large body of information does exist for a few places, such as the Sydney region and Port Phillip Bay and Western Port in Victoria. However, in most cases this was unpublished, was of varying quality, and had never been collated and interpreted.(63)

SOMER also suggests that a significant gap exists between marine science and marine environmental management in Australia, reflecting that perennial barrier between science and management. As a consequence, existing scientific knowledge has not been adequately applied in marine environmental management. Cooperative Research Centres which involve science, industry and management are an important recent initiative to overcome this problem.(63)

A national state of the environment reporting program is being established by the Commonwealth government(94). This will require quantitative, statistically-based, long-term monitoring using a nationally agreed set of indicators(63).

(Source: AIMS)

Figure 105: Australia has become a world leader in some aspects of marine science. *However there is little quantitative, long-term information existing on the state of the marine environment in this country. Scientists at the Australian Institute of Marine Science have discovered that long-lived massive corals have a record of environmental conditions preserved in their skeletons, similar to growth rings in trees. Ocean conditions and climate have been reconstructed for many hundreds of years from cores taken from corals. This shows a team of divers using hydraulic drills to core a giant coral.*

Report Card

Subject: Pollutant levels in Australia's marine environment

(A: not detectable, to D: very high)*

Pollution	Sources and Effects	Level
Coastal strip development (developed)	Decline in water quality; loss of habitat from reclamations, dredging, marinas; erosion of beaches; over-development; conflicts amongst users; loss of amenity; poor integrated planning. (1,29,40,41,62)	C-D
Nutrients (nitrogen, phosphorus) (developed)	Source: inland waters; sewage and run-off. Effects: widespread locally serious eutrophication; algal blooms; toxic algae; die-back of temperate seagrass; loss of bathing water quality; nutrients.	C-D
Nutrients (nitrogen, phosphorus) (undeveloped)	Source: inland waters (erosion, fertilisers etc). Effects: locally low to moderate eutrophication; occasional algal blooms; die-back of temperate seagrass; threats to nearshore corals.(42)	B-C
Oil (developed)	Source: developed run-off; chronic small spills while fuelling in harbours; occasional large shipping spills. Effects: chronic effects not known; large spills cause concentrated, moderate to long-term environmental damage.	B-C
Oil (undeveloped)	Source: operational discharges from ships, occasional spills Effects: large spills as above.(39,43)	A-B
Heavy metals (mercury, cadmium, copper etc) (developed)	Source: localised industrial discharges; refineries; antifouling paints; sewage; mining; ports. A few areas seriously contaminated (e.g. Derwent Estuary, Tas.; Port Pirie, SA). Results: little known; may be very toxic; bioaccumulate in food chains; contamination of seafood.	B-D
Heavy metals (undeveloped)	Source: natural concentrations and mining (e.g. Torres Strait). Effects: little known; possible bioconcentration in food chain.(44,52-57)	A-B
Chlorinated compounds (pesticides etc) (developed)	Source: industrial discharges; dumps; developed run-off; sewage. Effects: little known; bioaccumulates in food chains; may be very toxic.	B-C?
Chlorinated compounds (undeveloped)	Source: agricultural chemicals; dumps; distant sources. Effects: as above.(45,51-55)	A-B
Litter (developed)	Source: local catchments; dumps; visitors; fishers; shipping. Effects: loss of visual amenity; ingestion by wildlife.	B-C
Litter (undeveloped)	Source: vessels; fishers; visitors. Effects: as above. Locally serious in seal populations.(46)	A-B
Sewage (developed)	Source: primary treatment; ocean sewage outfalls. Effects: pathogenic micro-organisms; bathing water standards frequently exceeded in some developed beaches; important source of nutrients.	C-D
Sewage (undeveloped)	Localised problem.(42,47,51-57)	A-B
Introduced species	Currently localised problems (e.g. Northern Pacific seastar in eastern Tasmania) but potentially very widespread and serious.(48)	B D potentially
Population outbreaks	Currently localised serious problems (e.g. crown-of-thorns starfish on the Great Barrier Reef) but not known whether they are natural or human-induced.(49, 50)	B(?)

*Scores

A: No detectable problems, or trace levels of contaminants

B: Some problems or low levels of contaminants (or widespread low levels, or few sites with moderate levels)

C: Moderate problems or moderate levels of contaminants (or widespread moderate levels, or some sites with high levels)

D: Serious problems or high levels of contaminants (or widespread high levels, or many sites with very high levels)

Report Card

Subject: Water quality in the marine environment

(A: excellent, to D: poor)*

Pollution	Sources and Effects	Level
Coastal rivers (developed)	Moderate to serious sedimentation; elevated nutrients from land use, sewage; pollutants from developed and industrial discharges; acid sulphate soil run-off.	C-D
Coastal rivers (undeveloped)	Increased sedimentation; elevated nutrients.(1,6,42)	A-B
Estuaries, coastal lakes (developed)	Many estuaries eutrophic. Coastal lakes moderately to seriously eutrophic.	B-D
Estuaries, coastal lakes (undeveloped)	Possible minor sedimentation; elevated nutrients.(6,42,51-57)	A-
Nearshore coastal waters, bays (developed)	Elevated nutrients (e.g. SA Gulfs; Victorian Bays; NSW Bays; Moreton Bay; possibly Great Barrier Reef lagoon).	B-C
Nearshore coastal waters, bays (undeveloped)	Possible increases in sediments and nutrients.(6,42,51-57)	A
Ocean (developed)	Trace levels of chlorinated compounds etc (much lower than northern hemisphere, but increasing towards coast).(42-45)	A-
Ocean (undeveloped)	As above	A

*Scores
A: No detectable problems, or trace levels of contaminants
B: Some problems or low levels of contaminants
(or widespread low levels, or few sites with moderate levels)
C: Moderate problems or moderate levels of contaminants
(or widespread moderate levels, or some sites with high levels)
D: Serious problems or high levels of contaminants
(or widespread high levels, or many sites with very high levels)

Report Card

Subject: State of scientific knowledge of the marine environment

(A: excellent, to D: poor)*

Issues	Scientific Knowledge	State
Basic habitat descriptions	Lack of marine bioregionalisation; few coastal inventories. (5-14, 51-57)	B-D
Ecological knowledge	Poor understanding of processes; limited application of knowledge to management and ecologically sustainable development.(5-14)	B-D
Monitoring, marine environmental reporting	Few long-term data sets on any marine subject; large spatial gaps. Long-term quantitative information on key issues necessary.(5-14,30-35,42-47,51-57,69-82)	B-D

*Scores
A: EXCELLENT (Scientific knowledge adequate for ESD and maintenance of biodiversity)
B: GOOD (Generally adequate knowledge for above)
C: FAIR (Knowledge generally inadequate for above)
D: POOR (Knowledge very inadequate for above)

Regional issues in the marine environment

Figure 106.

Queensland

Population: 2.98 million (62% in the Brisbane and Moreton divisions). Coastline: 9,800 km long. Major features are south-eastern (SE) open coasts and bays; Great Barrier Reef region; Torres Strait; and Gulf of Carpentaria. Problem areas include Brisbane and Moreton Bay, Gold Coast, and some regional ports.(6-14,42-47,51,69)

Major State and regional issues include:

- changes in catchment uses
- increase in sediment and nutrient run-off (particularly in GBR lagoon and Moreton Bay)
- coastal strip development in SE (urban, industrial, marinas, agriculture, grazing)
- competing uses of coastal strip
- threats to Great Barrier Reef (water quality, effects of fishing, effects of trawling, tourism developments, crown-of-thorns starfish)
- loss of inshore habitat (mangroves, salt marsh)
- Aboriginal and Torres Strait Islander fishing rights and lack of involvement in management
- protection and preservation of Aboriginal and Torres Strait Islander sites of significance
- effects of ports (dredging, oil spills, possible introductions)
- shipping risks through Torres Strait and Great Barrier Reef inner route
- effects of tourism (especially Cairns, Whitsundays, Sunshine Coast and Gold Coast)
- destruction of cultural heritage sites
- effects of trawling (Moreton Bay, GBR)
- overfishing of some stocks
- recreational fishing and catch sharing (especially in SE)
- discharge of toxic liquid wastes (especially in SE)
- die-back of seagrass (Hervey Bay)

Northern
- coastal strip development and competing uses
- degradation of estuaries
- declines in seagrass
- acidification of estuaries (acid sulphate soil)
- sand mining
- eutrophication of coastal lakes

Central
- coastal strip development and competing uses
- ports related infrastructure
- declining water quality
- degradation of estuaries
- eutrophication of coastal lakes
- ocean sewage discharges (especially Sydney)
- state of swimming beaches (pollution, litter)
- localised pollution from sewage and industrial discharges (heavy metal, tributyl tin, organochlorine and petroleum, micro-organisms)
- large recreational fishery and catch-sharing
- shoreline fishing

Southern
- coastal strip development and competing uses
- ports, marinas and tourist developments
- eutrophication of coastal lakes
- overfishing (gemfish, southern bluefin tuna)
- Aboriginal fishing rights

Figure 107.

New South Wales

Population: 5.77 million (80% in coastal zone, most in Sydney/Newcastle/Wollongong). Coastline: 1,900 km. Major features are open coastlines, river estuaries, drowned river valleys on central coast, and large coastal lakes. Major issues stem from declining water quality in urban areas and coastal strip development. Problem areas include Sydney ocean sewage outfall sites (relocated 1990), Homebush Bay, Georges River and Lake Illawarra, Lake Macquarie and Tuggerah Lakes. (6-14,42-47,52)

Major State and regional issues include:
- declining water quality from sewage and run-off; elevated nutrients in estuaries and bays
- coastal strip development, catchment disturbances and loss of habitat
- destruction of cultural heritage sites
- modification of estuaries
- eutrophication of coastal lakes
- acidification of estuaries (acid sulphate soil)
- decline of 50% of seagrass (by eutrophication, habitat alteration)
- localised pollution by heavy metals, tributyl tin, chlorinated compounds and oil (especially in Sydney metropolitan area)
- poor bathing water quality (especially Sydney beaches in 1980s)
- decline in coastal fisheries
- large, unmanaged recreational fisheries and catch-sharing
- protection and preservation of Aboriginal sites of significance
- Aboriginal fishing rights and interests
- shoreline fishing
- effects of prawn trawling on sea floor communities

Figure 108.

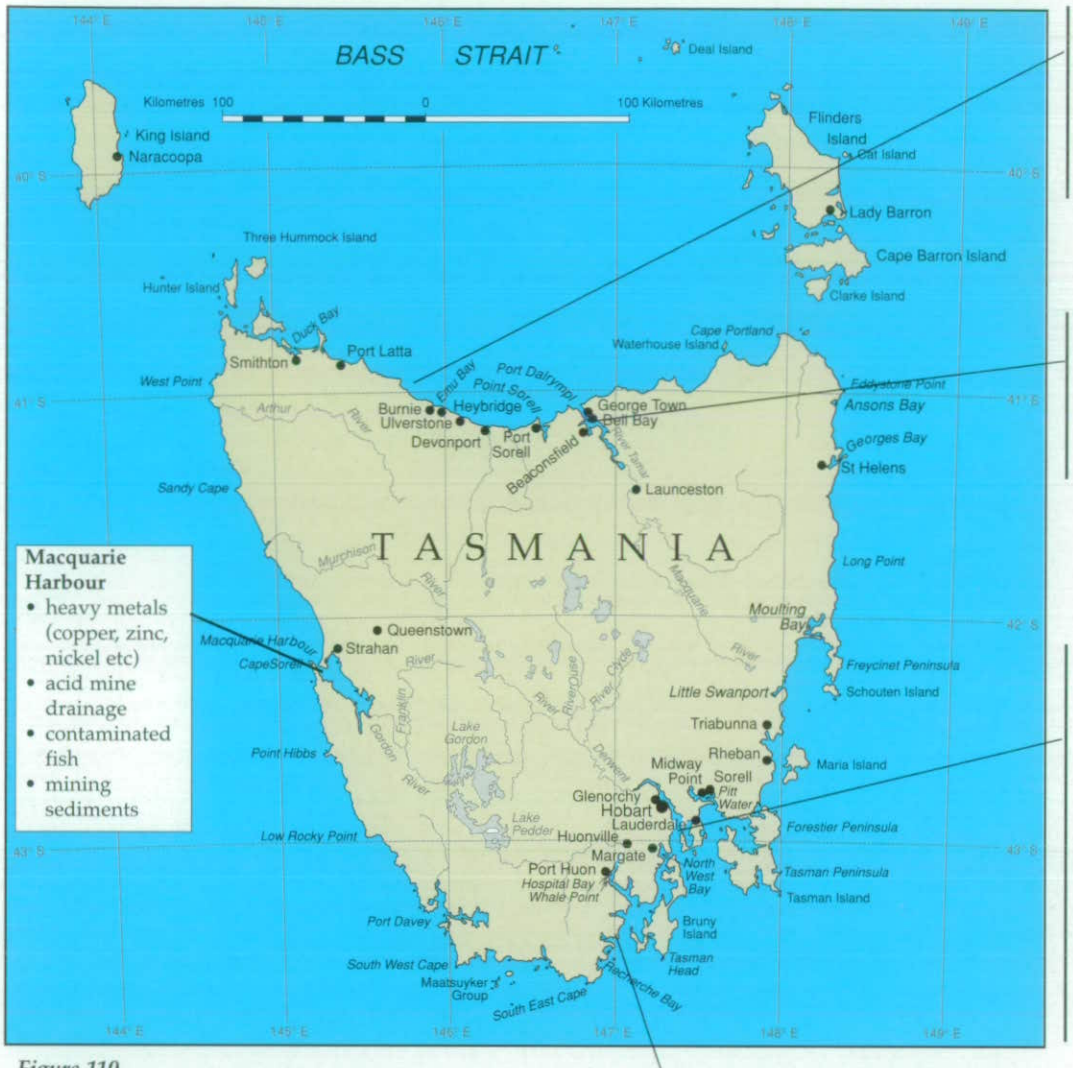
Victoria

Population: 3.7 million (70% in Melbourne & Geelong). Coastline: 2,000 km long. Highest coastal population density and industrial development in Australia. Major features: open coasts and lakes in east; large bays in centre; cliffed coast in west. Major issues stem from declining water quality in bays, inlets, estuaries and lakes. Problem areas include: Port Phillip Bay (especially Corio Bay, Hobsons Bay, Geelong Arm), and Western Port and Gippsland Lakes.(6-14,42-47,53)

Major State and regional issues include:

- below standard water quality of some coastal waters, particularly from nutrients in sewage effluent and stream discharges
- coastal strip development, catchment disturbances, silt from rivers, loss of habitat areas
- degradation of areas of estuaries and inlets
- die-off of seagrass
- localised pollution of sediments near boat harbours (e.g. Corio Bay)
- algal blooms
- impacts from offshore oil exploration and extraction
- localised oil spills (especially Port Phillip Bay)
- protection and preservation of Aboriginal sites of significance
- Aboriginal fishing rights and interests
- competing coastal uses (urban, industrial and tourism development, fisheries, oil and conservation)
- alteration of hydrological cycles in some estuaries
- introduction of exotic species (algae, seastars)
- overfishing (sharks, rock lobsters)
- effects of trawling and dredging on sea floor
- dredging and spoil disposal

Figure 109: Port Phillip Bay and Western Port region.



Burnie area
- industrial discharges (paper mill, refineries)
- elevated nutrients from sewage and agricultural run-off

Tamar River
- industrial discharges (smelters, wood chip)
- elevated nutrients from sewage

Macquarie Harbour
- heavy metals (copper, zinc, nickel etc)
- acid mine drainage
- contaminated fish
- mining sediments

Derwent River
- pollution by heavy metals (zinc, manganese, arsenic, cadmium etc)
- contamination of shellfish
- sewage (4 of 14 plants still have ministerial exemptions for discharges)
- high bacterial levels

D'Entrecasteaux Channel and North West Bay
- changing land use, sedimentation
- decline in seagrass and macroalgae
- overfishing (especially scallops)
- effects of scallop dredging on sea floor

Figure 110.

Tasmania

Population: 450,000 (180,000 in Hobart). Coastline: 3,200 km long. Australia's only island State. Major features: headlands interspersed with sand beaches and lagoons in north-east; cliffed coasts, sheltered bays and drowned river valleys in south-east; cliffed coasts and sand beaches in south; sand beaches, headlands, river estuaries and harbours in west; and open coast and river estuaries with numerous islands in the north. Major issues stem from poor water quality (heavy metals, nutrients), introductions of exotic species and fisheries (declining catches, catch-sharing). Problem areas include: Derwent River, Macquarie Harbour, Burnie area, D'Entrecasteaux Channel and North West Bay, Orielton Lagoon and Tamar River.(6-14,42-47, 54)

Major State and regional issues include:
- poor water quality in major estuaries from heavy metals from mining and refineries, and elevated nutrients from sewage, urban and agricultural run-off
- coastal catchment development from agricultural, urban and industrial development
- introductions of toxic dinoflagellate *(Gymnodinium catenatum)*, Japanese kelp *(Undaria pinnatifida)*, The Northern Pacific seastar *(Asterias amurensis)*, Pacific oyster *(Crassostrea gigas)*
- decline in fisheries (scallops, lobsters)
- lack of recreational gillnetting controls
- effects of dredging and trawling on the sea floor
- alteration of hydrological cycle of major estuaries
- protection and preservation of Aboriginal sites of significance
- Aboriginal fishing rights and interests

Figure 111.

South Australia

Population: 1.4 million (most in Adelaide and Fleurieu Peninsula). Coastline: 3,700 km and dry (fewest estuaries in Australia). Major features: mouth of the River Murray via Lake Alexandrina; large gulfs (Gulf St Vincent and Spencer Gulf) with cliffed coasts east and west. Major issues stem from declining water quality in gulfs and estuaries. Problem areas include: Port Adelaide, Whyalla, Port Augusta, Port Pirie and Port Lincoln. (6-14,42-47,55)

Major State and regional issues include:

- declining water quality: elevated nutrients from sewage and run-off
- degradation of estuaries (5 of 8 threatened)
- loss of habitat (especially mangroves, saltmarsh)
- die-back of seagrass in gulfs
- competing uses of coastal strip
- protection and preservation of Aboriginal sites of significance
- Aboriginal fishing rights and interests
- declining fish stocks (especially southern bluefin tuna, school sharks)
- industrial discharges, toxicants
- threatened species (Australian and New Zealand fur seals, Australian sea lions, southern right whales)
- development of aquaculture

Kimberley
- Aboriginal custodianship issues
- possible impacts of trawling
- localised sedimentation of estuaries

Pilbara
- Aboriginal custodianship issues
- effects of pair trawling on benthos
- oil and gas extraction on NW shelf
- local impacts of ports and salt fields

Gascoyne
- coral-eating snails in Ningaloo
- inshore fisheries (catch-sharing)
- management of whale shark tourism

South-west
- declining water quality (especially elevated nutrients)
- localised heavy metals and oil pollution (especially Cockburn Sound)
- degradation of estuaries
- loss of habitat
- modification of hydrological cycle
- decline of seagrass
- coastal strip development, marinas
- competing uses
- declining coastal fisheries

South
- declining water quality in estuaries and bays (SW)
- localised elevated nutrients, heavy metals (Albany)

Figure 112.

Western Australia

Population: 1.7 million (72% in the Perth metropolitan area). Coastline: 12,000 km. Major coastal regions are temperate south and south-west, and tropical Gascoyne, Pilbara and Kimberley coasts. Most of the State's vast coastline is arid and uninhabited. Marine issues are largely confined to the more populous and industrialised south-west (SW). Major issues stem from declining water quality, particularly elevated nutrients. Problem areas include: Cockburn Sound, Princess Royal Harbour, and Peel-Harvey system. (6-14,42-47,56)

Major State and regional issues include:
- water quality in south-western estuaries (especially nutrients, eutrophication)
- competing uses of coastal zone (SW)
- localised pollution in bays by heavy metals (SW)
- loss of seagrass (SW)
- catchment alteration
- Aboriginal sea rights and fisheries
- protection and preservation of Aboriginal sites of significance
- declining inshore fisheries (SW)
- catch-sharing (conflicts in commercial/ recreational fisheries)
- effects of trawling on sea floor
- environmental risk of petroleum exploration and extraction
- outbreaks of *Drupella* snails on coral reefs
- general lack of scientific knowledge of marine environment

Timor Sea
- offshore petroleum exploration and extraction

Darwin
- reclamation of mangroves for harbour development
- discharge of sewage
- localised high heavy metals (chromium, zinc, arsenic) from discharges, port spills

Figure 113.

Northern Territory

Population: 157,000, (85,000 on coast, 73,000 in Darwin). Coastline 7,200 km. Coastal areas are generally sparsely inhabited and much of the coastline is designated as Aboriginal land. The marine environment is generally pristine. Problems are largely confined to the Darwin area and are insignificant compared with southern States.(57)

Major Territory and regional issues include:
- localised issues in Darwin
- protection and preservation of Aboriginal sites of significance
- Aboriginal fishing rights (84% of coast is Aboriginal land)
- recreational fishing, conflicts in catch-sharing
- offshore petroleum exploration and production

Figure 114: Aboriginal controlled coastline of Northern Territory.

Marine conservation and marine protected areas

Many human activities also span land and sea, for example, recreation, fishing, transport, resource developments and defence[30-47]. Catchment uses may affect streams, rivers, estuaries and therefore distant coastal waters[1,42,91]. Actions and events on land may therefore have far-reaching consequences for the marine environment. Coastal zone management is complex as it involves not only two different but interconnected environments, but many different administrative jurisdictions[58,62].

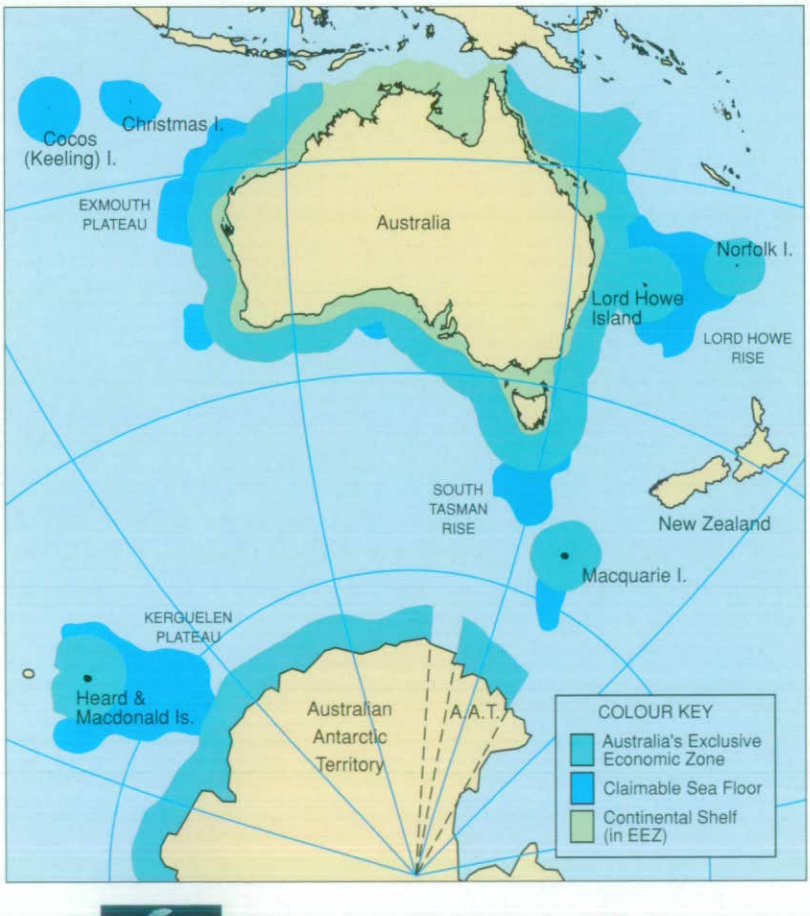
Marine environmental conservation in Australia involves a large number of international, regional, Commonwealth, State and Territory, and Local Government agreements, arrangements and agencies and involves a large number of different management strategies.[58-62,67,76-82]

Management of aquatic environments must consider the very high degree of connection within them and with land-based activities. In the sea, water masses (and the adults and larvae of many marine species, nutrients and pollutants) may be carried great distances in ocean currents. [2,5,15]

INTERNATIONAL ARRANGEMENTS AND RESPONSIBILITIES

The oceans link countries. No country can manage its marine environment and resources in isolation from other countries in its region, or from activities on the high seas. International shipping operates under international law, with the rights of innocent passage strongly defended by maritime nations. There are numerous international treaties, conventions and agreements that are relevant to the coastal zone. Many of these deal with general global issues such as climate change, biological diversity, and world heritage.[60]

The United Nations Law of the Sea Convention allows nations to claim six zones including territorial seas, (which extend 12 nautical miles from the coastal baseline), and a 200 nautical mile exclusive economic zone (EEZ)[53]. Australia's EEZ came into force on the 16 November 1994[1].



(Source: AGSO)

Figure 115: Australia's 200 mile Exclusive Economic Zone is over 11 million square kilometres in area and is one of the largest in the world. *The area of claimable sea floor is 14.8 million square kilometres.*

International borders

Although Australia (leaving aside the Australian Antarctic Territory) has no land borders, it has maritime borders with five other nations: France (Iles Kerguelen in the subantarctic, and New Caledonia); Indonesia; Papua New Guinea (Torres Strait); Solomon Islands (north-east); and New Zealand. Certain maritime boundaries with Indonesia are yet to be negotiated and no maritime boundaries have yet been negotiated with New Zealand[58]. The most complex of these is in Torres Strait which has several overlapping boundaries, differing for fishing, the sea bed, and the protected zone[58,74].

GOVERNMENT RESPONSIBILITIES

Australia has a three-tiered system of government, consisting of Commonwealth, State/Territory, and Local Government. Management of the coastal and marine environments involves each sector. The legislative basis for planning and management of the land area of the coastal zone is primarily provided by the States. State and Local Governments are generally responsible for day-to-day decision-making in the coastal zone[58-62,67]. The Northern Territory Government retains responsibility for both the legislative basis and day-to-day decision-making concerning environmental management. A fourth level of management, that of Aboriginal land holders, is unique to the Northern Territory[82].

States generally have primary jurisdiction over marine areas to three nautical miles from baselines (except in the Great Barrier Reef[69]), and the Commonwealth from there to the 200 nautical mile line[1,58].

Offshore Constitutional Settlement

The Offshore Constitutional Settlement established jurisdictions between the Commonwealth and States over marine areas. There are 'agreed arrangements' on the management of oil and gas, and other seabed minerals, the Great Barrier Reef Marine Park, other marine parks, historic shipwrecks, shipping, marine pollution and fishing.[58]

Many government inquiries have identified the fragmented and often duplicatory responsibilities in the coastal zone as severe impediments to effective planning and management.[1,58,62]

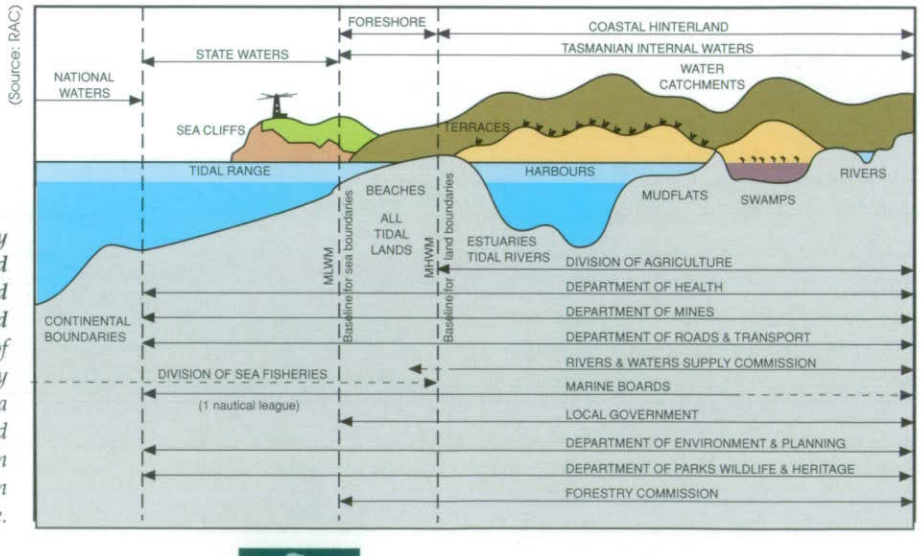


Figure 116: Many Commonwealth, State and Territory agencies are involved in coastal management around Australia. *The large number of agencies involved was identified by the 1993 Coastal Zone Inquiry as a difficulty in developing integrated coastal zone management in Australia. Agencies responsible in Tasmania are shown here.*

MARINE ENVIRONMENTAL MANAGEMENT STRATEGIES

The main strategies for marine environmental management in Australia include:

- maintaining water quality through controlling disposal of wastes and emissions entering catchments, the atmosphere and the sea[42-47];
- prohibiting or regulating destructive and unsustainable activities[30,33,34,48,59,69];
- protecting important habitats and areas[67-82];
- zoning for particular uses to separate and control incompatible uses[62,69-74];
- requiring environmental impact studies to minimise effects of developments[59];
- protecting certain organisms, particularly vulnerable and threatened species[15-18,60]; and
- regulating fisheries through licences, size limits, quotas (total allowable catches), seasons and other mechanisms[30,33].

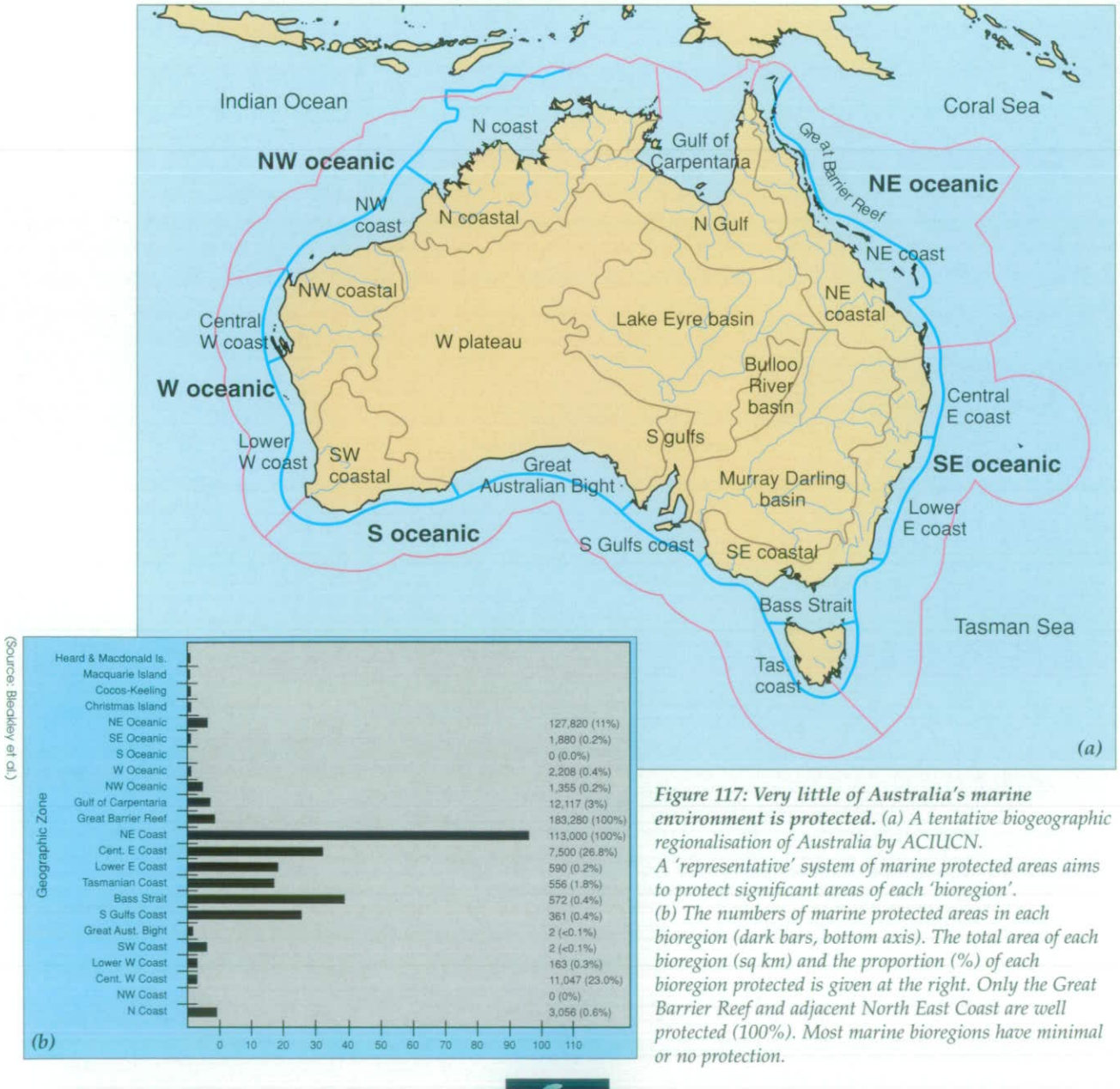


Figure 117: Very little of Australia's marine environment is protected. *(a) A tentative biogeographic regionalisation of Australia by ACIUCN. A 'representative' system of marine protected areas aims to protect significant areas of each 'bioregion'. (b) The numbers of marine protected areas in each bioregion (dark bars, bottom axis). The total area of each bioregion (sq km) and the proportion (%) of each bioregion protected is given at the right. Only the Great Barrier Reef and adjacent North East Coast are well protected (100%). Most marine bioregions have minimal or no protection.*

MARINE PROTECTED AREAS

A marine protected area (MPA) is any area of intertidal or subtidal terrain, together with its overlying water and associated flora, fauna, historical and cultural features, which has been reserved by law or other effective means to protect part or all of the enclosed environment.(67)

(Source: GBRMPA)

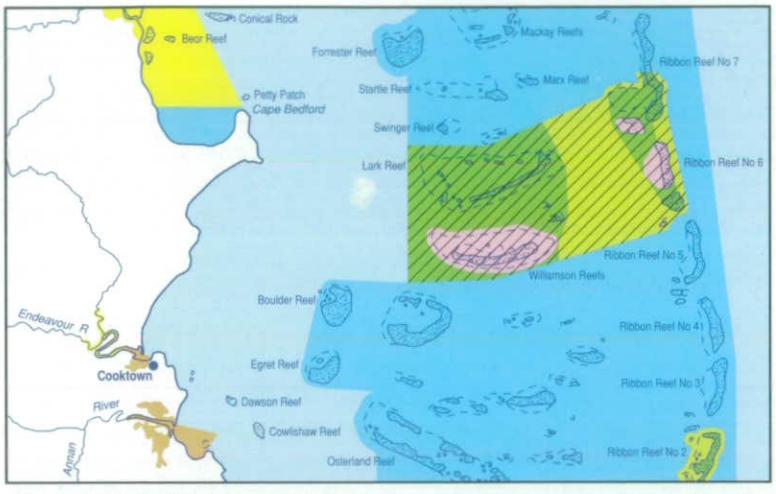


Figure 118: The 'multiple-use' Great Barrier Reef Marine Park allows commercial and recreational fishing, tourism, research, traditional hunting and other activities. *This is part of the zoning plan for the Cairns Section.*

Marine protected areas are a very important tool for marine conservation and management, particularly in protecting biodiversity, and achieving sustainable use of marine resources(15,67). Establishing a national network of marine protected areas around Australia is a primary objective of the Ocean Rescue 2000 program (67,68,83).

MPAs may serve many functions including conserving nature, protecting commercial fisheries resources, protecting human heritage and providing tourism, recreation, education and research opportunities. (67-82)

Australia is a world leader in using MPAs for marine conservation and management and has 24% of the total number of MPAs in the world.(67)

In 1992 Australia had 303 MPAs totalling an area of 463,200 square kilometres. About 5.2% of Australia's marine environment is protected in MPAs. However, a very large proportion of this, 74%, is within a single MPA, the Great Barrier Reef Marine Park. The number of MPAs has increased by almost 60% in the past decade. However, large sections of Australia's marine environment still have few or no MPAs.(67)

(Source: GBRMPA)

Figure 119: Queensland Department of Environment and Heritage Marine Park Rangers preparing a diving trail on the Great Barrier Reef.

Most MPAs are on the east coast of Australia, and especially along the Queensland coast. There are more MPAs south of the tropics (175 as opposed to 98), but the area protected in the tropics is more than ten times greater than that in the south. Most MPAs in the southern and eastern half of the continent are small, yet this is where human activity is greatest and the demand for conservation action is highest. The largest MPAs tend to be away from the areas of highest human activity.(67)

How much of the sea should be reserved in MPAs?

We do not yet know what amount of sea should be set aside in MPAs, what size they should be, and where these MPAs should be placed. However, MPAs that are established to maintain biodiversity should be sufficiently large to maintain ecosystem function, to protect all life cycle stages and to achieve adequate buffering or dilution of the impacts from human activities.(67) Where appropriate, MPAs might also be placed adjacent to land protected areas, and managed in a complementary manner(69).

The minimum viable size of a biodiversity MPA is likely to be much larger than the minimum viable size of a terrestrial reserve.
The Brundtland Report (World Commission on Environment and Development 1987(97)) recommended that 8% of the world's land and freshwater areas be set aside in protected areas.

MARINE CONSERVATION AND MARINE PROTECTED AREAS AROUND AUSTRALIA BY STATE AND TERRITORY

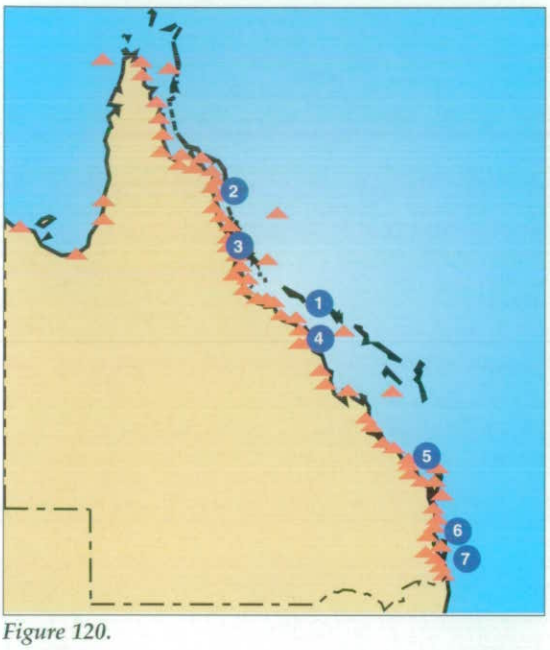


Figure 120.

Figure 121.

MAP KEY
Marine Protected Areas
1 Major MPAs (see bold text)

Queensland

Queensland has a long coastline and very diverse tropical and subtropical marine ecosystems. The major marine bioregions are the Gulf of Carpentaria, Torres Strait, Great Barrier Reef and south-east bays and exposed coastlines.(69,76)

Queensland has a well developed system of State MPAs as well as the Commonwealth's Great Barrier Reef Marine Park **(1)**. Seven MPAs have been declared under the *Marine Parks Act* 1982, with a total of 39,024 sq km: Cairns **(2)**, Townsville/Whitsunday **(3)**, Mackay/Capricorn **(4)**, Hervey Bay **(5)**, Woongarra, Pumicestone Passage **(6)** and Moreton Bay **(7)** Marine Parks. Some 83 MPAs with a total area of 6,028 sq km have been declared under the *Fisheries Act* 1976; these comprise 48 Fish Habitat Reserves, 29 Wetland Reserves and six Fish Sanctuaries. There are also 30 national parks and six environmental parks along the coast with a total intertidal area of 820 sq km. Five protected zones have been declared for shipwrecks.(76)

New South Wales

New South Wales has diverse tropical and temperate marine communities such as coral reefs, rocky reefs, estuaries, coastal lakes and mangroves (52,77). Aquatic Reserves are declared under amendments to the *NSW Fisheries and Oyster Farms Act* 1935, although new legislation is in the revised Act which is currently before Parliament. Aquatic Reserves are managed by New South Wales Fisheries. MPAs are also declared under the *National Parks and Wildlife Act* 1967 (77).

New South Wales has eight Aquatic Reserves: **(1)** the Julian Rocks (off Byron Bay); **(2)** the Solitary Islands (off Coffs Harbour-Wooli); **(3)** Fly Point-Halifax Park (Port Stephens); **(4)** Long Reef (North Sydney); **(5)** North Sydney Harbour (near Manly); **(6)** Towra Point (Botany Bay); **(7)** Shiprocks (Port Hacking); **(8)** Bushrangers Bay (south of Wollongong). With the exception of **(2)**, most are relatively small areas. Large multiple-use MPAs are planned for Lord Howe Island and Jervis Bay **(9)**. An extensive system of Intertidal Protected Areas is currently being established.(77)

New South Wales has 30 MPAs declared as parts of National Parks and Nature Reserves. These cover over 150,000 ha and include nearly 2,000 ha of mangrove and 280 ha of seagrass. Largest MPAs are: Fullerton Cove, Kooragang NP (1,536 ha); Cowan Ck and the Basin, Ku-ring-gai Chase NP (1,064 ha); Lake Innes and Lake Cathie, Lake Innes NP (1,150 ha); Bombah Broadwater, Myall and Boolambayte Lakes, Big Gibber to Mungo Brush beaches, Myall Lakes NP (9,700 ha).(77)

Victoria

Victoria has a wide variety of temperate marine habitats, from rocky shores and sandy beaches, to large sheltered bays, inlets, estuaries and coastal lakes.(53,78)

Victoria has a policy for integrated environmental management and has effectively combined the various marine environmental agencies into the Department of Conservation and Natural Resources, with a strong regional framework which aids in integrated catchment management. Marine responsibilities include fisheries, fauna and flora, and national parks.(78)

Victoria has largely emphasised pollution management to date, although it has established 12 relatively small MPAs. The main MPAs are the **(1)** Harold Holt Marine Reserves (Point Nepean, Point Lonsdale, Mud Island, Swan Bay, Pope's Eye); **(2)** Point Cook Marine Reserves **(3)** South Gippsland Marine and Coastal Parks (Wilsons Promontory Marine Park, Wilsons Promontory Marine Reserve, Shallow Inlet Marine and Coastal Park, Corner Inlet Marine and Coastal Park, Nooramunga Marine and Coastal Park); and **(4)** Bunurong Marine Park.(78)

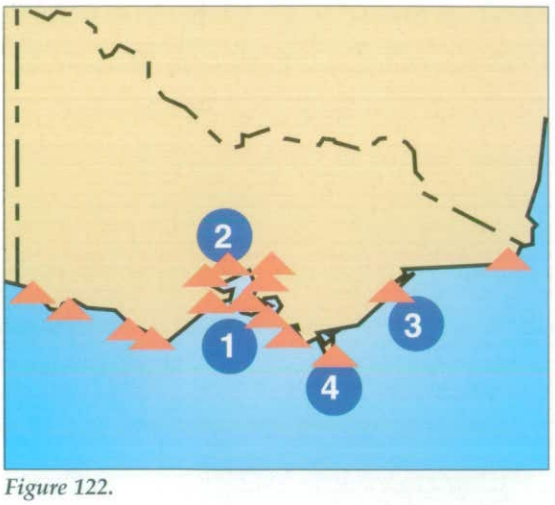


Figure 122.

Tasmania

Tasmania has diverse cool temperate and subantarctic marine habitats. It includes the core of one of the world's smallest marine bioregions, and a bioregion with one of the world's highest diversities of marine plants.(54,79)

MPAs are declared under the *National Parks and Wildlife Act* 1970 and are jointly managed by the Tasmanian Parks and Wildlife Service and Fisheries agencies under the *Fisheries Act* 1959.(79)

Tasmania has 19 MPAs (about 2% of the coast), the majority of which were set aside for reasons other than marine conservation. The main MPAs are: **(1)** Maria Island National Park; **(2)** Governor Island Marine Nature Reserve; **(3)** Tinderbox Marine Nature Reserve; **(4)** Nine Pin Point Marine Nature Reserve; and **(5)** Port Davy/Bathurst Harbour in the Southwest National Park.(78)

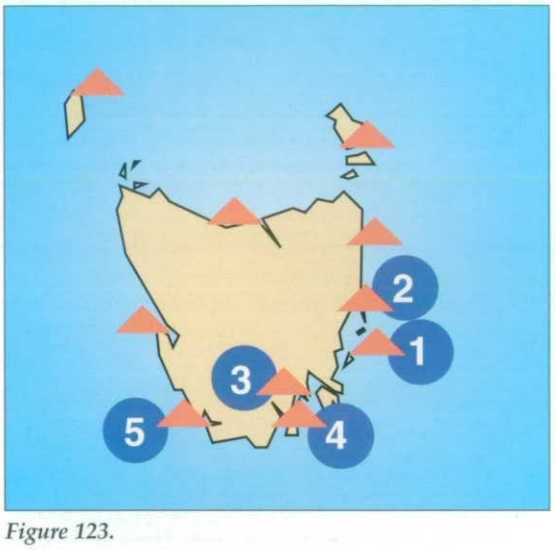


Figure 123.

South Australia

South Australia's biologically diverse coastal and marine ecosystems are of great ecological, cultural and economic importance.(55,80)

South Australia was the first State to legislate for MPAs, in 1971. Primary responsibility for the protection of aquatic habitats lies with the *Fisheries Act* 1981 but MPAs may also be declared under the *National Parks and Wildlife Act* 1972 and the *Historic Shipwrecks Act* 1981.(80)

South Australia currently has 30 MPAs, with a total area of around 300 sq km (1.5% of State waters). The main MPAs are: **(1)** Point Labatt; **(2)** Cowleds Landing; **(3)** Blanche Harbour; **(4)** Yatala Harbour; **(5)** Goose Island; **(6)** Troubridge Hill; **(7)** Chapman Creek; **(8)** Barker Inlet; **(9)** Port Noarlunga and Onkaparinga Estuary; **(10)** Aldinga Reef; **(11)** West Island; **(12)** American River; **(13)** Bales Beach, Seal Bay; **(14)** Clinton Conservation Park; **(15)** Troubridge Island Conservation Park; and **(16)** Dangerous Reef Conservation Park.(80)

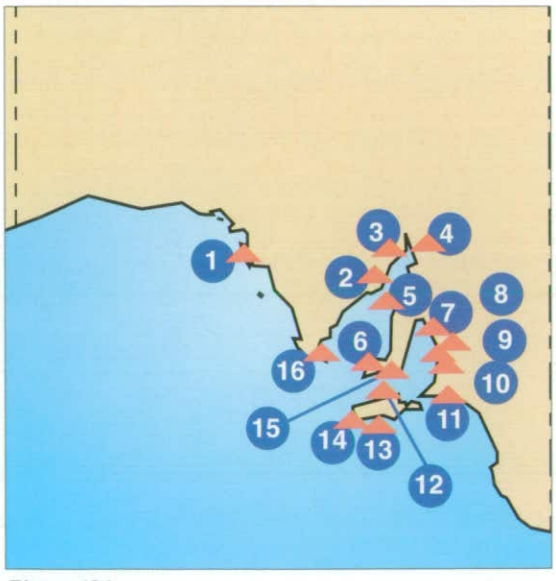


Figure 124.

Figure 125.

Western Australia

Western Australia has the longest coastline. It has biogeographically distinctive tropical and temperate fauna and flora, and an overlap zone.(56,81)

Marine conservation reserves are declared under the *Conservation and Land Management Act* 1984 and are managed by the Department of Conservation and Land Management (CALM), which is also responsible for the conservation of marine wildlife. Fish resources are managed by the Fisheries Department. The Environment Protection Authority assesses proposed projects which may affect the marine environment, and various commissions are responsible for particular waterways(81).

Western Australia has an active MPA program, with seven areas totalling 11,459 sq km. These are **(1)** Marmion; **(2)** Ningaloo; **(3)** Rowley Shoals; **(4)** Swan Estuary; **(5)** Shark Bay; **(6)** Shoalwater Islands Marine Parks; and **(7)** Hamelin Pool Marine Nature Reserve. A comprehensive scientific report released for public comment in 1994 identifies around 70 candidate areas for a network of MPAs, from the Kimberley Coast in the north, to the southern coast(81).

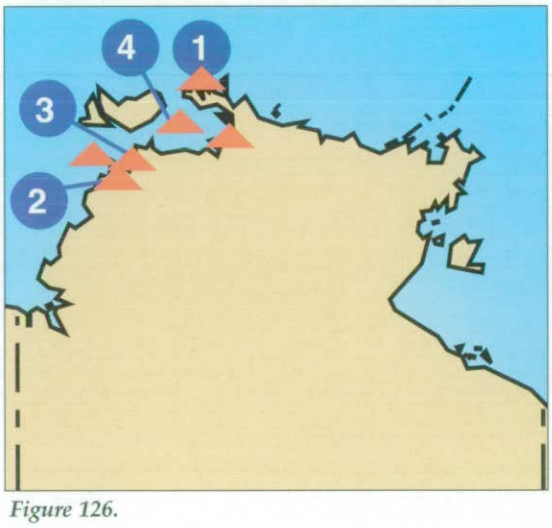


Figure 126.

Northern Territory

The Northern Territory contains some of the most pristine and culturally, scenically and ecologically important coastal and marine areas in Australia's tropics. Aboriginal people control around 84% of the coastline, to the low water marks.(57,82)

Agencies with responsibilities for marine conservation include the Conservation Commission of the Northern Territory and the Department of Primary Industry and Fisheries. So far MPAs have been established in the Cobourg and Darwin areas and others are planned.(82)

The Northern Territory's major MPAs are: **(1)** Cobourg Marine Park; **(2)** Casuarina Coastal Reserve; and **(3)** East Point Aquatic Life Reserve. The Beagle Gulf Marine Park **(4)** is being planned with the support of the Ocean Rescue 2000 program.(82)

MAJOR, MULTIPLE-USE MARINE PROTECTED AREAS AROUND AUSTRALIA

(Source: CSIRO LANDSAT 2)

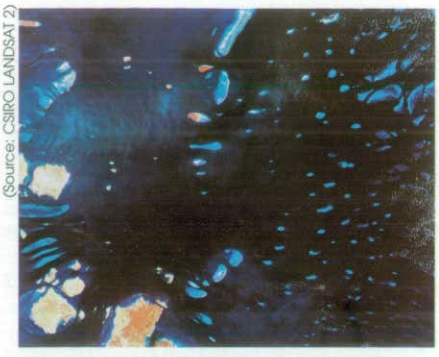


Figure 127: Torres Strait, a maze of islands and reefs between the mainland (below) and Papua New Guinea (top).

Torres Strait Protected Zone[74]

Torres Strait is a 150 km wide, shallow passage between Cape York and Papua New Guinea. It contains many reefs, over 100 islands and cays, and has a population of 6,300 Torres Strait Islanders. It has major populations of dugongs and turtles. The Torres Strait Treaty with Papua New Guinea protects the marine environment, provides access for vessels, and allocates fisheries and mineral resources. A marine conservation strategy is being prepared under the Ocean Rescue 2000 program.

Major uses: shipping; prawn and rock lobster fisheries.

Major environmental issues: possible heavy metals contamination from Papua New Guinea mines; threats of oils spills from shipping; offshore oil in Papua New Guinea; effects of prawn trawling.

(Source: GBRMPA)

Figure 128: The Great Barrier Reef Marine Park is the largest multiple-use marine protected area in the world.

Great Barrier Reef Marine Park (GBRMP)[69]

The GBRMP is the world's largest reef complex, the largest multiple-use MPA and a World Heritage Site. It is 2,500 km long and comprises 2,900 separate reefs and 940 islands. It was established under the *Great Barrier Reef Marine Park Act* 1975 and is managed by the Commonwealth GBRMP Authority, with the Queensland Department of Environment and Heritage responsible for day-to-day management.

Major uses: tourism (2 million visitors to GBR and coast each year); commercial and recreational fisheries; shipping. Economic value over $1 billion per annum.

Major environmental issues: water quality (especially elevated nutrients) in inshore areas; outbreaks of crown-of-thorns starfish; effects of trawling on sea floor biota; effects of fishing on reefs; threat of oil spills from shipping; effects of tourism.

(Source: CALM)

Figure 129: Ningaloo Marine Park in Western Australia is Australia's largest fringing reef.

The Ningaloo Marine Park[70]

Australia's longest fringing reef and the third largest MPA, Ningaloo Marine Park was established in 1987 in State and Commonwealth waters. It extends along 260 km of coast and has an area of 4,572 square km. Ningaloo is an ecologically unique mainland fringing coral reef and contains significant populations of dugongs, humpback whales, shore birds, turtles, and whale sharks. Ningaloo Marine Park is managed by the WA Department of Conservation and Land Management.

Major uses: tourism and recreational fishing.

Major environmental issues: outbreaks of coral-eating *Drupella* snails; increasing tourism; risk of pollution from oil production outside the marine park and from shipping.

(Source: CALM)

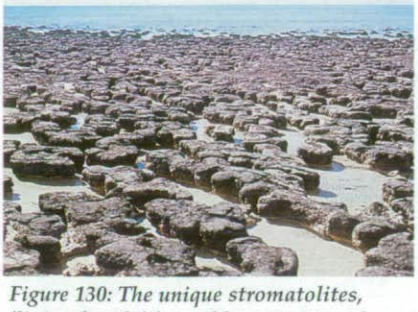


Figure 130: The unique stromatolites, 'living fossils' formed by primitive algae, in Hamelin Pool (WA).

Shark Bay Marine Park and Hamelin Pool Marine Nature Reserve[84]

Shark Bay Marine Park (7,487 sq km) and the adjacent Hamelin Pool Marine Nature Reserve (1,320 sq km) were gazetted in 1990. The seagrass meadows and the calcareous sand banks of Shark Bay are amongst the world's most extensive. Shark Bay Marine Park contains the most southerly resident populations of dugongs and green turtles, the internationally famous bottlenose dolphins of Monkey Mia, and important nursery areas for several valuable recreational and commercial fisheries. The Hamelin Pool Marine Nature Reserve includes unique stromatolites and Holocene coquina deposits. Together with equally significant terrestrial features, the area is now included in the World Heritage.

Major uses: commercial and recreational fishing; tourism (mainly at Monkey Mia and Hamelin Pool, but general nature-based tourism is increasing).

Major environmental issues: no major threats but will require management of fisheries (including aquaculture) and tourism. The major long-term issue is protection of unique stromatolites and seagrass.

Solitary Islands Marine Reserve[71]

A unique area of tropical/temperate overlap which includes coral communities, mangroves, rock platforms and rocky reefs. The Reserve extends along 70 km of coast north of Coffs Harbour and has an area of 950 square kilometres. It includes State and Commonwealth waters and is managed by NSW Department of Fisheries and the Australian Nature Conservation Agency (ANCA).

Major uses: commercial and recreational fishing; tourism (diving and water sports).

Major environmental issues: alteration of catchments and eutrophication of estuaries; recreational fisheries; tourism development.

(Source: Coffs Harbour Visitors Bureau)

Figure 131: Solitary Islands Marine Reserve.

Jervis Bay National Park[72]

A relatively pristine bay with diverse estuaries, dunes, seagrass beds, sand flats, and rock platforms and reefs. The land area in the Park is 6,312 ha and the marine area is 840 ha. It is part of the Commonwealth's Jervis Bay Territory and is managed by the Australian Nature Conservation Agency. NSW Fisheries is currently preparing a management plan for the remainder (93%) of the bay.

Major uses: commercial and recreational fisheries; recreation and tourism; naval activities; scientific research; educational activities.

Major environmental issues: Aboriginal fishing rights; effects of shipping; nutrients from discharges and run-off; tourism and recreational use.

(Source: K. McClymont)

Figure 132: Jervis Bay

Australian National Nature Reserves (managed by the Australian Nature Conservation Agency)

(1) Coringa-Herald and Lihou National Nature Reserves[73]

Rich and diverse Coral Sea reefs; cays; important seabird nesting sites (27 & 24 spp resp.). Areas: 8, 856 sq km and 8,436 sq km (resp.). Part of Commonwealth Coral Sea Islands External Territory; managing authority ANCA.

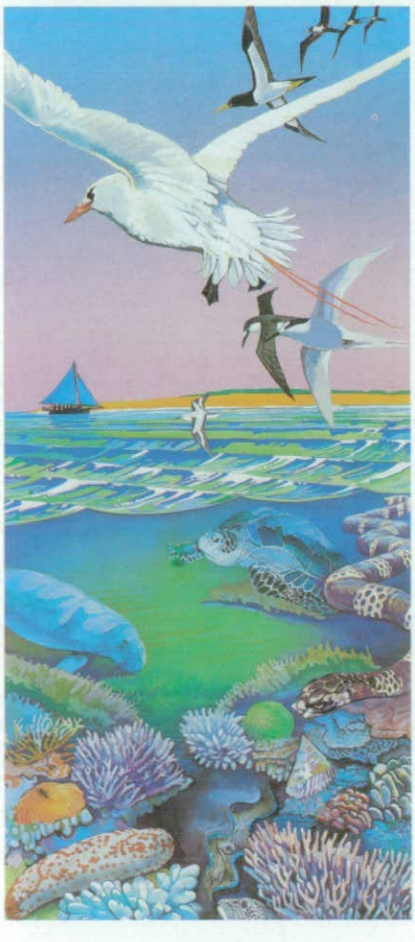
Major environmental issues: foreign fishing vessels (fish and clams); seaborne pollution.

(2) Ashmore Reef National Nature Reserve[73]

Rich and diverse Timor Sea coral reefs with high degree of endemism, especially sea snakes. Sand cays important seabird breeding and roosting sites for migratory shore birds. Area: 583 sq km. Part of Commonwealth External Territory of Ashmore and Cartier Islands. Managing authority ANCA.

Major uses: fisheries (by Indonesia).

Major environmental issues: taking of seabirds and turtles; possible overfishing; risk of oil spills.



(Source: I. Trapnell, Australian Nature Conservation Agency)

Figure 133: Ashmore Reef is a rich, shelf-edge atoll off the North West Shelf. *The reef supports a great variety of marine life, including three species of turtles, dugongs and sea snakes, and 83 species of birds have been recorded on the islands. Ashmore Reef was declared a National Nature Reserve in 1983 because of concerns of the effects of Indonesian fishers harvesting fish, molluscs and turtles. A Memorandum of Understanding with the Indonesian Government allows restricted access for Indonesian fishers.*

(3) Elizabeth and Middleton National Nature Reserve[73]

The southern-most coral reefs in the world; important feeding grounds for turtles and seabirds and refuge for black cod. Many shipwrecks. Area: 1,880 sq km. Managing authority ANCA.

Major uses: recreational fishing.

Major environmental issues: crown-of-thorns starfish outbreaks; overfishing.

(4) Mermaid Reef National Nature Reserve and Rowley Shoals Marine Park[73]

These are unique off-shore shelf atolls with a high degree of endemism. The former is a Commonwealth Nature Reserve (area: 540 sq km; managed by ANCA) and the latter is a Western Australian Marine Park (area: 232.5 sq km; managed by CALM).

(Source: P. Quilty, DEST)

Figure 134: Australia has a leading role in the international management of Antarctica, the world's last great wilderness.

Australian Antarctic Territory[75]

The Antarctic is uniquely managed through international treaties and conventions. Australia has a leading international role in research and environmental management. The region is one of the least polluted places on earth and is the last great wilderness.

Major uses: fishing; scientific research.

Major environmental issues: past overhunting of the great whales and changes in food chains; global pollution effects; tourism; localised pollution from research stations.

(Source: C. Speedie)

Figure 135: Heard Island is a major rookery for many species of sea birds and penguins such as these macaroni penguins.

Territory of Heard Island and McDonald Island[84]

This remote group of islands lying close together in the southern Indian Ocean features essentially undisturbed ecosystems, dramatic glaciated landscapes and Australia's only active volcano, Big Ben. It is a Commonwealth external territory managed by the Australian Antarctic Division.

Major uses: scientific research.

Major environmental issues: maintenance of an undisturbed environment and preventing introductions of non-indigenous species.

Report Card

Subject: Management of Australia's coastal and marine environments, pollution and cultural issues

(A: excellent, to D: poor)*

Issue	Details	State
Coastal development	Lack of strategic planning (identified in past reports and inquiries). (62)	C-D
Fisheries	Coastal catches declining; overfishing of some stocks (e.g. southern bluefin tuna, gemfish, shark, rock lobsters). (30-35)	B-D
Pollution point-sources	Guidelines and regulations in effect in most areas. Levels of some pollutants from point-sources improving. (42-47)	B
Pollution non point-sources	No overall controls (42)	D
Oil spills	NATPLAN in place but effectiveness limited by logistics and large coastline. (No large spill has ever been successfully contained in the open sea). (39)	C
Marine protected areas	Australia has largest number of MPAs in world. Much of north protected (Qld and WA rated A), but little of south. Most bioregions not adequately represented. (67,69-82)	A-C
Endangered species	Marine mammals previously depleted generally secure; regional concerns on turtles; gaps in knowledge on other groups. (15-18, 60)	B
Indigenous peoples	Customary rights in marine environment not recognised (except shores in Northern Territory); lack of commercial opportunities; lack of consultation and involvement in coastal management. (19-22)	D

*Scores

A: excellent (no significant environmental problems; management objectives achieved; ecologically sustainable development (ESD) established)

B: good (few serious problems; most objectives achieved; ESD achievable)

C: fair (many serious problems; few objectives achieved; ESD difficult)

D: poor (critical problems; no objectives achieved; ESD not achievable at present levels)

7

The state of Australia's marine environment and the major issues

THE MAJOR ISSUES IN THE MARINE ENVIRONMENT

A great number and variety of issues and problems were identified by the technical experts who contributed to SOMER. While it was difficult to compare diverse environmental, social, management and scientific issues, the SOMER Advisory Committee identified from these what they considered to be the most serious issues affecting our marine environment.

The top five concerns

1. Declining marine and coastal water/sediment quality, particularly as a result of inappropriate catchment land use practices
2. Loss of marine and coastal habitat
3. Unsustainable use of marine and coastal resources
4. Lack of marine science policy and lack of long-term research and monitoring of the marine environment
5. Lack of strategic, integrated planning in the marine and coastal environments

THE STATE OF THE MARINE ENVIRONMENT: *'Generally good but ...'*

It is not possible to simply and precisely assess the state of Australia's marine environment because of its vast size and great diversity, the diversity and complexity of issues affecting it, and the great gaps in our scientific knowledge of it.

However, on the basis of the existing limited information, and in comparison with both neighbouring countries and equivalent developed countries in the northern hemisphere[93,95], the condition or 'health' of Australia's marine environment might be rated as 'generally good', but with many important caveats or qualifiers.

The condition of specific areas ranges from 'almost pristine' in very remote, undeveloped areas[12,42-47,73,75,76,81,85], to locally 'poor' off many highly developed urban, industrial and intensively farmed areas in the south-east[42-47,51-55], and south-west[56] of the continent. The condition of offshore environments is better than inshore environments because of dilution of pollutants[45].

Undeveloped areas little affected

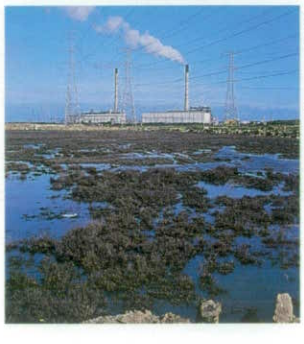
Most of our marine environment is far removed from the major population centres and is little affected by most human activities. The northern[57], far north-eastern[51,69] and most of the western coasts[57] of the continent, the Great Australian Bight[55] and Australia's External Territories[73] in the Indian Ocean, South Pacific, Southern Ocean and Antarctica[75] are amongst the least polluted places on earth.

Highly developed areas more seriously affected

Australia's population is highly concentrated in coastal cities in the south-east and south-west. Here the state of the adjacent marine environment may be locally poor[51-56]. So while the state of Australia's marine environment is on average, good, the state of the marine environment near where the urban Australian lives is often 'not good'.

(Source: I. Dutton)

Figure 136: The state of undeveloped coastlines is good. Rottnest Island (WA).



(Source: SARDI)

Figure 137: The state of developed coastlines is often not good. South Australia.

(Source: Gavin Ryan)

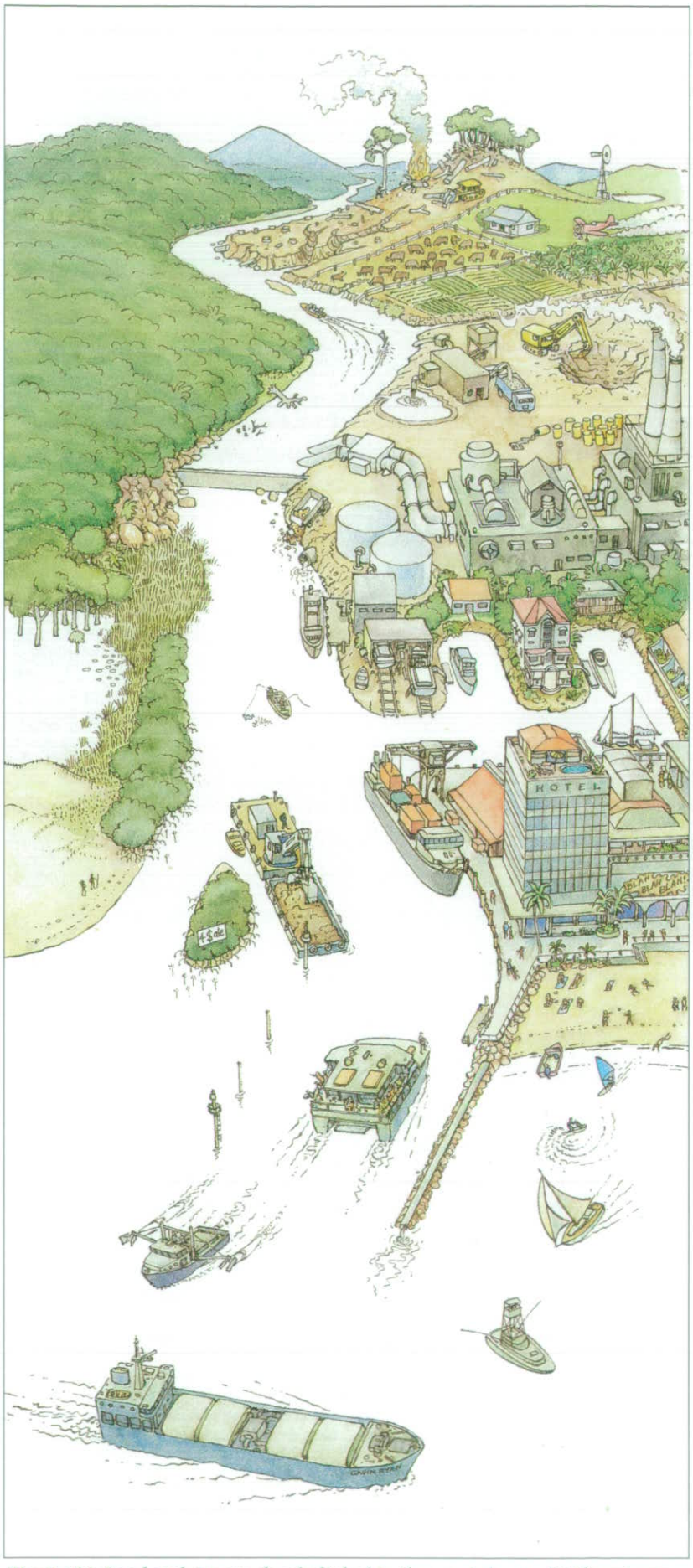


Figure 138: Land and sea are closely linked in the coastal zone. *Catchment uses in Australia have had major effects on estuaries and inshore waters.*

1. Declining water quality

Declining water quality and sedimentation were regarded as probably the most serious issues affecting Australia's marine and coastal environments. Land and sea are closely linked in the coastal zone. Elevated nutrients and sedimentation are largely the result of inappropriate catchment land use practices, sewage discharges and urban run-off.(1,6,40, 42-47,51-57)

• Sediments and nutrients

Elevated nutrients and sediments come from land run-off. Land erosion is the major source in rural areas, and sewage and urban run-off is the major source in urban areas. Sediments alter estuaries and shores and smother marine life. Elevated nutrients cause eutrophication, the harmful growth of algae. Blooms of blue-green algae are now common in many estuaries and bays. Blooms of introduced and native species of toxic dinoflagellates (microscopic algae probably introduced in ships' ballast waters) are a serious problem in Victoria and Tasmania, and threaten other States. Eutrophication is a serious threat to estuaries, temperate seagrass and tropical corals (next page).(1,4,6,10, 12, 42, 51-56)

• Oil pollution

The major source of oil entering the marine environment is urban run-off. Small but frequent spills from fuelling vessels in ports; and operational discharges from ships are also a significant source. Australia has been lucky so far; only two major spills (over 1,000 tonnes) have occurred, and these resulted in little long-term damage. A series of smaller spills since 1990 has caused greater damage to wildlife.(36-39,43)

• Heavy metals

Pollution from mercury, cadmium, lead and other heavy metals is a localised problem. Levels of heavy

(Source: The West Australian)

Figure 139: Oiled seal pup from **Sanko Harvest** *spill (WA).*

metals are high in seafood in Torres Strait; while mines in Papua New Guinea were implicated, preliminary research suggests that high levels are natural. Localised heavy metal 'hotspots' include Lake Macquarie (NSW), Corio Bay (Vic), Derwent and Macquarie Estuaries (Tas) and Port Pirie (SA). Tributyl tin from ships' antifouling paints is also a problem in many ports and marinas. Controls on industrial discharges and ships' antifouling paints have reduced levels in most areas monitored.(44,52-57)

• **Organochlorines**

Some organochlorines or chlorinated compounds used as herbicides and insecticides in industry are toxic to marine life and are bioaccumulated or magnified in marine food chains. Away from farm lands and cities in Australia, levels are very low. Local 'hotspots' include Sydney's sewage outfalls and Homebush Bay and off Melbourne's Port Phillip Bay sewage outfalls and Corio Bay.(45,52,53)

• **Beach and ocean litter**

Litter is a growing and very conspicuous problem on our beaches. Urban beaches are most affected but not even the remotest beach is free from litter. Litter reduces the scenic and recreational values of areas, and may affect wildlife. Turtles and whales may die from eating plastic bags. The incidence of seal entanglements in net fragments and other synthetic material in Tasmania is one of the highest in the world.(18,46,53,54)

(Source: K. McClymont)

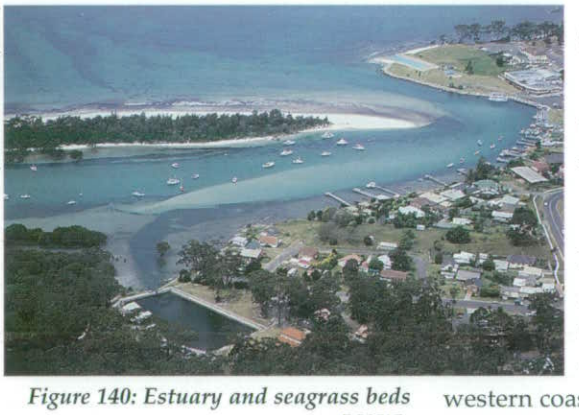


Figure 140: Estuary and seagrass beds (NSW).

2. Loss of marine and coastal habitat

Many of the environmental issues identified are related to water quality and loss of habitat, and are overlapping in nature.(7-14,51-57)

• **Degradation of estuaries and coastal lakes**

Estuarine environments in much of eastern and southern Australia are declining because of eutrophication and sedimentation, acid soil run-off, coastal developments, loss of habitat and overfishing. South-eastern and south-western coastal lakes, which have limited ocean water exchange, have been particularly affected by terrestrial run-off.(6-8,51-57)

• **Declines in temperate seagrass**

Seagrass beds are very important ecosystems. Elevated nutrients and sediments have caused serious die-backs of temperate seagrass beds in southern Australia. Around half of the seagrass in the estuaries of New South Wales has been lost. The majority of seagrass in Victoria's Western Port has been lost. Tasmania, the South Australian Gulfs and south-western Western Australia have also suffered locally serious declines in seagrass. A major loss of sub-tropical seagrass occurred in Hervey Bay in Queensland, causing a serious decline in the dugong population.(10,42,51-56)

• **Loss of mangrove and saltmarsh habitats**

Significant losses of saltmarsh and mangroves have occurred near urban areas through reclamations, drainage and other developments. This affects fish and other sea life which use these as nurseries and feeding grounds.(6-8,51-57)

• **Unsustainable coastal development**

Urban, industrial and port development, tourism and other uses have been responsible for significant degradation in the coastal strip in many areas around Australia, particularly in the south-east. (1,29,40,51-56,62)

(Source: GBRMPA)

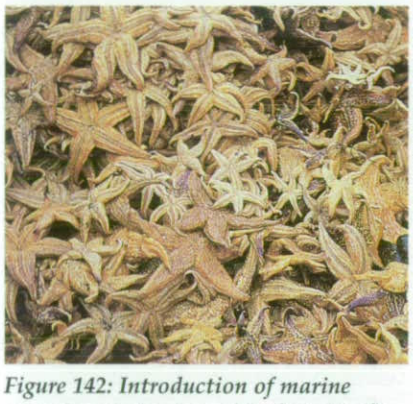
Figure 141: There is widespread concern on the effects of bottom trawling. *A trawler's by-catch.*

• **Effects of fishing on sea floor communities**

There is widespread concern about the environmental effects of trawling and scallop dredging on the sea floor community and on juvenile fish. The effects of fishing on the ecosystem are little known, but is likely to be significant and widespread. The large number of seabirds caught on tuna longlines is of growing concern. (30,32,34,51-56,69)

• **Introductions of foreign species**

The introduction of exotic pests and diseases via ships' ballast water is a potentially very serious problem in Australia's long isolated marine environment. Around 55 species are known to have been introduced, largely via ships' ballast waters and on ships' hulls. Blooms of introduced toxic marine algae and the ravenous Northern Pacific seastar threaten marine communities and aquaculture farms. The possible introduction of diseases such as cholera via ships' ballast waters is also of concern.(14,47,48,53,54)



(Source: Tasmanian Museum)

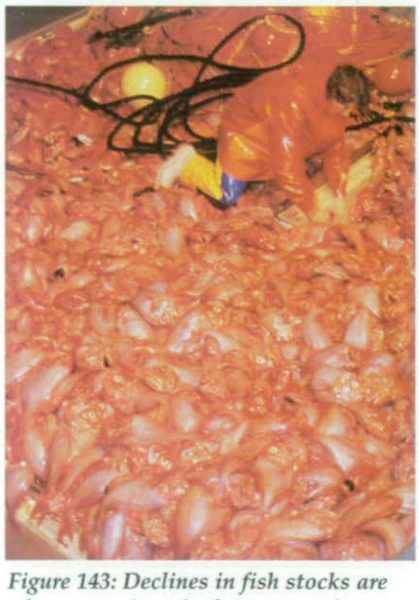
Figure 142: Introduction of marine pests is a major issue. *Northern Pacific seastars in Tasmania.*

• **Population increases in native species**

Outbreaks of the coral-eating crown-of-thorns starfish has resulted in significant loss of corals in the central one third of the Great Barrier Reef, and on the Tasman Sea reefs. Similar outbreaks of the coral-eating *Drupella* snail have affected large areas of Western Australia's Ningaloo Reef. The causes of the outbreaks are unknown. (49,50,51,56,69,70)

3. Unsustainable use of marine and coastal resources

Over-harvesting of fish and other marine life, coastal developments, and conflicting resource use, are critical issues around Australia.(29-35)



(Source: J. Lyle, Tasmanian Fisheries)

Figure 143: Declines in fish stocks are of concern. *A catch of orange roughy.*

• **Declines in fish stocks**

Australia is not rich in fisheries. We have experienced declines in some commercial fisheries over the past few years. Serious overfishing of southern bluefin tuna, southern sharks, gemfish, rock lobsters and other species has occurred. There is also a serious lack of accurate catch data on many of Australia's fisheries.(30-34)

• **Inappropriate fisheries practices**

Harvesting practices used in certain fisheries are causing significant impacts on marine ecosystems and habitats. Of particular concern are the impacts of trawling and scallop dredging on sea floor communities.(84)

4. Lack of marine science policy

Little geographically comprehensive and long-term scientific information is available on the marine environment. Without this it is difficult to accurately assess its condition, to identify trends, and to design and assess management programs. Many of the findings in

(Source: CSIRO)

Figure 144: CSIRO's research vessel **Southern Surveyor** *(Tas).*

(Source: M. Johnson, GBRMPA)

Figure 145: Coral reef ecologist at work (Qld).

SOMER are therefore based on limited data sets, descriptive information and expert scientific opinion.[1-57,63]

• Lack of long-term research and monitoring of Australia's marine environment

Difficulties in establishing long-term research and monitoring programs include: high cost of marine studies; difficulties in obtaining long-term funding for research and monitoring; lack of coordinated data acquisition and storage; and lack of standardised, cost-effective, statistically based scientific sampling techniques and indicators. [6-18,28-57]

• Lack of applied scientific knowledge on the marine environment

Local government environmental managers are highly critical of the lack of information on local marine environments, and the lack of simple, descriptive maps and inventories[51-57,62].

• Lack of scientific understanding of the functioning of marine ecosystems

Marine scientists are more concerned about the lack of understanding of how marine ecosystems function. They argue that effective management must be based on this.[6-18]

5. Other issues

• Lack of integrated planning in the coastal zone

Many of the problems identified in SOMER stem from the lack of integrated, long-term planning in the coastal and marine environments [1-47,51-57]. Australia does not have a clear direction or agreed national strategy for managing its marine or coastal environments.

The lack of strategic planning in the coastal zone has been identified as a major problem in a number of Commonwealth and State inquiries, most recently the Resource Assessment Commission's Coastal Zone Inquiry. Coastal zone management must consider the high degree of connection of land and sea (particularly catchment uses), the many human activities which span the land/sea interface, the wide dispersal of marine organisms and pollutants by currents, and the different administrative jurisdictions involved.[1-47,51-57,62]

• Lack of non point-source (diffuse) pollution controls

Guidelines and standards have been developed for point-source discharges. However, no guidelines have so far been developed for the multiple, non-point source or diffuse discharges from catchments. Constant, low levels of a range of different types of pollutants can have very serious chronic and cumulative effects.[42]

• Insufficient representation of marine protected areas (MPAs)

About 5.2% of Australia's marine environment has some level of protection. However, a very large proportion of protected areas (74%) is the Great Barrier Reef Marine Park. Many of Australia's marine bioregions are not sufficiently represented in MPAs.[67,77-80]

• **Indigenous issues**

Outside the Northern Territory, the legal uncertainty as to the existence of customary sea rights for Aboriginal and Torres Strait Islander peoples, their general lack of involvement in environmental management and lack of commercial opportunities in fisheries and tourism are important social issues. The 1993 *Native Title Act* caters for both customary land and sea rights. However the issue of the existence of sea rights has not yet been the subject of an authoritative decision by a court.(20-22,84)

(Source: GBRMPA)

Figure 146: Aboriginal dugong hunters (WA).

• **Social and cultural values of coast and sea**

Despite the obvious great importance of the coast and sea to Australians, knowledge of the social or cultural values of the marine environment is limited. Social and cultural values are generally inadequately considered in coastal zone planning and management.(23)

Regional issues

Hundreds of regional issues were raised in SOMER. The most serious include:

• **Condition of marine and coastal environments in south-east and south-west**

The widespread degradation of estuaries, coastal lakes and bays in New South Wales, Victoria, Tasmania, South Australia and south-western Western Australia is a serious local and national problem. Major causes are elevated nutrients, sedimentation, pollution, coastal strip development and overfishing. Of particular concern are the unique coastal lakes which are not found in the less populated and less degraded north.(42-47,51-56)

• **Condition of 'urban' marine environments**

Estuaries and coastal waters near the State capitals are generally the most disturbed parts of the marine environment. Some parts of Sydney Harbour, Port Phillip Bay, and the Derwent Estuary are so polluted by sewage, urban run-off and industrial discharges that they are frequently closed for bathing and fishing. However, controls on discharges are having an effect and most contaminated areas are showing signs of improvement.(42-47,51-56)

• **Elevated nutrients and sediments in the Great Barrier Reef lagoon**

Elevated nutrients from land run-off may be threatening the inner Great Barrier Reef. Corals are particularly sensitive to elevated levels of nitrates and phosphates. Some scientists fear the Great Barrier Reef lagoon, the waters between the mainland and the Great Barrier Reef, is eutrophic.(42,51,69)

(Source: Dept Conservation and Natural Resources, Vic.)

Figure 147: A general decline of marine environments off developed Australia is of national concern. *Port Phillip Bay (Vic).*

MANAGEMENT IMPLICATIONS

The most serious issues in Australia's marine environment stem from poor catchment use, and therefore declining water quality. Increased levels of nutrients and sediments are the major problems.

The most serious consequences of these are the die-back of seagrasses in temperate Australia [10] and threats to inshore corals in the wet tropics[12].

The major causes are soil erosion and declining inland water quality, two of our greatest problems on land[1]. The crisis in Australia's inland waters is well accepted. Elevated nutrients from soil erosion, agricultural fertilisers, live stock, sewage and urban run-off has resulted in regular blooms of toxic algae [14,42,53-55]. Not so well accepted is that this then becomes a problem in estuaries, coastal lakes, bays and coastal waters. Degradation of estuaries and die-back of seagrass cause declines in coastal fisheries[31].

The key issues in Australia are thus interrelated. Because the major source of marine environmental threats lie inland in the catchments, strategic, integrated planning and management in the coastal zone is of paramount importance. Integrated catchment management is probably almost as important to the sea as it is to the land.

(Source: Dept Conservation and Natural Resources, Vic.)

Figure 148: Many of the problems on land and sea are interrelated. *The Barwon River (Vic) carrying a heavy silt load after heavy rain in the catchment.*

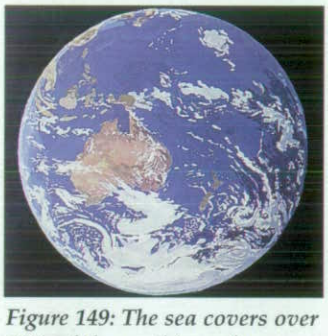
Future directions in marine environmental management

Coastal and marine environmental management, encompassing many different ecosystems, processes, resources and uses, is an evolving process. A number of important international and national initiatives since 1990 have stressed the importance of ecologically sustainable development and large-scale, long-term, integrated ecosystem management of the coastal and marine environment.

GLOBAL CONCERNS: UNCED CONFERENCE

The 1992 United Nations Conference on Environment and Development (UNCED) was convened because of widespread concerns about the degradation of the environment and the loss of global biodiversity.(92,96)

With respect to the ocean, UNCED recommended that all nations: (1) prevent, reduce, and control degradation of the marine environment so as to maintain and improve its life-support and productive capacities; (2) develop and increase the potential of marine living resources to meet human nutritional needs, as well as social, economic, and development needs; and (3) promote the integrated management and sustainable development of coastal areas and the marine environment.(92)



(Source: GBRMPA)

Figure 149: The sea covers over 70% of the earth's surface.

UNCED recognised that the achievement of these will require new strategies in marine environmental management, ones that can overcome geopolitical and interdisciplinary divisions. These should be based on principles of ecology and of ecologically sustainable development.(92)

ECOLOGICALLY SUSTAINABLE DEVELOPMENT

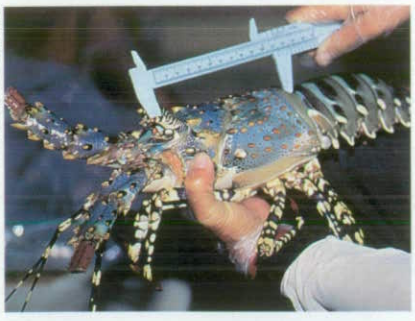
The concept of 'sustainable development' was placed on the global agenda through the 1987 report of the World Commission on Environment and Development entitled 'Our Common Future' (often known as the Brundtland Report). This report defined sustainable development as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs'. (WCED 1987, p43(97))

The concept of ecologically sustainable development (ESD) has been embraced by many Australian environmental managers, conservationists, economists and industrialists as an important unifying goal for conservation and development. ESD is seen as a means of managing increasing human demands on the ultimately limited capacity of the natural environment.

(Source: GBRMPA)

Figure 150: The future of Australia's marine tourism is great.

(Source: GBRMPA)



(Source: GBRMPA)

(Source: CoA)

(Source: CoA)

Figure 151: The goal of ESD is particularly important to Australia's commercial and recreational fisheries.

The development of the National Strategy for Ecologically Sustainable Development provided a framework through which all stakeholders, governments and community groups worked together to help achieve integrated economic social and environmental goals (61,84,98,99).

(Commonwealth of Australia 1992(98))

National Strategy for Ecologically Sustainable Development

The Goal

'Development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depend'.

The Core Objectives

- 'to enhance individual and community well-being and welfare by following a path of economic development that safeguards the welfare of future generations'
- 'to provide for equity within and between generations'
- 'to protect biological diversity and maintain essential ecological processes and life support systems'

The Guiding Principles

- 'decision making processes should effectively integrate both long and short-term economic, environmental, social and equity considerations'
- 'where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation'
- 'the global dimension of environmental impacts of actions and policies should be recognised and considered'
- 'the need to maintain and enhance international competitiveness in an environmentally sound manner should be recognised'
- 'cost effective and flexible policy instruments should be adopted, such as improved valuation, pricing and incentive mechanisms'
- 'decisions and actions should provide for broad community involvement on issues which affect them'
- 'the need to develop a strong, growing and diversified economy can enhance the capacity for environmental protection should be recognised'

'The objectives and principles need to be considered as a package with no objective or principle predominating over the others.'

The ESD working group on fisheries emphasised the importance of maintaining ecosystem function. Its recommendations included the development of a national marine conservation strategy incorporating a system of marine protected areas. The multi-use Great Barrier Reef Marine Park was cited as a model for large-scale, integrated marine management.(99)

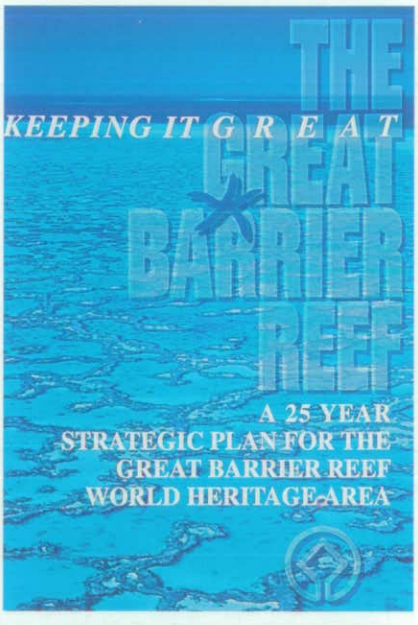
The implementation of ESD poses particular challenges to the disciplines of economics and ecology. Its implications to marine environmental management include the necessity to maintain ecosystem function; the requirements of a large-scale or 'systems' approach; the necessity to maintain water quality; the importance of large marine protected areas; and the importance of monitoring because of scientific uncertainty.(61)

The objective of ESD has become incorporated into the goals of many management agencies. The Ocean Rescue 2000 program itself is a formal part of the ESD response(83). The recommended national network of marine protected areas is now being developed, and the Australian Marine Conservation Plan will be based on the principles of ESD. The concept of large ecosystem management is currently being adopted by fisheries managers in Australia(30).

A model for integrated, large ecosystem management: the Great Barrier Reef World Heritage Area

The Great Barrier Reef is the largest complex of coral reefs in the world. It consists of around 2,900 separate reefs and is 2,500 kilometres in length. The Great Barrier Reef Marine Park (GBRMP) has an area of around 344,000 square kilometres. This is three quarters of the total area of marine protected areas in Australia. The GBRMP is also the world's largest marine protected area and the only large marine ecosystem which is comprehensively managed with the explicit goal of ensuring that its use is ecologically sustainable, in perpetuity.(69)

The GBRMP Authority, together with over 60 user and interest groups and government agencies and Aboriginal and Torres Strait Islander communities has recently developed a 25 Year Strategic Plan for the Great Barrier Reef World Heritage Area. The objectives of the strategic plan are a healthy environment, sustainable multiple use, maintenance and enhancement of values, integrated management, knowledge-based but cautious decision making in the absence of information, and an informed, involved, committed community. The plan will be reviewed regularly by its creators and its objectives will be adopted by the participating organisations. The Strategic Plan was launched formally by the Prime Minister, the Hon. Paul Keating, on 20 July, 1994. It is believed to be a world first in joint decision making, and is a good example of integrated management and ecologically sustainable development in action.(69)



(Source: GBRMPA)

Figure 152: The Great Barrier Reef Marine Park is a model for large-scale, integrated management.

INTEGRATED PLANNING IN THE COASTAL ZONE: RECOMMENDATIONS OF THE COASTAL ZONE INQUIRY

Almost sixty government reports and inquiries on Australia's coastal zone have been undertaken since 1960, reflecting the

(RAC 1993[91])

Principal Aims for National Coastal Action Program proposed by RAC

- reduce degradation caused by urban sprawl and activities in urban and remote locations in the coastal zone;
- provide better facilities for recreation in the coastal zone;
- provide better management and preservation of natural processes in coastal areas;
- achieve more effective and rational use of land in the zone for building, development, tourism and other uses;
- improve recognition by the community of the value of the resources of the zone;
- improve recognition of indigenous peoples' interests in management of the zone;
- improve water quality in streams, estuaries and coastal seas;
- improve management of fisheries through more effective management of sea-based resources of the zone.

(Source: CoA)

(Source: CoA)

Figure 153: The lack of integrated management of the coastal zone has been highlighted in many Government inquiries.

continuing crisis in coastal management in this country. The Resource Assessment Commission (RAC) Coastal Zone Inquiry (1993) made many recommendations on management of the coast.[62,91]

The major recommendation was that a National Coastal Action Program for the management of the resources of Australia's coastal zone be adopted by the Council of Australian Governments. This Plan would be implemented by the three spheres of government in consultation with community and industry groups that have responsibility for and interests in coastal zone management.[62,91]

At the time of writing, the Commonwealth response to the RAC Report was being finalised following discussions held with State and Local Governments.

(Source: QDPI)

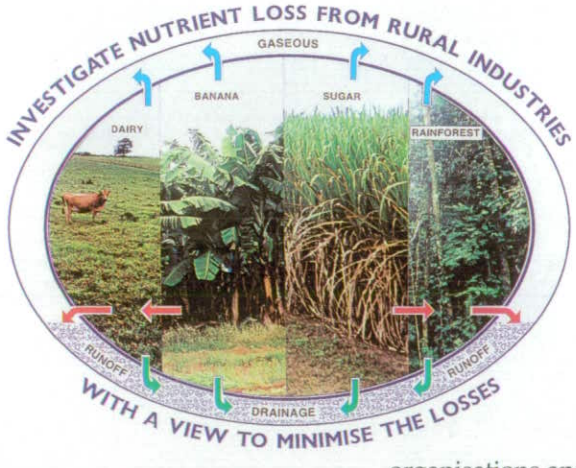


Figure 154: Land, rivers and sea benefit from integrated catchment management. This graphic describes a Queensland research program aimed at reducing nutrient loss from land.

INTEGRATED CATCHMENT MANAGEMENT

Catchment management programs to reduce soil erosion are underway throughout Australia (e.g. the Total Catchment Management program in New South Wales; Integrated Catchment Management programs in Queensland, Victoria and Western Australia). The programs involve local land holders, Local Government and State organisations and include strategies such as minimum tillage, control of stocking rates, contour cultivation, improved fertiliser management, revegetation of stream banks, buffer strips along stream banks, control of road side erosion, sewerage system upgrades, preservation of

wetlands as sediment and nutrient 'traps', and reduction of erosion during urban development.(42) The RAC Report suggests a 'Coastcare' program similar to Landcare be developed for coastal areas to complement the catchment activities(91).

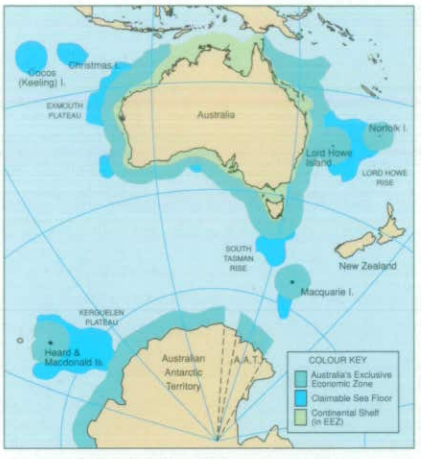
DECLARATION OF AUSTRALIA'S 200 MILE EXCLUSIVE ECONOMIC ZONE

Australia's 200 mile Exclusive Economic Zone (EEZ) was declared on 1 August 1994 and came into force on 16 November 1994. With an area of over 11 million square kilometres, its is one of the largest EEZs in the world.

In addition to providing rights to exploit the natural resources in the EEZ, the 1982 United Nations Convention on the Law of the Sea (UNCLOS) also obliges Australia to protect and preserve the marine environment in its EEZ (Article 192).

UNCLOS requires Australia to cooperate to prevent land-based marine pollution and to work internationally to achieve this. It requires further action to prevent marine pollution by dumping and from ships.

The Convention also requires Australia to further advance knowledge of its EEZ by undertaking marine scientific research. It also promotes the sustainable use and conservation of the living resources of the high seas.(102)



(Source: AGSO)

Figure 155: Australia's sea area is much larger than its land area.

NATIONAL STATE OF THE ENVIRONMENT REPORTING

Environmental managers require accurate, long-term quantitative information on the state of the environment in order to identify pressures and appropriate responses. Several Australian States have produced state of the marine environment reports in recent years, although these are dissimilar in approach.(52,53,55,56)

The Commonwealth Government has recently commenced a National State of the Environment reporting program based on a pressure-state-response model. Under this model, reports are structured in terms of the pressures on the environment arising from human activities and impacts, the state or condition of the environment and individual and institutional responses. It is intended that a national set of environmental indicators is then developed for future, quantitative reporting. The first descriptive report is scheduled for late 1995(94). SOMER is providing much of the baseline information on marine and estuarine environments for the National State of the Environment Report.

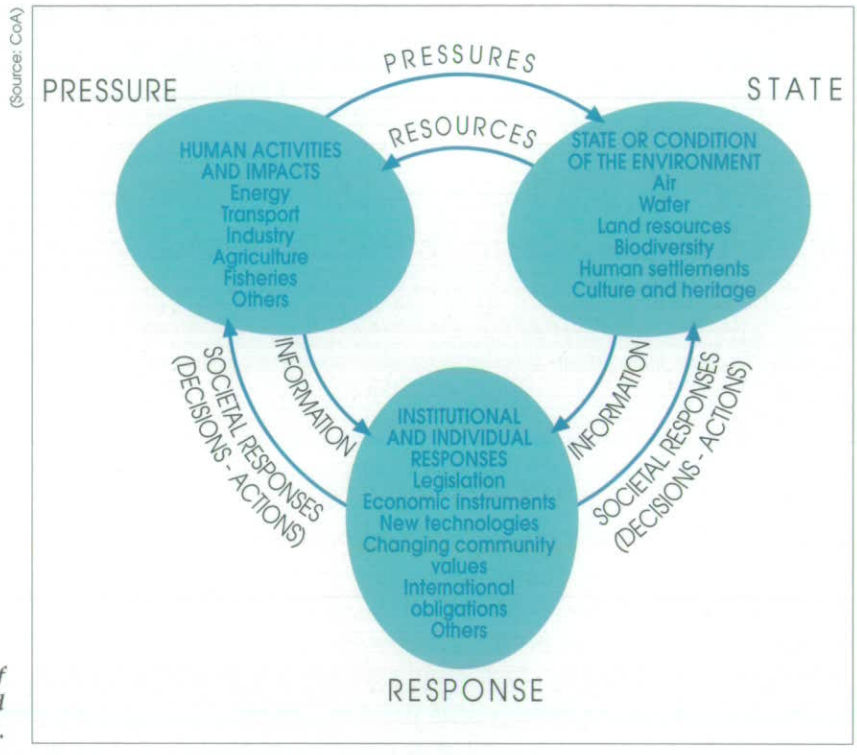


Figure 156: The new National State of the Environment Reports will be based on a pressure-state-response model.

THE OCEAN RESCUE 2000 PROGRAM

Figure 157: The Ocean Rescue 2000 Program aims to safeguard the marine environment for future generations.

The Ocean Rescue 2000 program, which began in 1991, is a Commonwealth Government initiative to promote the conservation and sustainable use of the marine and coastal environment of Australia. It builds on existing marine conservation and management programs and is part of the national strategy for Ecologically Sustainable Development.(83)

The principal objective of the program is to develop and implement a marine conservation plan to guide the use and management of Australia's marine resources.

The program consists of the following elements:

- National Representative System of Marine Protected Areas;
- Australian Marine Conservation Plan;
- State of the Marine Environment Report (SOMER);
- National Marine Education Program;
- National Marine Information System; and
- Marine and Coastal Community Network.

SETTING SAIL FOR THE FUTURE

(Source: GBRMPA)

The close connections between ecosystems, processes, resources, uses and issues in the coastal zone require that coastal zone management occur at an appropriate time and spatial scale and is closely integrated at all geographic and geopolitical levels.

The goals of marine environmental management are to maintain biodiversity and ecologically sustainable development. The alternatives are continuing environmental degradation and ecological collapse.

(Source: GBRMPA)

(Source: GBRMPA)

Figure 158: The goals of marine environmental management are ecologically sustainable development and the maintenance of biodiversity.

Information sources

The information contained in this report was obtained from the SOMER technical papers and summary; from unpublished submissions and contributions received during the Commonwealth, State and Territory review process; and from published sources.

The following are the information sources from SOMER Technical Papers (cited by chapter, subject, and author and affiliations).

Description of Australia's marine environment

Physical environment

1. The coastal zone (Dr L.P. Zann, Great Barrier Reef Marine Park Authority)
2. The ocean (Prof J. Middleton, Uni. NSW)
3. The seafloor (Dr P. Harris, Uni. of Sydney)
4. The land/sea interface (Dr M. Furnas, Australian Institute of Marine Science)

Biotic environment

5. Biogeography of Australia's marine biota (Dr G.C.P. Poore, Museum of Victoria)
6. Estuaries and enclosed waters (Prof. P. Saenger, Southern Cross Uni.)
7. Coastal saltmarsh (Assoc. Prof P. Adam, Uni. NSW)
8. Mangrove systems (Dr. A. Robertson & Dr D. Alongi, Australian Institute of Marine Science)
9. Seagrasses (Dr I. Poiner & C. Peterkin, CSIRO, Cleveland)
10. Hard and soft shores (Dr P.G. Fairweather, Macquarie Uni. & Dr G.P. Quinn, Monash Uni.)
11. Temperate reefs (Dr M.J. Keough, Uni. Melbourne & Dr A. Butler, Uni. Adelaide)
12. Coral reefs (Dr J.E.N. Veron, Australian Institute of Marine Science)
13. Deep water communities (Dr G.C.P. Poore, Museum of Victoria)
14. Phytoplankton (Dr G. Hallegraeff, Uni. Tasmania)

Status of marine biodiversity

15. Issues in the conservation of rare, threatened and endemic marine species (Dr G.P. Jones & Dr U.L. Kaly, James Cook Uni.)
16. The status of lower vertebrates (Dr F. Michaelis, Marine and Coastal Section, Dept. Environment, Sport and Territories)
17. Status of Australia's seabirds (Dr G.J.B. Ross, Australian Nature Conservation Agency, and 14 co-authors)
18. The status of marine reptiles and mammals (Prof. H. Marsh, James Cook Uni., Dr P.J. Corkeron, Uni. Sydney, Dr. C.J. Limpus, Queensland Dept. Environment and Heritage, Dr P.D. Shaughnessy, CSIRO, Canberra & T.M. Ward, James Cook Uni.)

Australians and the marine environment

Importance to indigenous communities

19. Pre-European use of the sea by Aboriginal people: an archaeological perspective (A. Nicholson & S. Cane, Narooma)
20. Aboriginal maritime culture (Dr D. Smyth, James Cook Uni.)
21. Use of the coastal and marine environment by Aboriginal communities: case study from northern New South Wales (S. Schnierer, S. Robinson, R. Heron & J. Nayutah, Southern Cross Uni.)
22. Torres Strait Islander maritime culture (Dr. D. Lawrence, Great Barrier Reef Marine Park Authority)

Importance to general community

23. Social values and perceptions of the marine environment (Dr L.P. Zann, Great Barrier Reef Marine Park Authority & I. Dutton, Southern Cross Uni.)
24. Maritime cultural heritage (M. Staniforth and K. Jones, Australian National Maritime Museum)
25. Coastal cultural heritage (M.L. Walkington and A. Marsden, Australian Heritage Commission)
26. Community involvement in marine conservation (Dr L.P. Zann & D. Alcock, Great Barrier Reef Marine Park Authority)

Uses of the coastal and marine environments and their impacts

27. The economic value of the marine environment (S. Driml, Australian National Uni.)

Tourism and recreation

28. Coastal and marine tourism and recreation (S. Driml, Australian National Uni.)
29. Impacts of tourism on marine and coastal systems (I. Dutton & K. Luckie, Southern Cross Uni.)

Fisheries

30. Status of commercial fisheries (K. McLoughlin, Bureau of Resource Science)
31. Coastal fisheries: a critical review (Dr. R. Kearney, NSW Fisheries).
32. The by-catch issue and effects of trawling (Dr S.J. Kennelly, NSW Fisheries)
33. Recreational fisheries and the catch-sharing issue (G. Coleman, Sports and Recreational Fishing Federation, Canberra, & B. Shorthouse, Consultant, Great Barrier Reef Marine Park Authority)
34. Shoreline harvesting (Dr G.P. Quinn, Monash Uni., Dr P.G. Fairweather, Macquarie Uni. & Dr M.J. Keough, Uni. Melbourne)
35. Aquaculture and potential environmental impacts (Dr P. Rothlisberg, CSIRO, Cleveland & C. Barlow, Queensland Dept. Primary Industries)

Transport and energy

36. Shipping and ports (S. Raaymakers, Australian Maritime Safety Authority/Great Barrier Reef Marine Park Authority)
37. Offshore petroleum exploration and production (J. Beck, K. Pendoley & I. Stejskal, Australian Petroleum Exploration Association)
38. Offshore petroleum and marine conservation (Dr L.P. Zann, Great Barrier Reef Marine Park Authority)
39. Oil spills, prevention and control (S. Raaymakers, Australian Maritime Safety Authority/Great Barrier Reef Marine Park Authority)

General issues in the coastal and marine environments

Coastal development and climate change

40. Coastal modifications and their effects (Dr E. Bird, Geostudies, Melbourne)
41. Climate change, sea level rise and potential effects on Australia's coastal and marine environments (Dr C. Mitchell, CSIRO, Mordialloc & I. Carruthers, Climate Change and Environmental Liaison Branch, Dept. Environment, Sport and Territories)

Water quality and marine pollution

42. Nutrients and eutrophication in coastal waters (J. Brodie, Great Barrier Reef Marine Park Authority)
43. Hydrocarbon levels in the marine environment (Prof. D.W. Connell, Griffith Uni.)
44. Heavy metals and organometals in the marine environment (Dr G.E. Batley, CSIRO Centre for Advanced Analytical Chemistry, Menai)
45. Organochlorines in the marine environment (Dr. B. Richardson, Deakin Uni.)
46. Ocean and beach litter (Dr. N. Wace, Australian National Uni., A. Reynolds, Greenpeace Australia & Dr L.P. Zann, Great Barrier Reef Marine Park Authority)
47. Microorganisms in the marine environment and human health (Dr N.J. Ashbolt, AWT Science and Environment, Sydney)

Introduced and native pests

48. Exotic marine species and the ballast water problem (Dr L. Lehane, Science Communications Services, Canberra; L. Arundell, Bureau of Resource Sciences, Canberra & Dr L.P. Zann, Great Barrier Reef Marine Park Authority)
49. Crown-of-thorns starfish outbreaks on Australian coral reefs (Dr P.J. Moran, Australian Institute of Marine Science; Dr B. Lassig & Dr L.P. Zann, Great Barrier Reef Marine Park Authority)
50. Outbreaks of coral-eating snails on Australian coral reefs (Dr A. Ayling, Sea Research, Daintree)

Issues in the marine environment around Australia

51. Issues in Queensland's marine environment (D. Tarte, M. Hall & K. Stocks, Australian Littoral Society)
52. Issues in New South Wales' marine environment (Dr R. Macdonald (issues) & N. Philip (sewage), Environment Protection Authority of New South Wales)
53. Issues in Victoria's marine environment (R. Winstanley, Victorian Fisheries Research Institute)
54. Issues in Tasmania's marine environment (C. Rees, for Parks and Wildlife Service, Department of Environment and Land Management)
55. Issues in South Australia's marine environment (Dr K. Edyvane, South Australian Research and Development Institute (Aquatic Sciences)
56. Issues in Western Australia's marine environment (Dr J.A. Stoddart, Kinhill Engineers & Dr C. J. Simpson, Environmental Protection Authority)
57. Issues in the Northern Territory's marine environment (Dr R. Hanley, Northern Territory Museum)

Marine environmental management and conservation

Administrative and legal aspects

58. Australia's maritime zones, international borders and intergovernmental arrangements on the marine environment (Dr V. Prescott, Uni. Melbourne; Dr. A. Bergin, Australian Defence Force Academy, Canberra; & Dr M. Howard, Uni. Tasmania)
59. Environmental impact assessment (Dr A. Martyn & Prof. B. Boer, Faculty of Law, Uni. Sydney)
60. Protection of marine species: national and international responsibilities (Dr I. Ivanovici, G. Anderson, F. Antram, B. Male, R. Moore & K. Weaver, Australian Nature Conservation Agency)

Management framework

61. Ecologically sustainable development: the National Strategy and implications for marine environmental management (S. Driml, Australian National Uni., Canberra & Dr L.P. Zann, Great Barrier Reef Marine Park Authority)
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67. Assessment of marine protected areas in Australia (C. Bleakley, Great Barrier Reef Marine Park Authority, Dr I. Ivanovici, Commonwealth Environmental Protection Agency & P. Ottesen, Great Barrier Reef Marine Park Authority)
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73. National Nature Reserves (M. Griffin, ANCA)
74. The Torres Strait Protected Zone (Dr D. Lawrence & Dr W. Gladstone, Great Barrier Reef Marine Park Authority)
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Marine conservation and marine protected areas in Australian States and Territories

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Division of Wildlife and Ecology); Australian Institute of Marine Science; Department of Foreign Affairs and Trade; Department of the Prime Minister and Cabinet; Department of Primary Industries and Energy; Hydrographic Office, Royal Australian Navy; Department of Tourism; Department of Transport (including Australian Maritime Safety Authority); Australian Fisheries Management Authority; Bureau of Resource Sciences; Australian Nature Conservation Agency; and Aboriginal and Torres Strait Islander Commission.

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Glossary of technical terms

absorption: Disappearance through incorporation in something else.

acute: Having a sudden onset, lasting a short time. (Opposite to **chronic**).

adsorption: The retention of materials on the surface of solid particles, including organisms and substrates.

anthropogenic: Created by humans.

aquaculture: Cultivation of fish, molluscs, and other aquatic organisms in fresh or salt water for human use.

Australian Fishing Zone (AFZ): Proclaimed 200 nautical mile wide zone around the coast within which Australia controls domestic and foreign access to fish resources.

bathymetry: The measurement of ocean depths to determine the sea floor topography.

benthos (benthic): All marine organisms living upon or in the bottom of the sea.

bioaccumulation: The process by which chemicals are taken up by organisms leading to a concentration of the substance in their tissues.

bioavailability: That portion of a chemical compound or element that can be taken up readily by living organisms.

bioconcentration: Ability of organisms to selectively accumulate certain substances within their bodies.

biogenic: Materials produced by the actions of living organisms.

biodiversity: The variety of all life forms: the different plants, animals and micro-organisms, the genes they contain and the ecosystems they form. It is a concept that emphasises the inter-relatedness of the biological world. It is often considered at three levels: genetic diversity, species diversity and ecosystem diversity.

biogeographic: Relating to large regions with distinct fauna and flora.

biological oxygen demand: Measure of oxygen depletion in water due to bacterial decay of organic pollutants. Gives an indication of how much organic matter is in the water.

biomagnification: Build-up of contaminants in organisms in successively higher trophic levels.

biomass: As measured by ecologists, the dried weight of all organic matter in the ecosystem.

bioregion: A large area with distinct fauna and flora.

biota: Collectively, the plants, micro-organisms and animals of a region.

bloom: A proliferation of plants (such as macroalgae or phytoplankton) during favourable growing conditions generated by nutrient or sunlight availability.

by-catch: Species taken incidentally in a fishery where other species are the target. By-catch species may be of lesser value than the target species, and are often discarded.

cetaceans: Members of the mammalian group *Cetacea*, including whales, dolphins and porpoises.

chlorophenols: A group of toxic chemicals used as biocides, herbicides and insecticides, and most commonly, for wood preservation.

chlorophyta: The green algae.

chronic: Having a continuous or persistent effect. (Opposite to **acute**).

coastal: The region extending seaward and inland from the shoreline that is influenced by, and exerts an influence on, the seas and their resources and biota.

coastal strip: Various definitions. Taken here as the area extending three kilometres inland (or further inland where there are marine sediments) from the low tide mark.

coastal zone: Various definitions. Taken here as the area of land and sea, extending landward to the edge of the coastal-draining rivers, and seaward to the edge of the 200 mile EEZ.

coliform: A group of bacteria used as an indicator of sanitary quality in water.

contaminant: Any physical, chemical or biological substance (usually man-made) which is introduced into the environment. Does not imply an effect (see **pollution**).

crustaceans: A class of arthropods which have gills and bodies covered by a hard shell (e.g. crabs, lobsters, shrimps, barnacles).

DDT: An organochlorine insecticide used to control a variety of insect pests, but now banned in some countries because of its persistence in the environment.

dinoflagellates: A group of single-celled algae.

dioxins: Chemical compounds largely formed as waste products or by-products in the manufacture of other chemicals (e.g. by municipal incinerators, motor vehicles, herbicides and sewage sludge). Some are hazardous to humans at relatively low levels.

dredge spoil: Sediments and materials removed from the seabed as a result of dredging activity.

ecology: Study of living organisms and their relationships to one another and the environment.

ecologically sustainable development (ESD): Development which meets the needs of the present without compromising the ability of future generations to meet their needs. A development which is compatible with the continuing functioning of essential ecological processes.

ecosystem: The physical and chemical environment of a community of organisms, and all the interactions among those organisms and between organisms and their environment.

ecotourism: Nature-based tourism that involves education and interpretation of the natural environment and is managed to be ecologically sustainable.

ecotoxicology: The study of the fate and effects of pollutants in natural ecosystems.

effluent: A complex waste material which is a by-product of human activity (e.g. liquid industrial discharge or sewage).

endemic: 'Native' species confined to a given region (e.g. a species endemic to southern Australia is not found anywhere else).

endangered species: A plant, animal or micro-organism that is in immediate danger of biological extinction (see **threatened species**).

environmental impact assessment (EIA): Formal process or document prepared primarily to identify potential impacts of proposed laws or projects that may affect the environment.

estuaries: The areas of inlets or mouths of rivers which are influenced by the tides and where salt and fresh waters mix.

eutrophication: Increase in the nutrient status of a water body, and consequently the rapid growth of plants, both natural and as a result of human activity. Excessive plant production may deplete oxygen and suffocate animals.

Exclusive Economic Zone (EEZ) : Concept proposed at the UN Law of the Sea Conference, whereby coastal states assume jurisdiction over the exploration and exploitation of marine resources in their adjacent section of continental shelf taken arbitrarily to be a band extending 200 nautical miles from the shore or baseline.

food chain: A specific nutrient and energy pathway in ecosystems proceeding from producer to consumer.

food web: Complex intermeshing of individual food chains in an ecosystem.

ghost fishing: Damaged/abandoned fishing gear (e.g. nets) which continue to trap fish etc.

gillnets: Fishing nets designed to ensnare fish by the gills.

grazers: Animals which eat plants (e.g. algae) by cropping.

guideline: Directing principle for action. Also, numerical concentrations to maintain a designated use (e.g. water use).

habitat: A geographic area that can provide for the key activities of life.

hazardous waste: Any harmful solid, liquid or gaseous waste product of manufacturing or other human activities which by its nature is inherently dangerous to handle or dispose of.

heavy metals: Metallic elements with relatively high atomic weights (over 5.0 specific gravity), such as lead, cadmium, arsenic and mercury. Generally toxic in relatively low concentrations to plant and animal life.

hydrocarbons: Organic molecules containing hydrogen and carbon. Major components of petroleum released during the incomplete combustion of organic fuels.

inorganic: Matter other than plant or animal, and not containing a combination of carbon/hydrogen/oxygen as in living things.

invertebrates: Animals without internal skeletal structure. Range from protozoans to sea squirts.

littoral: Of or pertaining to a shore, especially a seashore. The specific zone of the sea floor lying between tide levels.

longline: A fishing line consisting of many hooks or lures which may be bottom set or drifting.

macroalgae: Large algae (e.g. kelp).

marine environment: The maritime area extending, in the case of watercourses, up to the freshwater limit and including intertidal zones and the shoreline, estuary, bay, harbour, nearshore and offshore waters.

marine mammals: Animals of the ClassMammalia having glands for nourishment of young, and living in or depending upon the sea (e.g. whales, seals, dugongs).

micro-organism: Any microscopic organism, including bacteria, viruses, single-celled algae and protozoans.

monitoring: Routine counting, testing or measuring of environmental factors or biota to determine their status or condition.

nearshore: The zone extending seaward from the shore to a distance where the water column is under minimal influence from continental conditions.

nitrification: The process whereby ammonia compounds etc. are oxidised to nitrites or nitrates, especially by bacterial action.

non point-source pollution: Diffuse source of pollution such as an eroding field, urban and suburban lands, and forests. (Compare with **point-source pollution**).

nutrients: Elements or compounds essential as raw materials for organic growth and development such as carbon, oxygen, nitrogen and phosphorus.

oceanography: The scientific study and exploration of the oceans and seas in all their aspects, including all processes in the oceans and interactions and relations with earth and the universe.

offshore: The comparatively flat zone of variable width extending from the outer margin of the shore to the edge of the continental shelf.

organic: Of chemical compounds based on carbon chains or rings, and also containing hydrogen with or without oxygen, nitrogen or other elements.

organochlorine: A chlorine containing hydrocarbons. Includes many pesticides and industrial chemicals.

organotins: Organic chemicals bonded to the tin atom. A powerful biocidal agent against a wide spectrum of fouling and boring organisms (mainly as tributyl tins). High toxicity to all marine organisms.

pelagic: Associated with the surface or middle depths of a body of water.

phaeophyta: Brown algae or seaweeds.

pinnipeds: The seals, sealions and walruses.

plankton: Aquatic, free drifting, suspended organisms (plants: phytoplankton; animals: zooplankton).

point-source pollution: Easily discernible stationary source of pollution such as a factory. (Compare with non-point source pollution).

pollution: The introduction by man, directly or indirectly, of substances or energy into the marine environment, including estuaries, which results or is likely to result in such deleterious effects as to harm living resources and marine life, be hazardous to human health, hinder marine activities, including fishing and other marine uses, or impair the quality of sea water and reduce amenities.

polychlorinated biphenyls (PCBs): Group of chlorinated organic compounds, that are non-corroding and resistant to heat and biological degradation and used as insulation in electrical equipment. Capable of biomagnification; disrupt reproduction in some species.

primary waste-water treatment: First step in sewage treatment to remove large solid objects by screens (filters) and sediment and organic matter in settling chambers (see **secondary** and **tertiary waste-water treatment**).

protozoa: Group of single-celled animals.

rare species: Of small population size. May or may not be at risk of becoming endangered.

recolonisation: Reappearance of a population of organisms in a given location or habitat.

red tide: A reddish discolouration of coastal surface waters due to concentrations of certain toxin-producing dinoflagellates (microscopic planktonic organisms) and often a cause of major fish kills and paralytic shellfish poisoning.

rhodophyta: The red algae or seaweeds.

secondary waste-water treatment: After primary treatment, removal of biodegradable organic matter from sewage using bacteria and other micro-organisms, inactivated sludge or trickle filters. Also removes some of the phosphorus (30%) and nitrate (50%).

sediment: Soil particles, sand and other mineral or organic matter eroded from land and carried in surface waters.

sessile: Organisms fixed in one position to a substrate.

shellfish: An aquatic invertebrate, such as a mollusc or crustacean, that has a shell or exoskeleton. Usually refers to molluscs such as clams, mussels.

siltation: Sediments deposited by water in channels, harbours etc.

species: A group of plants, animals or micro-organisms that have a high degree of similarity and generally can interbreed only among themselves.

substrate: (Biological) Base of substance upon which an organism is growing. (Hydrological) The bottom material of a waterway.

subtidal: Below the low-water mark.

supratidal: Above high-water mark and the spray zone.

surfactant: A material that facilitates and accentuates the emulsifying, wetting and other surface-modifying properties of substances.

suspended solids: Any solid substance present in water in an undissolved state, usually contributing directly to turbidity.

tailings: Second grade or waste rock fragments derived from screening or processing of raw ores.

tertiary waste-water treatment: Removal of nitrates, phosphates, chlorinated compounds, salts, acids, metals and toxic organics after secondary treatment.

thermocline: Region below the surface layer of the sea, where temperature declines rapidly with increasing depth.

threatened species: Plant, animal or micro-organisms which may be common in parts of their range but are severely depleted in others.

toxicity: The inherent potential or capacity of a material to cause adverse effects in a living organisms.

toxic industry: One which manufactures, utilises, or produces as a by-product any substance which may adversely affect the health of organisms.

trophic: Relating to processes of energy and nutrient transfer from one or more organisms to others in an ecosystem.

turbidity: The cloudy conditions caused by suspended solids in liquid.

uptake: A process by which materials are transferred to an aquatic organism.

waste-water: Water that carries wastes from homes, businesses, and industries; a mixture of water and dissolved or suspended solids.

wetlands: Land areas along fresh and salt water (coastal wetlands, such as salt marshes, tidal basins and mangrove swamps) that are flooded all or part of the time.

Major acronyms

ABRS	Australian Biological Resources Study
ABS	Australian Bureau of Statistics
AGSO	Australian Geological Survey Organisation
AMSA	Australian Maritime Safety Authority
ANCA	Australian Nature Conservation Agency
ANZECC	Australian and New Zealand Environment and Conservation Council
APEA	Australian Petroleum Exploration Association
ATSIC	Aboriginal and Torres Strait Islander Commission
BRS	Bureau of Resource Sciences
BTCE	Bureau of Transport and Communications Economics
CALM	Department of Conservation and Land Management (WA)
CEPA	Commonwealth Environment Protection Agency
CoA	Commonwealth of Australia
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DASET	Department of the Arts, Sport, the Environment and Territories (Commonwealth)
DEST	Department of the Environment, Sport and Territories (formerly DASET)
EEZ	Exclusive Economic Zone
ESD	Ecologically Sustainable Development
FAO	Food and Agriculture Organisation of the United Nations
GBRMP	Great Barrier Reef Marine Park
GBRMPA	Great Barrier Reef Marine Park Authority
GDP	Gross Domestic Product
HORSCERA	House of Representatives Standing Committee on the Environment, Recreation and the Arts
IMO	International Maritime Organisation
IOC	International Oceanic Commission
IUCN	International Union for the Conservation of Nature and Natural Resources - World Conservation Union
MARPOL	International Convention for the Prevention of Pollution from Ships
MPA	Marine Protected Area
NATPLAN	National Plan to Combat Pollution of the Sea by Oil
NP	National Park
PAHs	polycyclic aromatic hydrocarbons
PCBs	polychlorinated biphenyls
RAC	Resource Assessment Commission
SARDI	South Australian Research and Development Institute
SOMER	State of the Marine Environment Report (for Australia)
TAFE	Technical and Further Education
TBT	tributyl tin
UN	United Nations
UNCED	United Nations Conference on Environment and Development
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
WCED	World Commission on Environment and Development

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