Australia has responsibility for one of the world's largest ocean territories. With the right to access this territory comes the obligation under the United Nations Convention on the Law of the Sea to conserve resources, combat pollution and advance exploration and marine research.

Sharing the bounty

In the relative wilds of the Great Australian Bight – an area roughly the size of Victoria – tuna fishers set their lines as they have done for more than 40 years. Beneath their boats is a unique collection of marine life, 80% of which is found in southern Australia and nowhere else on earth. Beneath the seabed, mining companies search for minerals, oil and gas. From surrounding cliff tops, ecotourism operators keep watch for whales which have bred here for thousands of years.

In October 1997, the Federal Minister for the Environment, Senator Robert Hill, announced a proposal to establish in the Bight Australia's second-largest marine park (the first in southern temperate waters). The proposal sets in motion the Government's policy of developing a national representative system of marine protected areas to balance the needs of resource use and biodiversity conservation.

In the Bight, striking this balance would require restricting fishing activities. In one area of the park, fishing would be banned for six months of the year to allow whale breeding. In another section – a 20 nautical mile strip from the state park boundary to the edge of Australia's Exclusive Economic Zone (EEZ) – surface fishing would be permitted, but trawling banned to protect the seabed.

Fishers say the proposed two-million-hectare marine park will cost thousands of jobs in an industry worth $100 million a year. Conservationists say the park will protect the endangered southern right whale, the Australian sea lion, and unique seabed dwelling species. But they also want a ban on mineral exploration and extraction in the park's protected areas during the public comment period, and the extension of the seabed protection area to include pelagic species such as the southern bluefin tuna. The Government is awaiting public opinion on its marine park proposal.

Tools for growth

The challenge to sustainably manage South Australia's marine resources is echoed far across Australia's ocean territory which covers 16.1 million km^2 (including the 11 million km^2 EEZ). With the right to access this expanded territory, granted in 1994, came an obligation under the United Nations Convention on the Law of the Sea to conserve both living and non-living resources, combat pollution and advance exploration and marine research.

This means developing strategies for sustainably managing burgeoning industries based on minerals, petroleum, fishing, pharmaceuticals and biotechnology. Their combined value is $35 billion annually, and is expected to reach $80 billion by 2020.

One of the greatest impediments to achieving economic development and conservation goals is the lack of knowledge of the oceans under Australia's jurisdiction. The largest scientific team dedicated to filling the knowledge gaps is led by Dr Keith Sainsbury of CSIRO Marine Research, Hobart.

Sainsbury says successful multiple use of the oceans must consider the cumulative and interactive effects of human activities, rather than considering each impact in isolation – a lesson that has been learned the hard way on land. Also needed is a substantial increase in Australia's capacity to monitor and observe the ocean, linked to a precautionary management approach, he says.

Sainsbury says the developing Patagonian toothfish fishery in Australia's sub-Antarctic waters illustrates clearly the need for multiple-use management of marine industries.

'Here is a valuable fisheries resource in an environmentally-sensitive area,' Sainsbury says. 'It is our role as scientists to provide the information needed to ensure the integrity of the sub-Antarctic ecosystem is maintained, while balancing the need for wealth generation for Australia.

The Patagonian toothfish, which grows to two metres and 100 kg, has been harvested commercially for 12 years. This surprisingly recent exploitation is due the fish's remote habitat: down to 1500 m beneath the sea surface, often in the far reaches of the Southern Ocean.

In 1994, an Australian developmental fishery began for the Patagonian toothfish around Macquarie Island. But it wasn't until October 1997, when military helicopters helped apprehend two foreign fishing vessels suspected of illegal fishing further south at Heard and McDonald islands, that the toothfish came to the attention of many Australians. The high seas drama highlighted both the plight of the toothfish, and the vastness of Australia's ocean territory.

The Australian Antarctic Division has been monitoring the fishery since 1994. The 1997-1998 quota of 1500 tonnes is about half the level that the division believes to be sustainable for the newly discovered fishing areas around Macquarie Island.

Two new research projects funded by the Fisheries Research and Development Corporation began this year to identify the distribution, movement, and abundance of toothfish around Macquarie Island, examine ecological effects of fishing, and provide advice on management strategies.

The projects, by CSIRO Marine Research, the Australian Antarctic Division, and the Australian National University, with support from Austral Fisheries, are seen as a stepping stone to the development of an Australian Southern Ocean fishery.

Deep secrets

Exploration and management elsewhere in Australia's EEZ is also in its early stages, and could be compared to the situation of terrestrial Australia 150 years ago.

Dr Keith Sainsbury: 'The developing Macquarie Island Patagonian toothfish fishery provides an excellent example of the need for multiple-use management of marine industries'.

A Patagonian prize

IN the 1960s, when the United States and Russia tested nuclear weapons above ground, clouds of radioactive carbon filled the atmosphere. This radiation eventually ended up in the ocean, some of it being incorporated as a pulse of carbon 14 into the bones of animals.

The age of fish that were alive during the testing can be determined by analysing their ear bones. Fish ear bones (otoliths) are a useful tool for determining age because they grow in successive concentric rings, in a similar way to the growth rings of trees. By counting the number of rings laid down since the pulse of carbon 14, Dr John Kalish from the Australian National University has estimated toothfish live for at least 35 years. This information is critical for understanding the productivity of the fishery.

With the help of observers from the Australian Fisheries Management Authority, Dr Dick Williams from the Australian Antarctic Division is using tagging to investigate the abundance, movement and growth of Patagonian toothfish around Macquarie Island. The toothfish are brought on deck, tagged with both internal electronic tags and external plastic tags and then released. Because toothfish lack swim bladders, they survive the enormous pressure change, swimming straight back down to depth on their return to the water. When the fish are recaptured by commercial vessels, the tags are returned to the researchers. Internal tags are automatically detected on the fish processing line.

Only about 5% of Australia's 11 million km^2 EEZ has been mapped. In recent years, a volcanic province the size of Iceland was discovered off the Western Australian coast, and a cluster of deep-sea volcanoes, deeper than Australia's highest mountain, Mt Kosciusko, have been discovered off Tasmania, close to the orange roughy fishing grounds.

In the the past decade, 800 new species of fish have been identified in Australia's marine territory, indicating a biodiversity that is high on a global scale. The few surveys conducted of the upper continental slope (200-400 m depth) have already discovered more than twice the number of species found on similar slopes in the Atlantic after decades of extensive surveys by the United States and Europe. But for ocean depths below 1500 m – which is more than 70% of the entire Australian ocean jurisdiction – almost nothing is known.

Research by CSIRO into tropical and pelagic fisheries is managed by Dr Ian Poiner. He says managing the marine environment for multiple use will guard against the tyranny of many small decisions. 'A decision about a particular development could occur without considering the whole ecology of the area, the cumulative effects on the marine environment,' he says. 'Potential "downstream" effects of such development could be more costly than any benefit derived from it.'

Developments on land can have significant effects on the marine environment. An example is the suggestion to dam rivers draining into the southern Gulf of Carpentaria to develop intensive agriculture. While the dams and weirs may have served local agriculturists, they would have been detrimental to the northern prawn fishery – worth $100-$200 million each year – because of impacts of changed water flows on the habitats of juvenile prawns.

Poiner says northern Australia is experiencing increasing development pressure from a diversity of land and sea uses. Significant knowledge gaps need to be overcome, especially relating to the impacts of catchments and their associated land uses on the tropical coastal zone, and scientific information needs to underpin the development and implementation of negotiated approaches to multiple-use management.

Slicing the pie

Zoning is an obvious way of objectively dividing up the marine 'pie'. Zoning for particular uses to separate and control incompatible uses was identified as a marine environment strategy in the *State of the Marine Environment Report* (1995). Zoning and marine protected areas are also recommended for inclusion in Australia's National Ocean Policy by a multi-agency team led by Drs Sainsbury and Ward from CSIRO.

Perhaps the most notable example of working marine zoning is provided by the Great Barrier Reef Marine Park – the world's largest multiple-use marine park area. The park, which covers 350 000 km^2, is managed by the Great Barrier Reef Marine Park Authority whose task is to 'provide for the protection, wise use, understanding and enjoyment of the Great Barrier Reef in perpetuity'. A system of zoning and permits controls the park's various uses: fishing, tourism, traditional hunting, and shipping.

Monitoring of the effects of these activities on the biota and reef system is an important feature of multiple-use management. For example, Dr Roland Pitcher from CSIRO's tropical and pelagic research team has shown intensive prawn trawling can cause incremental degradation to areas between the coral reefs. From experiments on the effects of trawling, it was shown that each trawl removes between 10% and 15% of seabed species and fish.

While trawling appears to be extensive throughout the Great Barrier Reef region, only small areas are fished intensively and it is likely that trawling can be managed sustainably. Monitoring the recovery of these systems after experimental trawling is under way, but poor knowledge of the intereef ecosystems is hampering efforts to assess effects of fishing.

In separate studies, Pitcher's team is mapping the seabed fauna of continental shelf areas between the reefs to build a picture of the habitat and ecosystem that supports fisheries in the region. This is particularly important in light of new accurate position-fixing technology which is allowing fishers to work closer to reefs and into areas that were previously regarded as untrawlable and acted as a refuge because of uncharted reefs.

In one survey of deep-ocean seamounts off southern Tasmania, new species have been found in virtually every animal group, from corals and hydroids to crabs and fish. In 1995, the deep-sea seamounts were made an interim marine protected area with agreement from the fishing industry.

The northern prawn fishery is trialing bycatch reduction devices to exclude from the nets non-target species such as turtles. These pictures contrast catches made with (below left) and without the devices (below).

The kind of information revealed in this study is essential to underpin the Government's national system of marine protected areas. It helps managers to zone activities in a way that protects representative ecosystems and areas of high conservation value, while allowing activities such as fishing in other areas.

CSIRO marine ecologist Dr Nic Bax reports a similar situation in Australia's south-east fishery which has been trawled since early this century, but still has unfished areas at all depths which house a great diversity of life forms on pristine reefs. 'These areas have acted as the insurance policy for the system, and many fishers are keen to have them protected in an equitable and enforceable manner,' Bax says.

This is a 'win-win' outcome. To sustain an ecosystem and the fisheries it supports, you need intact habitat, Bax says. If we can identify critical habitats and ensure they are protected, all uses of the marine environment will benefit in the long term. These areas need not be closed to use, but only protected from destructive uses.

'Zoning does not mean doing nothing; it means setting up appropriate uses for different areas, and ensuring you have them right,' Bax says. 'You may have a particular area where no trawling is allowed, but drilling for oil and gas is permitted, or, conversely, an area where fishing is allowed alongside tourism, but exploratory drilling is excluded.'

Surprisingly, management on the basis of ecosystems rather than single species can often yield results that are counter-intuitive. 'It may seem contradictory that oil and gas development may have benefits for marine biodiversity, but when a pipeline is laid you create an area that is restricted to shipping and can't be fished by mobile gear,' Bax says.

'It is in fact a de-facto refuge and conservation unit – an area bound by a pipeline – policed by the oil industry where marine life is not subject to fishing pressure for fear that oil and gas infrastructure would be damaged by mobile trawl gear.'

Taming tourism

Tourism generates more than $16.1 billion each year in Australia, and employs more than 535 000 people. Forecasts predict tourism will generate $20 billion by the year 2000. With most of Australia's tourism concentrated in the marine and coastal zone, continued growth will increase pressure on the environment upon which the industry relies.

Dr David Die from CSIRO's Cleveland Laboratory, has proposed a research project for Queensland's Wide Bay region to map environmental and infrastructure characteristics relevant to tourism. The results of the pilot study would eventually be related to the broader Queensland coastline. 'Only when such broad-scale characteristics are defined can coastal planners assess how to fulfill the requirements for development and minimise its impact on the coastal and marine environments,' Die says.

Multiple use of the seas is a challenge that can not be achieved without solid baseline information on the marine environment. Stakeholders, such as tourist operators, fishers, miners, and local councils that pass sewage into the sea will need to meet performance measures based on these principles, and scientific support will need to underpin decision making about potential and present uses.

To this end, marine scientists around Australia are mapping, exploring and monitoring Australia's ocean territories as fast as their funding can carry them.

Australia's north-west region supports a range of expanding industries including oil and gas extraction, commercial fishing, aquaculture, and tourism. The Western Australian Government is funding a scientifically-based management program to ensure the sustainability of these industries, as well as protecting the environment. An important aim will be to protect the region's mangrove-lined shores which prevent coastal erosion and consequent silting of adjacent reefs, and provide nurseries for juvenile marine species. Coral reefs protect the shores from violent waves.

Woodside Offshore Petroleum