Assessment REPORT

Resources

Macquarie Island's picture

THE SOUTH-EAST REGIONAL MARINE PLAN

Title:
Resources – Macquarie Island's picture
The South-east Regional Marine Plan
Assessment Reports

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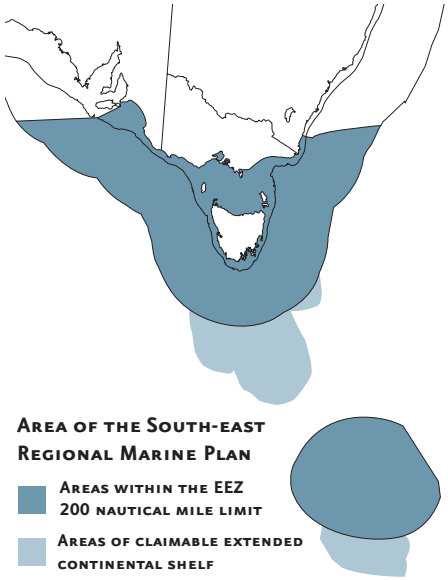
Preface

Australia's Oceans Policy and regional marine planning provides a framework for the people of Australia to explore, use, protect and enjoy our extensive marine resources. As its base, the Policy recognises the need to protect the biological diversity of the marine environment while at the same time promoting and encouraging sustainable, secure marine industries.

Regional marine planning is a way of achieving the *Oceans Policy* vision. It uses large marine ecosystems as one of the starting points for the planning process by creating planning boundaries that are based on ecosystem characteristics – a major step towards ecosystem-based management.

This assessment report is one of six that are an initial step in better managing Australia's oceans. They provide a knowledge base for developing the South-east Regional Marine Plan – the first regional marine plan being implemented under *Australia's Oceans Policy*.

The South-east Marine Region brings together three of the large marine ecosystems: the South-eastern, the South Tasman Rise and Macquarie.



The South-east Marine Region covers over 2 million square kilometres of water off Victoria, Tasmania (including Macquarie Island), southern New South Wales and eastern South Australia.

The Region includes both inshore (State) waters (from the shore to three nautical miles outside the territorial baseline) and Commonwealth waters (from three to 200 nautical miles outside the territorial baseline), as well as the claimable continental shelf beyond the Exclusive Economic Zone.

To build a solid understanding of the complexities of the Region, information on ecosystems and human activities were gathered for both State and Commonwealth waters across six areas:

- biological and physical characteristics – identifying the key ecological characteristics in the Region, their linkages and interactions

- uses within the South-east Marine Region – describing our knowledge of the nature and dimension of human uses and their relationship with each other
- impacts on the ecosystem – providing an objective analysis of how activities can affect the Region's natural system
- community and cultural values – ensuring community wishes and aspirations are reflected in the planning process
- Indigenous uses and values – gaining an understanding of and support for Indigenous interests in the Region
- management and institutional arrangements – analysing current legislative and institutional frameworks to determine the best mechanism for implementing regional marine plans.

Specific scientific projects have filled gaps in our knowledge wherever possible and have clarified some areas in our understanding of the deep ocean's ecosystems. Specialist working groups of stakeholders and experts in their fields have provided invaluable direction and input to the planning process. As well, stakeholder workshops, community surveys and consultations have all helped build our knowledge base and have provided a voice for the people of the South-east Marine Region. Without this consultation, the picture would not be complete.

Moving forward

The six assessment reports are about increasing our understanding and appreciation of the Region's wealth and ecosystem diversity, and starting to define what we want for the Region. From this shared understanding, we will move forward to define a plan that maintains ocean health and supports competitive yet sustainable industries, as well as enhancing the enjoyment and sense of stewardship the people of Australia feel for the oceans.

While the Region includes State coastal waters, the South-east Regional Marine Plan will focus on the Commonwealth ocean waters.

The shared values and understanding of the Region gathered during the assessment stage give us a foundation for building a plan for the Region. The National Oceans Office has produced an Assessment Summary which brings together the key findings of the six assessment reports.

Supporting this Summary is a Discussion Paper which provides topic areas to help communities, industry and government begin discussion on the planning objectives, issues and concerns for the South-east Regional Marine Plan. The Discussion Paper also details the next stage of the planning process for the South-east Regional Marine Plan.

Your input into the regional marine planning process is important. To register your interest or for more information about the South-east Regional Marine Plan, *Australia's Oceans Policy* and the National Oceans Office, visit www.oceans.gov.au, or phone (03) 6221 5000.

Introduction

This report about the Macquarie Island Large Marine Domain is one of a set of National Oceans Office reports covering the assessment of uses in the South-east Marine Region. A broader discussion of uses within the Region can be found in the report *Resources: using our oceans*.

Information about other aspects of the Macquarie Island Large Marine Domain is in the assessment reports examining the biological and physical characteristics, impacts of uses on the natural system and current management and institutional arrangements. These reports can be obtained at www.oceans.gov.au or by contacting the National Oceans Office on 03 6221 5000.

This report describes Macquarie Island and its surrounding waters and provides an overview of the past, present and possible future uses of the Macquarie Island Large Marine Domain. It examines the Domain's early sealing history, its recognition as a World Heritage area, its commercial fishery and the declaration of the world's largest marine protected area in its eastern waters. The report concludes with an assessment of the possible future uses of the Domain.

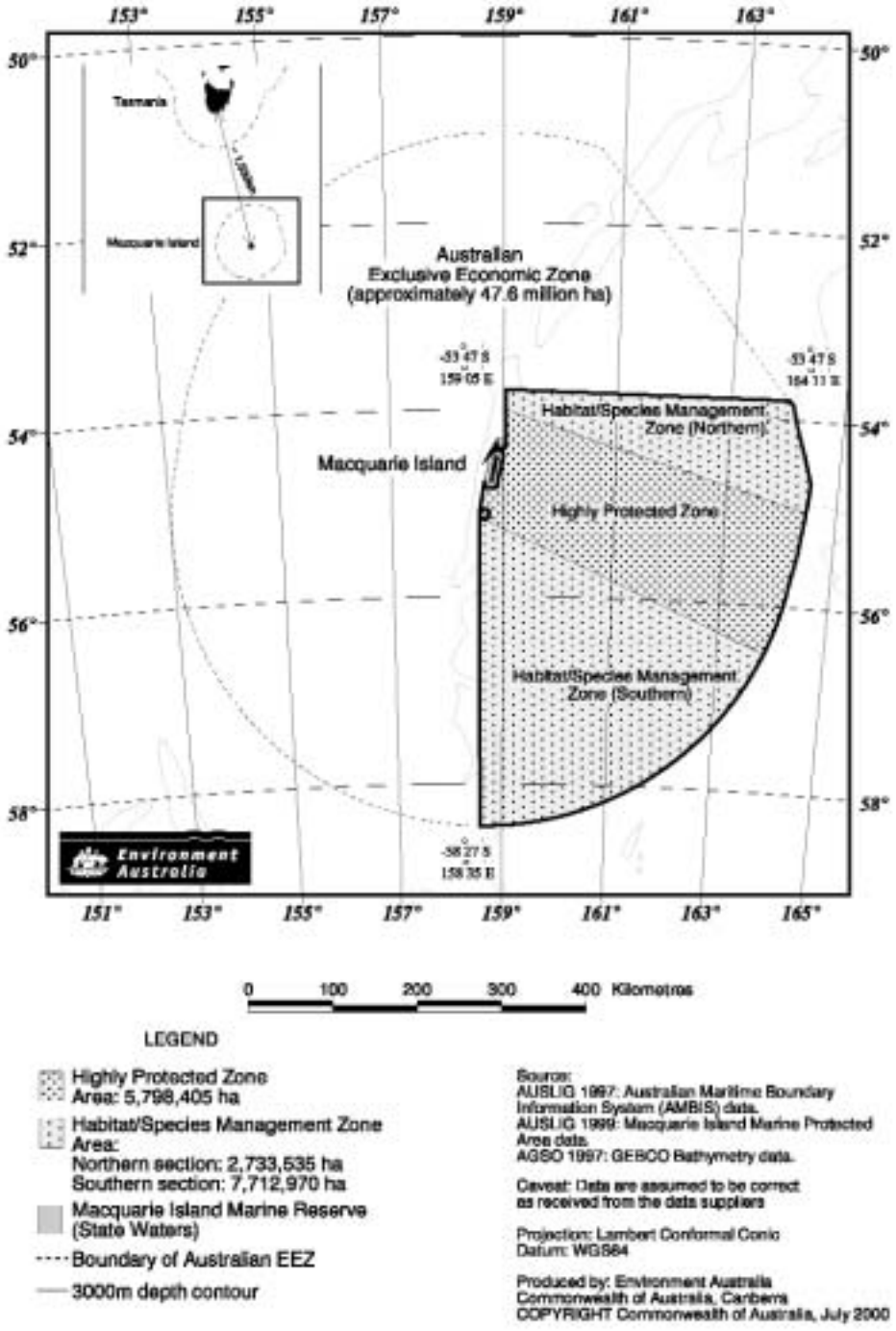
Features of the Macquarie Island Large Marine Domain

Macquarie Island is one of two Australian subantarctic islands in the Southern Ocean. It is located 1500 kilometres southeast of Tasmania and 1300 kilometres north of the Antarctic continent at latitude 54°30'S and longitude 158°57'E. The island is 34 kilometres long and up to 5 kilometres wide with a total surface area of 128 square kilometres (see Map 1). The highest point is Mt Hamilton, at 433 metres. Macquarie Island has two outlying groups of islets: Judge and Clerk, lying about 11 km to the north, and Bishop and Clerk, lying about 37 km south.

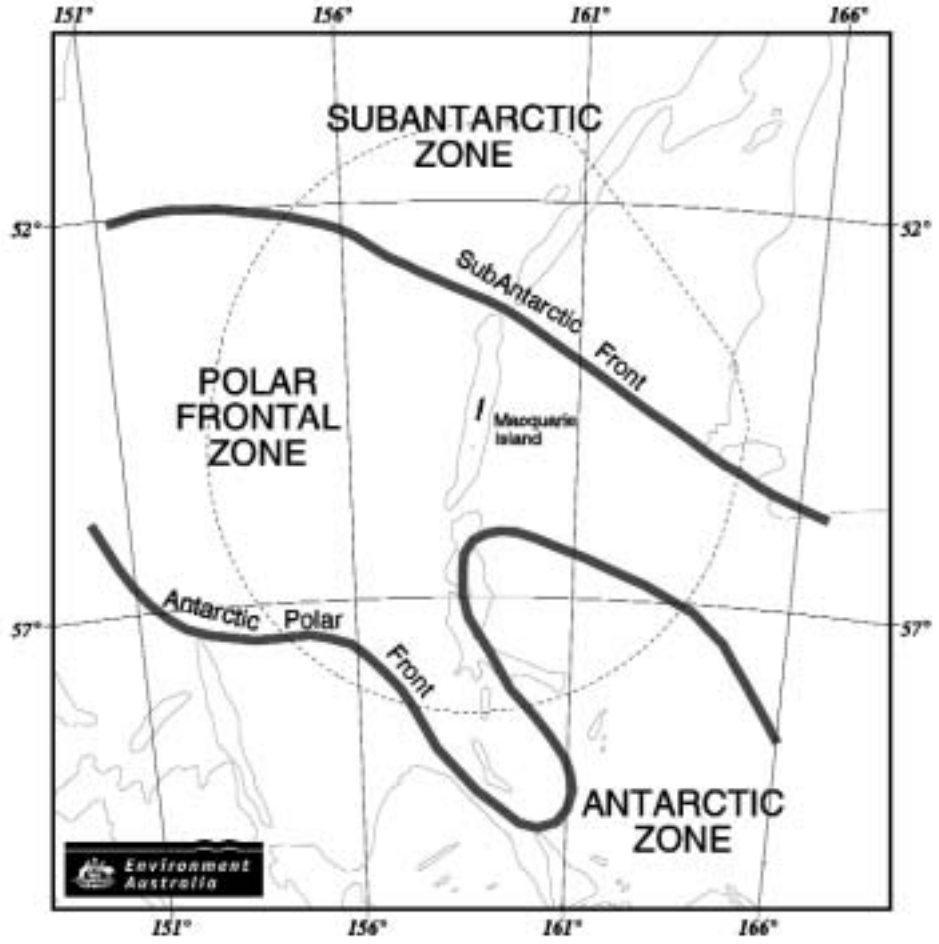
The Island is the exposed crest of the Macquarie Ridge, a spreading north-south ocean floor ridge raised by the integration of the Indian-Australian and Pacific tectonic plates.

The Antarctic Polar Front ocean current is about 55°S, some 20 nautical miles south of Macquarie Island. It is the southernmost limit of the Polar Frontal Zone (the Antarctic Convergence), a complex system that covers about 4° of latitude. The Front moves seasonally and sometimes reaches Macquarie Island, causing a marked drop in surface water temperature. The Macquarie Island region is broadly transitional in terms of surface water temperature and sub-surface water masses (CSIRO 2000).

Map 1: *Location and area of Macquarie Island, and the Macquarie Island Marine Park.*



Map 2: *Major ocean fronts in the Macquarie Island Region.*



0 100 200 300 400 Kilometres

LEGEND

---- Australian Exclusive Economic Zone

— 3000m depth contour

Source:
AUSLIG 1997: Australian Maritime Boundary Information System (AMBIS) data.
Area data.
AGSO 1997: GEBCO Bathymetry data.

Location of fronts and zones adapted from Gordon, 1972 as cited in Robinson and Scott, 1999

Caveat: Data are assumed to be correct as received from the data suppliers

Produced by: Environment Australia
Commonwealth of Australia, Canberra

Projection: Lambert Conformal Conic
Datum: WGS84

The climate is oceanic with a mean monthly temperature of 3.8°C. The mean annual precipitation of 920mm falls on average 312 days of the year. The average wind speed is 18 knots and humidity averages 89% (Selkirk et al. 1990).

The bathymetry, hydrography and ecological productivity of the Macquarie Island Large Marine Domain are discussed in more detail in the National Oceans Office report: *Ecosystems – nature's diversity*.

The distinctive inshore biota around Macquarie Island resembles that of Antarctica. Along the deep submarine ridges the biota is a mixture of Antarctic and cool temperate species normally found well to the north. The cool temperate biota is dominated by New Zealand species and more widely occurring species found off southern Australia (IMCRA 1997).

Macquarie Island is a Tasmanian State Reserve managed by the Parks and Wildlife Service of the Department of Primary Industry, Water & the Environment (DPIWE). It is an International Biosphere Reserve and a World Heritage Area recognised for its unique geological characteristics. It is the only known location in a major oceanic basin where oceanic crust, a mid-ocean ridge, has been lifted above sea level.

The Macquarie Island Large Marine Domain includes Commonwealth waters, extending from the 12 nautical miles territorial sea around Macquarie Island and its islets out to the edge of Australia's Exclusive Economic Zone (AEEZ). The AEEZ is 200 nautical miles, except in an area to the northeast (around Auckland and Campbell Islands) where it abuts the New Zealand EEZ. The area of the AEEZ around Macquarie Island is about 469 000 km^2. The whole southeastern quadrant of the AEEZ coincides with the 16.2 million hectare (162 000 km^2) Macquarie Island Marine Park (see Map 1 and Table 1).

There are no permanent inhabitants of Macquarie Island although the Australian National Antarctic Research Expeditions (ANARE) have occupied a research station there since 1948. The only access to the island is by sea and there are no harbours or landing facilities. Shipping traffic in the area is minimal and is mainly resupply vessels for the station and tourist vessels. Entry to Macquarie Island is by permit only.

Table 1:
Areas of zones making up Australia's marine jurisdiction around Macquarie Island.

Australian landmass	**7 683 017**
Macquarie Island landmass	**124**
Coastal waters (3nm)	795
Territorial waters (12nm)	4 594
AEEZ (200nm)	469 587
Extended Continental Shelf (ECS) beyond AEEZ	
Conservative ECS	81 115
Extra ECS area	24 973
Maximum ECS	106 088
Continental Shelf (including AEEZ)	
Conservative	550 702
Maximum	575 675
Adjacent area off Tasmania	2 135 275
Total marine jurisdiction	**580 269**
Total jurisdiction (onshore and offshore)	**580 393**

Source: AGSO 2000b. Page 55.

Brief history of early use

Macquarie Island was first discovered by Captain Frederick Hasselburgh of the *Perseverance* while searching for fur seals in waters south of New Zealand. When the *Perseverance* was blown off course, he came across an unchartered subantarctic island southwest of Campbell Island in July 1810. He named the island and its outlying reefs and islets 'the Macquaries' after the Governor of the colony of New South Wales (Morgan 2000). In July 1810, Hasselburgh landed a crew of eight sealers with nine months supplies and returned to Sydney for further men and equipment. Hasselburgh recognised the enormous economic potential for sealing and attempted to keep its location secret. By December 1810, however, another three Sydney-based sealing gangs were operating on the island. In the first 18 months of operations around 120 000 fur seals were killed and shipped back to Sydney.

Macquarie Island was never a base for whaling as its coast offered no safe anchorages (Selkirk et al. 1990).

Exploitation of seals and penguins

In 1813 a gang from the *Mary and Sally* landed at the Isthmus and established a permanent try works for producing oil. Within a decade sealing operations at Macquarie Island had turned exclusively to hunting elephant seals. Huts and try works were located at the Isthmus, Sandy Bay, Lusitania Bay and Caroline Cove.

By 1815 the original population of an estimated 250 000 fur seals had declined dramatically, with only 5000 skins taken during the entire season.

In 1820 Russian explorer Thaddeus Bellingshausen reported that 40 men were working on the island. He left an interesting description of the sealer's hut at Sandy Bay:

> 20 feet long by 10 feet broad, inside it was lined with skins of seals, the outside was covered with a kind of grass which grows on the island. At one end was a small hearth, and a lamp was always kept alight. Beside the hearth was a bedstead. Provisions were stored at the other end of the hut. Inside it was so black and dark from the smoke that the smouldering light from the lamp and from the holes in the wall over which bladders were stretched, scarcely lit the interior of the hut, and until we got accustomed to the light the sealers had to lead us by the hand.
>
> (Debenham, 1945)

Sealers took advantage of the animals' tendency to congregate in large numbers in restricted areas during their breeding season. Fur seals were herded together, clubbed to death and skinned immediately. The pelts were salted and usually stored in timber casks. The larger and slower elephant seals were clubbed and lanced before being stripped of their blubber, which was rendered down to oil in large cast iron cauldrons known as trypots. The oil was allowed to cool before being run into casks, ready for shipping.

By 1830 the fur seal population had been almost exterminated and the elephant seal population reduced to about 30% of its original numbers. After the decline in the seal population only three vessels were recorded as visiting the island between 1830 and 1874, including a sealing party in 1851 and 1852. From 1875 elephant seal oil production was revived by New Zealand entrepreneurs Nichol and Tucker, and Cormack, Elder and Company. Sealing was largely concentrated at the northern end of the Island between the Isthmus and Sandy Bay, but sealing gangs also used existing facilities along the eastern coast (DPIWE 2001a).

Captain Donald Sinclair, who was in charge of one of these sealing gangs, left a detailed account of operations between December 1877 and January 1878. It is clear that the killing and processing of 274 elephant seals so late in the season was an arduous task:

> After shooting the animals, the blubber is cut off and placed in bags which hold about one hundredweight … Sometimes the elephants are shot about eight miles away and the blubber, dripping with blood – which fills the boots and saturates the clothing – has to be carried that distance in the snow, the man picking his way over bogs, around precipices and among boulders as best he may.
>
> (Norman 1989)

Cormack, Elder and Company gradually extended their operations over a decade to include Lusitania Bay and Hurd Point before finally abandoning the Island in December 1884. Intermittent sealing expeditions to the Island continued until 1899.

In 1890 New Zealander Joseph Hatch established extensive processing facilities and a more regular pattern of seasonal work. His gangs of about eight men operated on Macquarie Island for the next 20 years. During this period his low-technology, cheap operation was upgraded to a more intensive and expensive industry using large steam boilers and digesters for producing oil from a wider range of species including penguins.

In April 1891, the Tasmanian Government issued a Government Notice in accordance with the *Tasmanian Fisheries Act 1889* stipulating:

> The taking of seals, whether known by the name seals, elephant seals, or lion seals, or any other local name upon Macquarie Island, and the Islands adjacent there-to in the South Pacific Ocean, being dependencies of the colony of Tasmania, is hereby prohibited.

Hatch's headquarters were initially established at Lusitania Bay where the first digester plant was built in November 1890. Coal, timber and firewood were regular items on the lists of stores taken to the island. In early 1892, Hatch's headquarters were transferred to The Nuggets. Over the years digester plants were also set up at the Isthmus, Hurd Point and Hasselborough Bay. The lack of suitable anchorages continually plagued the landing and loading operations and Hatch lost three vessels, the *Gratitude*, the *Jessie Niccol* and the *Clyde*, at Macquarie Island.

In 1902 Hatch secured a licence for sole occupancy of Macquarie Island from the Tasmanian Government and continued his capital investment in plant and equipment. During the 1913 season the gang obtained 385 casks of sea elephant oil and 447 casks of penguin oil for a total of almost 140 tonnes. The sealers gave the bulls time to form their harems and then killed the bulls for oil. A well-conditioned full-grown animal yielded about half a tonne of oil with a market value from £20 to £25 per tonne. Sealing would have been a profitable industry at the time, if it were not for the high financial toll associated with shipwrecks.

Hatch also exploited the resident penguin population of over three million birds. Initially, operations concentrated on the large king penguin colony at Lusitania Bay and later on the smaller but more numerous royal penguins at The Nuggets. Birds at The Nuggets were herded into a fenced-off enclosure where the 'fats' were picked out and clubbed before being packed into the steam digesters. The Nuggets colonies were the most heavily exploited because they were closest to the works already established for boiling down elephant seals.

The 1891 Government Notice prohibiting the taking of seals was largely ignored due to the difficulties of enforcement. In 1915 Douglas Mawson and other members of the Australasian Antarctic Expedition began a campaign to stop commercial exploitation of Macquarie Island's wildlife by having it declared a Wildlife Sanctuary. Despite continued public denials by Hatch, he was finally forced through the cancellation of his licence and increasing financial difficulties to cease operations at Macquarie Island in February 1920. The last load of oil was taken off in April 1919 and his company was liquidated in April 1920.

After boiling down penguins for oil stopped, the Nuggets' royal penguin colonies increased to cover 40 000 square metres by 1984, a 16.5% increase between 1913 and 1984 (Copson 1987).

Shipwrecks

The Macquarie Island region has a long history of shipwrecks. The first known shipwreck was the *Campbell Macquarie*, 1812, but Captain Smith of the *Aurora* reported pieces of wreckage from a large old-fashioned sailing vessel in 1810. Several other shipwrecks followed with the most recent being the *Nella Dan* in 1987.

Table 2:
Shipwrecks of Macquarie Island

Reported by and date	Vessel	Location
1810 Captain Smith, Master of the *Aurora*	*Unknown wreck*	Captain Smith saw several pieces of wreck of a large vessel, apparently very old and high up in the grass. The origin of this wreck is a mystery. It is likely that the vessel was wrecked elsewhere and floated to the Macquarie islands on the Antarctic Circumpolar Current.
1812 James Kelly, a castaway from the *Campbell Macquarie*, was rescued by the Perseverance, reported the wreck to the Sydney Gazette.	*Campbell Macquarie*	The first known wreck on Macquarie Island. Captain Siddins later set fire to the vessel. Four 'Lascars' (Indian sailors) died while stranded on the Island.
1825 The brig *Cyprus* arrived at Hobart bringing the *Caroline* castaways from Macquarie Island.	*Caroline*	In the early morning of 17 March 1825, the Caroline's cables parted and the ship was blown onto the rocks at a cove now named Caroline Cove. The *Caroline* broke up and her cargo of oil barrels washed ashore.
1838 Bannerman reported this wreck in a 1913 publication, claiming the survivors eked out a miserable existence for two years before being rescued.	*Lord Nelson*	A reef on the north of the Island is named 'Lord Nelson Reef', after a vessel of that name which reputed to have been wrecked there. However, there are no substantiated reports of a Lord Nelson shipwreck in this area.
1851 The *Lord Duncan* rescued the crew of the *Countess of Minto* and took them back to New Zealand.	*Countess of Minto*	The barque *Countess of Minto* arrived in a gale at the north coast of Macquarie Island on 31 November 1851. Suddenly the wind died and the vessel became trapped in the surf. Her steering failed and she started to drift ashore near The Nuggets. Captain Allen dropped two anchors but the vessel soon struck the rocks, rapidly filled with water, rolled and started to break up.
1877 Sealer, Captain Donald Sinclair, noted the presence of this figurehead in his journal.	*eagle figurehead*	A large eagle figurehead was reported at what is now Eagle Cove on the northwest coast in 1877. There are no first-hand reports of an *Eagle* or a ship that might have born an eagle figurehead, trading in the area at the time. The eagle figurehead was probably flotsam of the Antarctic Circumpolar Current.
1877 The *Friendship* took the Bencleugh castaways back to New Zealand in time to spend Christmas with their families.	*Bencleugh*	In August 1877 two furious gales blew the sails away and smashed the wheel. A towering wave broke on board, the bower cable parted and a great white wall of water buried the ship in fathoms of water at Middle Beach. Crewman, Henry Whalley, son of a Tasmanian Aboriginal woman taken by sealers to Kangaroo Island, later died from injuries sustained during the wreck.

Reported by and date	Vessel	Location
1891 An extensive search for this steamship by the New Zealand proved fruitless.	*Kakanui*	The *Kakanui* was chartered by the New Zealand Government to rescue a stranded gang of Joseph Hatch's sealers. The *Kakanui* collected six men and two boys from Lusitania Bay and sailed into a fierce storm.
1890 The *Tutanekai*, leased by Joseph Hatch, was sent to Macquarie Island in search of the Gratitude.	*Gratitude*	On 10 November 1898, the *Gratitude* was damaged by a huge wave breaking on board. The anchor lost its hold and the ketch drifted swiftly towards the reef. She beached at Nuggets Bay where rough weather for a further two days badly damaged her side. In late November waves threw the wreck above the high water mark. There were no casualties of this shipwreck.
1910 A gang of sealers employed by Joseph Hatch.	*Jessie Niccol*	A sealing gang employed by Joseph Hatch was rafting barrels of oil to the *Jessie Niccol* when a storm arose. She slipped her moorings that night and drifted onto the rocks. Three men drowned, including the master, who allegedly went down with the ship to avoid the ire of his employer, Hatch.
1911 The wreck of the *Clyde* was witnessed by a sealing party that had earlier survived the *Jessie Niccol* shipwreck.	*Clyde*	The schooner *Clyde* arrived on Macquarie Island on 13 November 1911 in a treacherous southeasterly gale. Her anchors dragged and she was blown close to shore on North East Bay. Captain Smith let out the spare anchor and tried to wait out the storm but the *Clyde* lost her two anchors during the storm and drifted close inshore. She struck a reef then swung broadside to the sea. A huge wave lifted the vessel over the reef about 50 feet from shore. She washed broadside onto the beach. There were no casualties.
1914 The Australian Government organised an extensive search for the *Endeavour* but found no trace of her. Weather records showed that the vessel would have met heavy weather approximately 200 nautical miles from Macquarie Island.	*Endeavour*	The Australian Government's fisheries research vessel *Endeavour* left Macquarie island for Hobart at the end of 1914 after bringing new staff and supplies to the island. The boat left in a heavy fog, carrying twenty one men, including the Director of Australian Fisheries.
1973 Peter Hill and Bob Thompson from ANARE discovered a headless female figurehead at Sellick Bay.	*This may have belonged to the composite clipper Torrens, which met an accident at sea in 1899.*	The link to the *Torrens* is postulated by Roberts and Morgan (2000). This clipper was en route from London to Port Adelaide when she met with an accident at sea in the vicinity of the Crozet islands. Her bow was extensively damaged and her figurehead dislodged.
1987 The Australian Antarctic Division	*Nella Dan*	On 3 December 1987 winds blew the *Nella Dan* onto rocks in Buckles Bay where she was anchored close to the Macquarie Island station. Divers later inspected her hull and declared the damage too great to justify a salvage attempt. She was towed out to sea and scuttled.

Source: Morgan, A (2000)

Research

Formal scientific investigations of Macquarie Island and the Antarctic Region began in 1911. Organised and led by Dr Douglas Mawson, the Australasian Antarctic Expedition (AAE) carried out extensive scientific observations including biological and oceanographic research from the expedition's vessel *Aurora* between 1911 and 1914.

Late in 1911 the AAE established a wireless relay at Wireless Hill on Macquarie Island. A living hut was also built on the Isthmus for a party of five men who remained on the island to record the first series of meteorological data. AAE members also mapped the island and collected geological and biological specimens. The party left the island in December 1913 and were replaced by the Commonwealth Meteorological Expedition. The station's records and one of the expedition members were lost in 1914 when the Commonwealth research vessel *Endeavour* disappeared without trace after leaving Macquarie Island. The station was abandoned in December 1915.

During the summers of 1929 and 1931 Mawson organised and led the British, Australian and New Zealand Antarctic Research Expedition (BANZARE) to explore the region of Antarctica south of Australia.

The British, Australian and New Zealand Antarctic Research Expedition (BANZARE)

In July 1927, the Australian National Research Council formed an Antarctic Committee that decided an expedition led by Sir Douglas Mawson should explore the region of Antarctica directly south of Australia, including Macquarie Island. With support from three governments the British, Australian and New Zealand Antarctic Research Expedition (BANZARE) set sail for the Antarctic in October 1929.

In two summer voyages the vessel *Discovery* and the expedition aircraft traversed the whole coastline from 45°E to 160°E. Three new landings were made and aircraft flights discovered what was then called the BANZARE Coast and Princess Elizabeth Land. The expedition generated such voluminous scientific results that reports were still being published three decades later. This work effectively defined the limits of what was five years later to become the Australian Antarctic Territory (AAT).

To capitalise on the achievements of BANZARE, permanent Antarctic stations were planned to support further exploratory work and conduct meteorological and other studies. The ship *Wyatt Earp* was purchased by the government but further exploration was deferred with the outbreak of the Second World War.

Source: Australian Antarctic Division, 2000

In May 1948 the Federal Government set up the Australian Antarctic Division[1] (AAD) to provide administrative and logistic support for the Australian National Antarctic Research Expeditions (ANARE). During the 1947–1948 summer a scientific station was established at the Isthmus on the northern end of Macquarie Island. The Tasmanian Parks and Wildlife Service (TPWS) and the AAD have a cooperative work program based at the station on the island. The station is occupied continually with around 40 expeditioners over summer and 16–20 over winter.

[1] The Australian Antarctic Division (AAD) is the lead agency for Australia's Antarctic Program. The AAD is responsible for the coordination and management of the ASAC (Antarctic Science Advisory Committee) programs; for conducting research in high-priority areas of Antarctic science; for coordinating and managing Australia's shipping and field program in Antarctica; and for administering the Australian Antarctic Territory and the subantarctic Territory of Heard and McDonald Islands.

Description of current major uses

Shipping

Shipping is the only form of transport available to the Macquarie Island region. Between 18-20 commercial vessels and up to 10 yachts were involved in non-governmental operations in Antarctic and subantarctic coastal regions during the 2000–2001 summer. In addition, AAD polar re-supply vessels deliver and retrieve staff and supplies to and from ANARE stations.

Tourist operations, operated by a range of companies, can carry between 30 and 800 people, the majority being in the 30–150 passenger class. The yachts carry six to twelve people. A small number of ships operate from Bluff (New Zealand) and Hobart (Australia).

The Australian Antarctic Division services the research station on Macquarie Island. Supply ships generally travel from November to April with a turn around time of two to four days. A voyage early in the season brings summer staff and cargo to the island and takes winter staff home. A voyage later in the season retrieves summer staff and resupplies the Island. During 2000–2001, eleven supply visits were made to the Island. Maps of voyage tracks are created from the vessels' daily report (see Map 3).

Commercial fishing

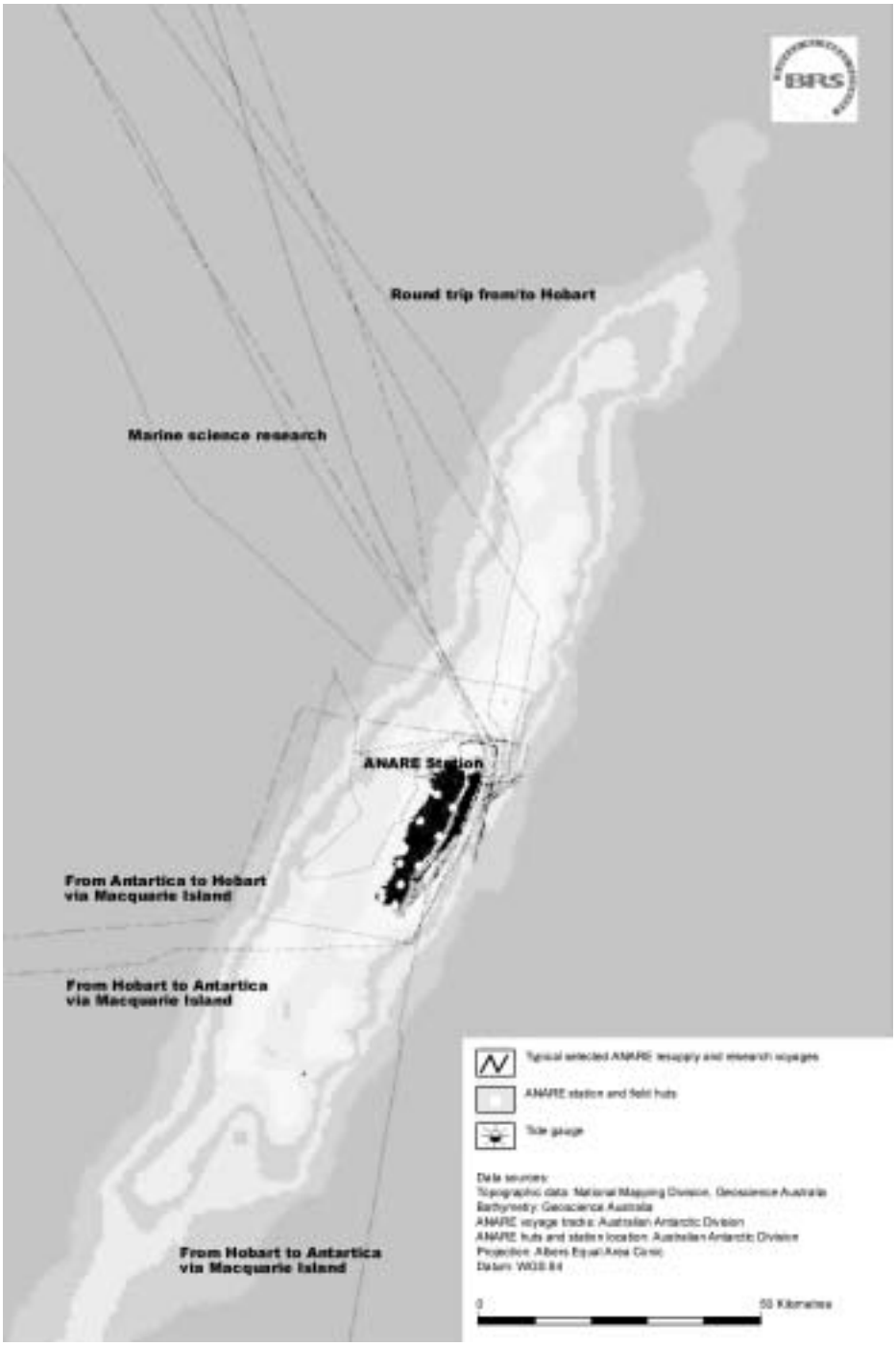
Fishing only occurs in Commonwealth waters. Commercial fishing in waters between 3 and 200 nautical miles around Macquarie Island is managed by the Australian Fisheries Management Authority (AFMA).

There is no record of commercial fishing in the area until 1994 when the AFMA was approached by an Australian fishing company for a concession to undertake exploratory fishing around Macquarie Island.

From November 1994 to April 1996 a single Fishing Permit holder conducted exploratory trawling[2], targeting Patagonian toothfish (*Dissostichus eleginoides*), which is found between sub-temperate and subantarctic latitudes (40–55°S) at depths of 600–3200 metres. Fishing for toothfish takes place between 600–1000 metres.

[2] Because there is only one boat operating in the fishery, AFMA confidentiality provisions require that any published data contain as a minimum the combined data of five boats.

Map 3: *Typical selected ANARE resupply and research voyage.*



Source: Larcombe et al. (2002).

In 1996 an *Approved Management Policy* was produced for the developmental fisheries in the Australian Fishing Zone (AFZ) around Macquarie Island (AFMA 1996). The objectives of the Policy were to manage the fishery in accordance with the *Commonwealth Fisheries Administration Act 1991 and the Fisheries Management Act 1991*.

The Policy's conditions require the ship to carry two AFMA approved observers to fit an operational Integrated Computer Vessel Monitoring System (ICVMS), to monitor vessel location and to provide data on catch, effort and ecosystem interactions, such as any bycatch of marine mammals and seabirds. The operator has to provide assistance to the observers (AFMA 1996).

Commercial fishing around Macquarie Island is restricted to demersal and mid- water pelagic trawling, primarily targeting Patagonian toothfish. This fishery targets only the sediment-filled troughs and canyons and therefore uses a relatively small proportion of the seabed. Patagonian toothfish is primarily exported to Japan, Asia and the Unites States of America (AFMA 2001). Mid-water trawling is also used to target mackerel ice fish (*Champsocephalus gunnari*). Longline fishing is not permitted in the Macquarie Island AFZ to protect the endangered wandering albatross and other species.

AFMA set up the Macquarie Island Developmental Fishery Stock Assessment Group (MacSAG) to provide expert advice on the status of Patagonian toothfish stocks around Macquarie Island (AFMA 1996). In addition, AFMA established the subantarctic Ecological Assessment Group (SEAG) to provide advice on other issues relevant to commercial fishing around Macquarie Island. Advice from these two groups is pivotal in determining management measures such as total allowable catches. In 1997 AFMA replaced MacSAG and SEAG with the Fishery Assessment Group (MacFAG), which combines their functions.

In mid-1999 AFMA developed and implemented *the Macquarie Island Fishery Interim Management* Policy for the period October 1999 to June 2001, which permitted access by a single boat using the trawl method. The Policy has been extended for a further 18 months to December 2002 to allow CSIRO to complete an evaluation of the management strategy for the fishery.

The single boat has operated under a number of conditions designed to minimise the impact of fishing on the environment. It also collects data as part of the scientific research program designed to assist in the longer-term management of the fishery (Table 3). A Total Allowable Catch (TAC) was implemented in 1996 for new fishing areas to limit the possible impact on target and non-target species, and to encourage further exploration of potential fishing grounds (Department of Agriculture Fisheries & Forestry – Australia 1999). Other conditions include providing trained observers on each trip to collect fisheries and environmental data, and information about the bycatch and gear used, including changes in gear (AFMA 1999). In addition, the commercial operator is required to provide data including intent to leave port, completion of logbooks and the reporting of bycatch, lost fishing gear or other non-biodegradable products.

Patagonian toothfish

There are two species of toothfish: the Antarctic toothfish (Dissostichus mawsoni) and the Patagonian toothfish (Dissostichus eleginoides). They are very similar in appearance and habits but Antarctic toothfish live close to the Antarctic continent and Patagonian toothfish in subantarctic waters on shelves, around islands and submarine banks.

Toothfish are bottom-living, but move off to feed. They are found at depths of between 300 m and 2500 m. The Antarctic toothfish has antifreeze proteins in its tissues so it can survive in seawater below the normal freezing point of tissue. The Patagonian toothfish lacks these proteins because it lives in warmer water.

Toothfish eggs and larvae are pelagic (free swimming/floating near the sea surface) and the larvae feed on zooplankton. Toothfish eat small fish and squid in mid-water and a range of fish, crabs, prawns etc. on the bottom. They reproduce when they are 8 to 10 years old and between 70 cm and 95 cm long. The maximum size is 2.2 m in length and about 120 kg in weight. The oldest recorded toothfish was about 45 years old.

Both species of toothfish are eaten by sperm whales and elephant seals, but the extent of this is unknown. The fish are usually too large to be eaten by other predators.

The main features of the fishery are provided in Table 4.

Table 3:
Total Allowable Catches for the Macquarie Island Fishery.

	Patagonian toothfish TAC (tonnes)		
Period	**Total TAC**	**Limit on Aurora Trough**	**Other species (tonnes)**
Sep 96 – Aug 97	1000	750	200
Sep 97 – Dec 98	1500	200	200
Jan 99 – Dec 99	600	40 (research only) commercial fishing prohibited	200
Jan 00 – Dec 00	510	40 (research only)	50 (per species applied by CCAMLR*)

*Commission for the Conervation of Antarctic Marine Living Resources.

Source: AFMA 2000

Bycatch management

The Subantarctic Fisheries Bycatch Action Plan (AFMA 2001) was developed under the Commonwealth Policy on Fisheries By-catch Policy (AFMA 2000) to ensure that direct and indirect impacts on aquatic systems are taken into account when fisheries management regimes are developed and implemented.

The Action Plan covers both the Heard and Macquarie Island fisheries. The objectives include reducing the bycatch, improving protection for vulnerable species (including seabirds and marine mammals) and deciding the acceptable extent of ecological impacts. To achieve these objectives the Action Plan identifies the following strategies:

- develop and review non-target species catch limits
- monitor non-target catches
- evaluate fishing impacts on seabirds and marine mammals
- investigate alternative fishing gear.

To provide protection for juvenile fish and ecologically related species (eg coral and seabirds), the following restrictions apply to fishing gear:

- the minimum mesh size is 120 mm (to protect juvenile and some bycatch species)
- the use of net monitoring cables is prohibited (to protect seabirds)
- the minimum bobbin size is 520 mm in diameter (to protect habitat)
- the minimum "rock hopper" rubber disc size is 40 centimetres.

Research

Exploratory and research expeditions have visited Macquarie Island since the 1800s. A substantial amount of information about the Island's geology and ecology has been produced from these voyages and from the current research based at the Island (Environment Australia 2001).

Australian Antarctic Division (AAD)

The Australian Antarctic Division (AAD) is responsible for coordinating scientific research in the Australian Antarctic region. The AAD runs ten programs covering Antarctic Marine Living Resources, Astronomy, Atmospheric Sciences, Biology, Cosmic Ray Physics, Geosciences, Glaciology, Human Biology and Medicine,

Table 4:
Main Features of the Macquarie Island Fishery

Status of the Patagonian toothfish	Uncertain Level of fishing is consistent with the precautionary approach The Aurora Trough population was overfished and no target catch was permitted in 1999
Reliability of the assessment	Low, but research plan in place to improve reliability
Current catch (1999)	600 t, commercial fishing was prohibited in Aurora Trough
Long-term potential yield	Unknown
Major management objective	Precautionary approach to developmental fishing is consistent with legislative requirements and the CCAMLR arrangements
Management methods	Limited entry (one boat); Total Allowable Catch

Source: Bureau of Rural Science (1999).

Human Impacts and Oceanography. Each of these programs is responsible for part of a five-year Science Strategic Plan approved by the Antarctic Science Advisory Committee (ASAC) and endorsed by the Minister for Environment and Heritage.

The marine-based programs in Biology, Antarctic Marine Living Resources, Geosciences and Oceanography use a purpose-built ice-breaking research vessel, (the *RSV Aurora Australis*) and, to a lesser extent, the supply ship the *RV Polar Bird*.

The Australian Antarctic Scientific Research Program, co-ordinated by the AAD, is one of the larger National Research Programs. Approximately 160 projects are conducted annually at the nation's three permanent continental research stations at Mawson, Davis, and Casey and the subantarctic station on Macquarie Island. Each season about 250 scientists travel south, drawn from Australian and overseas universities, research institutions and the AAD itself.

Cooperative Research Centre for Antarctica and the Southern Ocean (Antarctic CRC)

The Cooperative Research Centre for Antarctica and the Southern Ocean (Antarctic CRC) established in 1991 at the Hobart campus of the University of Tasmania. It is now one of the largest Polar research organisations in the world with 30 full-time equivalent research scientists and 32 support staff. It has the same Director as the Institute of Antarctic and Southern Ocean Studies, a postgraduate research department with about 65 students.

The Antarctic CRC scientists are investigating the oceanic and atmospheric circulations of the south polar region, their interaction with sea ice and the continental ice-sheet, and their relation to global environmental change and biological productivity. They are working to establish baselines of natural variability from geologic and paeleo-environmental records (from both onshore and offshore Antarctica). Staff are also investigating the political and legal aspects of Antarctic government and management.

The CRC's diverse research programs within the Macquarie Island Large Marine Domain include establishing automatic weather stations, studying oceanographic conditions with drifting recording buoys, sea level studies, and investigating atmospheric and space phenomena. There is also a newly established human impacts research program.

Biological research programs include the feeding and reproductive habits of subantarctic wildlife. Another major study is investigating the population and fishery biology of the toothfish and its interactions with other species to provide scientific advice for ecologically sustainable development of the fishery. The study was jointly funded by the Fishery Research and Development Corporation (FRDC), CSIRO Marine Research, Australian Antarctic Division (AAD) and Austral Fisheries Pty Ltd (He, Xi & Furlani 2001).

In early 2000, the Australian Geological Survey Organisation (AGSO) completed a 25-day seabed mapping and geophysical survey off southern Tasmania and south of Macquarie Island, which mapped the

seafloor along the southern Macquarie Ridge Complex. The survey helped to define Australia's marine jurisdiction and the seafloor characteristics in the southern portion of the Macquarie Island Marine Park within the Australian EEZ. The work also highlighted features such as:

- a high relief axial valley adjoining the deep Hjort Trench
- the broadening to the south of the submerged Hjort Ridge, east of the Hjort Trench
- the seafloor spreading tectonic fabric across the Hjort Ridge summit
- a linear trough/ridge feature that obliquely truncates the southern end of the Hjort Trench and adjoining axial valley.

Conservation

Macquarie Island and its surrounds are protected by the Macquarie Island Marine Park and the Macquarie Island Nature Reserve.

The Macquarie Island Marine Park was declared on 22 October 1999 under the Commonwealth *National Parks and Wildlife Act 1975*. The Marine Park contains the world's largest marine protected zone covering approximately 16.2 million hectares (162 000 sq km) along the southeast quadrant of the Macquarie Island out to the EEZ. The Marine Park includes environments from the sea surface to 100 m below the sea floor.

The *Environment Protection and Biodiversity Conservation Act 1999* requires the Director of National Parks and Wildlife to prepare a management plan for the protection and conservation of the marine reserve.

A Draft Management Plan for Macquarie Island Marine Park was released for public comment in February 2001, and the final plan released on 26 September 2001. The Plan includes strategic objectives, management goals and strategies to achieve them. The Plan will operate for seven years unless revoked or amended sooner and will be reviewed approximately two years before it expires.

The Marine Park assists Australia meet its international obligations under:

- *Convention on Biological Diversity* – which requires parties to pursue conservation of biological diversity and the sustainable use of its components establishing a system of protected areas where special measures need to be taken
- *World Heritage Convention* – which aims to promote cooperation among nations to protect heritage of outstanding universal value
- *Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention)* – which provides direction to negotiate and implement agreements with other countries, including cooperation and support for research
- *Agreement on the Conservation of Albatrosses and Petrels 2001* – which aims to help parties to the Convention on the *Conservation of Migratory Species of Wild Animals 1979* apply the precautionary approach
- *International Convention for the Regulation of Whaling* – which requires conservation of whale stocks by completely protecting certain species, designating specific areas as whale sanctuaries, and promoting relevant research
- *Convention for the Conservation for Antarctic Marine Living Resources (CCAMLR)* – which in 1993 adopted a resolution calling on members with jurisdiction in adjacent areas to harmonise with the CCAMLR measures, and ensure any harvesting is responsible
- *Convention for the Conservation of Antarctic Seals 1972 (CCAS)* – which protects all seals in Antarctic waters; and includes significant foraging grounds of elephant seals breeding on Macquarie Island.

The terrestrial component of the Macquarie Island Nature Reserve, which extends to three nautical miles, is an International Biosphere Reserve. It is one of Australia's twelve Biosphere Reserves and the only one located in the Southern Ocean. Biosphere Reserves are areas nominated by a member of the United Nations Educational, Scientific and Cultural Organisation (UNESCO) because they have been given international recognition by the Man and the Biosphere Programme (Carleton and McCormick-Ray 1994).

The Macquarie Island Marine Park is part of the National Representative System of Marine Protected Areas (NRSMPA). The NRSMPA aims to establish a comprehensive, adequate and representative system of marine protected areas to contribute to the long-term ecological viability of marine systems, to maintain ecological processes and protect Australia's biological diversity (Environment Australia 2001). The main purpose of the Marine Park is to protect its conservation values from human disturbance. It also provides for the special needs of threatened species, migratory species and species vulnerable to disturbance.

The Marine Park was declared to:

- protect the unique and vulnerable marine ecosystems of the southeastern portion of the Macquarie Island region, particularly the migratory, feeding and breeding ranges of marine mammals and seabirds; threatened species that depend on the area; and the unique benthic habitat
- add a representative sample of the Macquarie Island Region to the NRSMPA
- integrate the management of conservation values and multiple uses in the Region. Sainsbury et al. (1997) state that multiple use management of Australia's oceans is underpinned by four fundamental principles: ecosystem integrity; wealth generation and resources use; equity; and participatory decision making.

The Macquarie Island Region is important habitat for five species of seals and 38 species of seabirds during various stages of their life cycle. A number of these species are under local or global threat according to Commonwealth/State legislation and/or IUCN Red List Criteria (See Table 5).

What is the IUCN Red List of endangered species?

The 2000 IUCN Red List is the world's most comprehensive inventory of the global conservation status of plant and animal species. It uses a set of criteria to evaluate the extinction risk of thousands of species and subspecies. With its strong scientific base, the IUCN Red List is recognised as the most authoritative guide to the status of biological diversity.

The aim of the Red List is to convey the urgency and scale of conservation problems to the public and policy makers, and to motivate the global community to try to reduce the numbers of species becoming extinct.

The Macquarie Island Marine Park has three IUCN categorised zones:

- one Highly Protected Zone of 5.8 million hectares where fishing, petroleum and mineral exploration is prohibited
- two Habitat/Species Management Zones comprising 10.4 million hectares where scientific research is the primary activity.

Some of the management goals and strategies for these zones relate to scientific research and monitoring in the Marine Park.

Table 5:
Threatened Species of the Macquarie Island Region.

Common name	Scientific name	Status
Royal penguin	*Eudyptes schlegeli*	Vulnerable **a f**
Rockhopper penguin	*E. chrysocome filholi*	Vulnerable **a f**
Gentoo penguin	*Pygoscelis papua papua*	Vulnerable **f**
King penguin	*Aptenodytes patagonicus*	Near threatened **f**
Wandering albatross	*Diomedea exulans*	Vulnerable **a** / Endangered **d e** / Critically endangered **f**
Black-browed albatross	*Thalassarche melanophrys*	Near threatened **c** / Vulnerable **e** / Endangered **f**
Grey-headed albatross	*T. chrysostoma*	Vulnerable **a d e**
Light-mantled sooty albatross	*Phoebetria palpebrata*	Vulnerable **e f**
Sooty albatross	*P. fusca*	Vulnerable **a d** / Rare **e**
South Georgian diving petrel	*Pelecanoides georgicus*	Vulnerable **f**
White-headed petrel	*Pterodroma lessonii*	Vulnerable **f**
Blue petrel	*Halobaena caerulea*	Critically endangered **f** / Vulnerable **d**
Grey petrel	*Procellaria cinerea*	Endangered **f**
Wilson's storm petrel (subantarctic)	*Oceanites oceanicus*	Vulnerable **f**
Antarctic prion	*Pachyptila desolata*	Vulnerable **f**
Fairy prion (southern)	*P. turtur*	Endangered **f** / Vulnerable **d**
Imperial shag (Macquarie Island)	*Leucocarbo atriceps purpurascens*	Vulnerable **f**
Red-crowned parakeet		Extinct
Buff-banded rail	*Macquarie Island rail*	Extinct
Subantarctic skua (southern)	*Catharacta lonnbergi lonnbergi*	Vulnerable **f**
Antarctic tern (NZ)	*Sterna vittata*	Endangered **d f**
Hooker's sea lion	*Phocarctos hookeri*	Vulnerable **a**
Southern elephant seal	*Mirounga leonina*	Vulnerable **b d**
Antarctic fur seal	*Arctocephalus gazella*	Conservation dependent **b**

Footnotes

a – Redlisted in IUCN 2000.
b – According to IUCN criteria in Shaughnessy (1999).
c – According to IUCN criteria in Croxall and Gales (1998).
d – Listed as threatened species under section 178 of the Environment Protection and Biodiversity Conservation Act.
e – Listed under the Tasmanian Threatened Species Protection Act 1995.
f – According to IUCN criteria in Garnett and Crowley (2000).

Note the southern elephant seal (endangered), subantarctic fur seal (endangered), southern giant petrel (vulnerable) and northern giant petrel (rare) have been approved by the Tasmanian Parliament for listing under the *Tasmanian Threatened Species Protection Act 1995*.

Source: Environment Australia (2001a).

Highly Protected Zone

Approximately 12% of the EEZ around Macquarie Island is a highly protected zone. It includes a substantial portion of a highly productive part of the region, where pelagic food such as krill is suspected to be readily available for predators such as seals and penguins. These highly productive waters extending southeast beyond the edge of the EEZ are probably used in transit by many of the estimated 3.5 million seabirds (20 breeding species) associated with Macquarie Island. Many of the estimated 100 000 seals (four breeding species) associated with Macquarie Island are also thought to feed regularly in these waters and to travel through the area on the way to more distant feeding grounds in Antarctic waters.

Highly Protected Zone

The major aim of management of the Highly Protected Zone is to preserve this largely unmodified ocean in its natural condition. In this Zone:

- no resource extraction, including commercial fishing, petroleum and mineral exploration, is permitted
- no commercial tourism or dumping of waste is permitted
- public access to the zone is restricted to the minimum possible
- approved research activities (including biological, ecological, geological and oceanographic studies) are permitted.

The objectives of the Highly Protected Zone are to:

- give a high level of protection to areas of known high conservation value
- protect critical areas (for foraging, breeding, resting, moulting, or transit) for endemic, vulnerable and migratory species from habitat degradation and other interference from human activities
- provide refuge areas for wide-ranging mobile species and endemic vulnerable and threatened species
- provide scientific reference areas for further studies of the natural ecosystems and the effects of human activities.

Source: Department of Environment and Heritage 1999

Habitat/Species Management Zones

There is one Habitat/Species Management Zone of 2.7 million hectares to the north; and another of 7.7 million hectares to the south. These areas together cover about 22% of the Macquarie Island EEZ.

The northern zone includes some of the known feeding grounds of breeding fur seals, which are concentrated on the northern tip of Macquarie Island. The seals also forage towards the northern gap in the ridge. The southern zone covers much of the known penguin feeding grounds and a large section of the corridor used by many species to move to and from more southern waters.

Habitat/Species Management Zone

The major management aim of the Habitat/Species Management Zone is to protect habitat and refuges for species targeted for conservation. In this zone:

- no activities deleterious or contrary to the purpose of the zone are permitted, including dumping and littering
- limited commercial tourism is allowed under a permit issued by the Director of National Parks and Wildlife under the Environment Protection and Biodiversity Conservation Act
- scientific research compatible with the objectives of the Marine Park and management goals for this zone is allowed
- no mining or exploration for petroleum or mineral is permitted
- limited commercial fishing may be permitted if the applicant provides evidence that their activities will be consistent with 1 above and contributes resources to any research required to assess and monitor the impacts of the proposed activities.

The objectives of the Habitat/Species Management Zone are to:

- protect unique geographical features, natural ecological processes and unusual biological communities from habitat degradation
- contribute to the representativeness and comprehensiveness of the NRSMPA
- facilitate scientific research and environmental monitoring for sustainable resource management (primarily of living resources but may include some non-living resources)
- assess the effects of human activities on the ecosystems
- prevent activities that would have significant negative impacts on the long-term ecological viability of the marine systems.

Source: (Environment Australia 2001)

Macquarie Island Nature Reserve and World Heritage Area State Protection

Macquarie Island was declared a Wildlife Sanctuary in 1933 under the *Animals and Birds Protection Act 1928*. In 1971, under the *Tasmanian National Parks and Wildlife Act 1970*, Macquarie Island became a Conservation Area and on 14 June 1972 a State Reserve. In 1978 the island was declared a Nature Reserve. In 2000 the Nature Reserve was extended to three nautical miles from low water mark around the island and outlying islets, providing for the complete protection of all fish, flora and fauna, as well as the seabed within the Nature Reserve.

National and International Recognition

Macquarie Island was declared a Biosphere Reserve under the UNESCO *Man and the Biosphere Program* in 1977 and placed on the Register of the National Estate in 1980. In 1997 the Island and its surrounding waters out to 12 nautical miles was inscribed on the World Heritage List as the Macquarie Island World Heritage Area. The Macquarie Island Marine Park was declared in 1999.

Macquarie Island Nature Reserve comprises Macquarie Island, Bishop and Clerk Islets, and Judge and Clerk Islets. It includes all adjacent offshore islands, rocks, reefs and State territorial waters extending to three nautical miles. The nature reserve and its waters are a restricted area (declared 1979) and entry requires written authorisation from the Director of Tasmanian Parks and Wildlife Service.

The reserve is managed by the Parks and Wildlife Service of DPIWE, which has a management plan (Department of Parks, Wildlife and Heritage 1991) to:

- protect the natural and historical assets
- repair past damage as far as possible
- encourage research into the natural and historical features of the region providing it has no long-term detrimental effects.

A new management plan for the Macquarie Island Nature Reserve and State component of the World Heritage Area is currently in preparation. Once gazetted, the new management plan will remain in effect for ten years, and will include joint management arrangements with the Commonwealth in regard to their marine protected areas and the ANARE station.

Macquarie Island is home to a variety of wildlife. Elephant and fur seals breed on the island as do royal, king, gentoo and rockhopper penguins. Other fauna includes skuas, petrels and albatrosses.

Seals of Macquarie Island

Macquarie Island is unique in that it contains three fur seal species: the Antarctic (*Arctocephalus gazella*), subantarctic (*A. tropicalis*) and New Zealand fur seals (*A. forsteri*).

We do not know what species of fur seal lived on the Island when it was first discovered. The New Zealand fur seal is the most common species, with over 2000 individuals. However, most of these are non-breeding males and only an occasional female breed on the island. The small fur seal breeding population on Macquarie Island consists of mixed colonies of mainly Antarctic and subantarctic fur seals.

The fourth species of seal breeding at Macquarie Island is the elephant seal. An estimated one-seventh of the world's elephant seals live on Macquarie Island. The elephant seal has recently been listed as an endangered species on the Tasmanian Threatened Species Order 2001, which updates schedules in the Tasmanian Threatened Species Protection Act 1995. The elephant seal has not been listed as endangered by the Commonwealth at this time.

Penguins of Macquarie Island

Royal penguins (*Eudyptes schlegeli*) are the most numerous penguins on the island. Their population was estimated at around 850 000. The royal penguin is endemic to Macquarie Island. It relies on the ocean surrounding the island for its diet of myctophid fish (52% of the diet), krill (euphausiids) (26%), other crustaceans and squid. The penguins spend seven months of the year at Macquarie Island foraging offshore for squid and fish at the Antarctic Polar Front (where Antarctic and subantarctic surface waters meet).

Over 100 000 pairs of king penguins (*Aptenodytes patagonicus*) breed on many of the subantarctic and Antarctic islands between 46°S and 55°S, mainly in the Atlantic Ocean sector (estimated 1989). Macquarie Island has the third largest colony of king penguins in the world. They are permanent residents, feeding mainly on fish.

Gentoo penguins live all year round on the island. This is the only gentoo penguin population in the Pacific Ocean sector (most live in the Atlantic Ocean sector). Less than 5000 pairs breed at Macquarie Island. They generally feed inshore on squid and fish.

There are no accurate counts of rockhopper penguins but estimates range from 100 000 to 500 000 breeding pairs globally. Unlike the other three penguin species on Macquarie Island, rockhoppers occur in other areas of the Pacific sector such as the southern islands of New Zealand. Rockhoppers spend seven months on Macquarie Island and feed offshore on shrimps and some fish and squid (DPIWE 2001b).

Albatrosses of Macquarie Island

The light-mantled sooty albatross (*Phoebetria palpebrata*) is the most abundant of the four albatross species breeding at Macquarie Island. In 1992–1993 the population was estimated to be 1100 breeding pairs per annum. They usually breed every second year but only once every 3–4 years on Macquarie Island. Nests are scattered around the coast.

Colonies of the black-browed albatross number around 40 pairs on Macquarie Island and 100 pairs on Bishop & Clerk Islands. The grey-headed albatross number about 60-80 pairs each year.

Nineteen pairs of wandering albatrosses breed at Macquarie Island. Although it is unlikely to have ever been a major breeding site, that population was more numerous in the past. This species is believed to be at risk from longline fishing in the Southern Ocean. Parents may travel thousands of kilometres searching for squid, fish and carrion to feed their chicks, which take 11 months to fledge (DPIWE 2001b).

Macquarie Island World Heritage geological values

In 1997 Macquarie Island, with its surrounding waters out to 12 nautical miles, was granted World Heritage status according to the 1972 Convention for the protection of the World Cultural and Natural Heritage (World Heritage Convention). World Heritage status was granted on the grounds of the Island's unique geological values.

The Macquarie Island World Heritage geological values are:

- above sea level evidence of sea-floor spreading and tectonic processes along a mid-oceanic spreading centre
- the only known example of two oceanic plates colliding, producing a ridge and island at a major strike slip plate boundary
- the only known example of oceanic crust uplifted by transpression[3] at an ocean-ocean plate boundary
- the only known example of an ophiolite complex (distinctive assemblage of mafic to ultramafic rocks) in its original geological setting
- a near-pristine example of an ophiolite
- evidence of the structure, processes of formation and geochemistry of lower layers of Earth's lithosphere with sequences from all levels of the crust down to 6 km
- an example of the structure and composition of both the oceanic crust and the upper mantle
- the only known example of oceanic crust formed by sea-floor spreading which is accessible above sea level and still actively forming, undeformed, and uncontaminated
- evidence of the exposure of a segment of a major active plate boundary in an oceanic setting
- evidence of continuing tectonic and structural processes, including frequent and large earthquakes and dramatic uplift
- an example of the reversal of geological processes, with tectonic plates moving apart and then reversing to collide.

Macquarie Island is important for its exceptional natural beauty and contains superlative natural phenomena.

Macquarie Island's aesthetic values include:

- spectacular steep escarpments
- extensive peat beds
- large numbers of lakes, tarns and pools
- dramatic changes in vegetation cover due to the climate
- extensive gatherings of wildlife, including royal and king penguins, especially during the breeding season
- four majestic albatross species nesting
- impressive colonies of elephant seals
- the remote, dramatic and undisturbed location.

[3] Transpression is where two relatively rigid bodies rub together as they move. An oceanic plate boundary occurs where there are compressional forces and also lateral movement.

Tourism

There is no airstrip on the Island – the only access is by sea. The first records of passengers on ships were in 1891, when the ketch *Gratitude* carried four tourists on a relief voyage to Macquarie Island and in 1899, when the New Zealand Government vessel *Tutanekai* carried eight passengers, including one child.

Between 1972 and 1981 there were occasional visits by yachts and the tourist vessels *Lindblad Explorer* and *World Discoverer*. Visitors generally spent only one day on the Island as there was little in the way of management and no facilities for visitors (Dr Irynej Skira pers. comm).

The present tourist operations began in 1988 when operators approached the Australian Quarantine & Inspection Service (AQIS) and the Tasmanian Government to allow vessels to visit the island (See Table 6). A total of 47 vessels carrying 3320 tourists have visited the Island in the past twelve years. Visitors land on the Isthmus and at Sandy Bay, where they are met by Tasmanian Parks and Wildlife Service staff. Wooden walkways and viewing platforms protect the environment and make both places easily accessible.

During the 1990-91 season, 559 people visited Macquarie Island (Hall & Wouters 1994), each paying $100 in advance for the possibility of landing at two sites designated by the TPWS. The visitor fees also funded construction of tourist boardwalks and viewing platforms at Sandy Bay and the Isthmus for viewing penguin colonies, scenery, historic sites and the ANARE research station. The boardwalks help protect the natural environments in these areas, which are heavily used by expeditioners. The fees also partly fund staff salaries and management programs on the island, including feral cat and rabbit control.

In 1992 the TPWS produced a Minimum Impact Code for all the Island's visitors – tourists and expeditioners. The Code provides guidelines for protecting Macquarie Island's natural and cultural values as well as its values for scientific research and limited tourist visits (*ANARE News 1993*).

Table 6:
Tourist visits to Macquarie Island since 1987/88.

	Approved Ship Visits	Actual Ship Visits	Approved passenger landings	Actual passenger landings	% less than expected
1987/88	1	1	-	18	-
1988/89	0	0	-	0	-
1989/90	0	0	-	0	-
1990/91	4	4	-	559	-
1991/92	0	0	-	0	-
1992/93	4	4	-	416	-
1993/94	4	3	-	128	-
1994/95	5	5	432	342	20%
1995/96	9	8	421	351	18%
1996/97	6	6	526	490	7%
1997/98	6	6	376	313	17%
1998/99	6	6	458	374	20%
1999/2000	7	4	558	329	40%
TOTAL	**52**	**47**	**2771**	**3320**	**-**
% less passenger landings than expected (average 1994/95-1999/00)	-	-	-	-	20%

Source: DPIWE 2000

Additional guidelines for tourism operators at Macquarie Island set nine directives for protecting the environment:

- all tourist operators must be ship-based with no overnight stay on the island except in an emergency. Shore visits are only permitted between the hours of 0700 and 1900 local station time
- people can only be landed and picked up at beaches designated by the TPWS
- the areas that may be accessed on foot are designated by the TPWS and all shore parties are to be in two-way radio communication with the ship and must not be more than one hour's walking time from the beach where they are to be picked up
- shore parties must be organised in-groups of no more than ten people, including one leader/guide with each party
- strict quarantine procedures will be enforced to prevent exotic species being taken ashore in equipment or clothing
- any food and drink items to be consumed during visits ashore must be unopened, pre-packed, processed food or drinks, previously approved by the TPWS
- no food is to be given to wildlife
- all rubbish and unused food items must be returned to the ship. No ship borne rubbish, including food items can be disposed of in Tasmanian territorial waters
- no collecting of flora, fauna, historical sites or artefacts, geological specimens or objects is permitted (Hall & Wouters 1994).

In 1991 seven private tour operators founded the International Association of Antarctica Tour Operators (IAATO). IAATO has grown to include 30 member and associate member companies in the United States, Argentina, Australia, Belgium, Canada, Chile, Germany, Great Britain, the Netherlands, and New Zealand. IAATO is dedicated to provide appropriate, safe and environmentally responsible private-sector travel to the Antarctic and subantarctic (including Macquarie Island) as set out in the Antarctic Treaty System[4].

Ocean Disposal

In the 1970s and early 1980s, boats were known to have dumped rubbish from field huts four to five times, about 0.5 miles off the east and west coast. The rubbish was placed in 44-gallon drums, burnt and dumped. Resupply vessels also dumped food scraps just off the island. This practice stopped in the mid-1980s.

[4]The Antarctic Treaty was signed in Washington on 1 December 1959 by twelve nations, including Australia. The Treaty stipulates that Antarctica should be used exclusively for peaceful purposes and that participating nations should consult on the uses of the whole continent to prevent international discord.

Future uses and opportunities

The remoteness of the Macquarie Island Large Marine Domain itself limits the number of possible future uses. The most likely future extractive uses of the resources around Macquarie Island will possibly revolve around commercial fisheries, both a continuation of the current targeting of Patagonian toothfish and the targeting of new species. These possibilities and those relating to other uses are discussed below.

Shipping

The current level of shipping within the region is unlikely to increase unless commercial restrictions are changed, which is unlikely. The scientific research station on Macquarie Island is also unlikely to expand.

Petroleum and minerals

There is currently no exploration or extraction of mineral or petroleum resources in the Macquarie Island Large Marine Domain. Even if petroleum and mineral deposits existed, the remoteness, rapid drop-off, depths and weather and sea-state conditions in the area would make the activities risky.

The *Austrea* scientific trip to the region during January-February 2000 examined the area's petroleum and mineral potential. It found that within the area mapped by AGSO only the northern Hjort Trench could be considered a sedimentary basin. Several factors, however, indicate that the northern Hjort Trench is unlikely to contain petroleum reserves. Although it contains a considerable amount of sediment, the restricted nature of the trench means that the total volume of sediment and, therefore, possible hydrocarbons generated is minor. Due to its location along a mobile plate boundary the sedimentary pile is heavily faulted and disturbed, providing ready pathways for the escape of generated hydrocarbons. Most importantly, the region is not favourable for the development of petroleum because it is too remote from major sources of plant materials and other land-formed sediments (AGSO 2000).

Despite some suggestions that the Hjort Trench sediments may contain deposits of methane gas (AGSO 2000), this is not supported by the seismic and echosounder data and such deposits are unknown in the water depths involved (ie 5500-6500 m) (AGSO 2001). Future attempts to extract methane gas extraction are therefore unlikely.

Large mineral reserves in the Macquarie Island Large Marine Domain are possible because extensive superficial sediment mapping has shown a correlation between the seafloor to the west of the Hjort Trench and areas of manganese nodule pavements. Other potential mineral deposits are related to current or former submarine volcanic activity, resulting in sulphide mineralisation. Although direct evidence is lacking, the mapped seamounts and smaller volcanic edifices are potential locations for such hydrothermal deposits (AGSO 2000).

Despite the above possibilities, mineral extraction from the Domain is unlikely to occur except in the distant future.

Commercial fishing

The development of new fisheries within the Domain may be possible but depends on addressing numerous barriers, including:

- identifying suitable commercial fish stocks
- determining their biomass/stocks
- assessing the ecological implications of harvesting
- ensuring the development and eventual use do not cause unacceptable environmental impacts
- allocating a commercially viable harvest
- the willingness of companies to fish in such isolated waters
- continued developments in gear technology
- establishing markets.

The possibilities of expanding the current Patagonian toothfish fishery and creating new fisheries are examined below.

Patagonian toothfish

The potential for the Patagonian toothfish fishery to increase its current catch (TAC) within the Domain requires a greater understanding of its ecology, including toothfish biology and populations, and interactions with marine predators such as seabirds and seals. We also need to discover new populations within the Domain. To ensure the fishery is managed sustainably, we would need to assess the relative importance of the toothfish in the Macquarie Island ecosystem (Goldsworthy et al. 2001) and understand the impacts the fishery might have on the benthos and the range of bycatch species.

Current assessments of fish stocks are based on the precautionary assumptions that:

- there is no recruitment of fish from outside the Macquarie Island area, and little or no interchange of fish between the known fishing grounds
- the median biomass of spawning stock should not be permitted to fall below 50% of its level before exploitation
- there should be no more that a 10% probability that the biomass of spawning stock will decline below 20% of its level before exploitation.

Estimates of toothfish biomass are very uncertain due to our poor understanding of the distribution and movements of the population (Tuck et al. 1999). However, there are still large areas within the Domain where fishing has not yet taken place. The fisheries potential of these areas is unknown (D Williams & S Nicol pers. comm. 2001) but information from the *Austrea* cruise suggests that the shelf and upper slope areas of the Macquarie Ridge are not the right depth to provide habitat for the Patagonian toothfish (AGSO 2000). It is unlikely there would be scope for further fishing for Patagonian toothfish around Macquarie Island unless large new populations of fish are discovered (AFMA 1999).

Other fisheries

There is little scientific information indicating that there is a viable fishery for other species within the Domain (D Williams & S Nicol pers. comm. 2001). However fishing of squid, crab and myctophid (lanternfish) fish at similar latitudes in other parts of the world indicates that these fisheries might be established around Macquarie Island (excluding the Highly Protected Zone of the Marine Park).

Myctophid fishes (Lanternfish)

The future development of a myctophid fishery is possible given that myctophid fisheries have been established at similar latitudes elsewhere. However, a range of barriers – including limited technology, unknown biomass, and lack of markets – must be overcome to make a myctophid fishery around Macquarie Island viable (Goldsworthy et al. 2001).

Gjøsaeter and Kawaguchi reviewed the economic potential of myctophid fishes around the world (reported in Stiassny 2001). The estimated global biomass is around 600 million tonnes (a one-hour trawl off the coast of Argentina yielded some 30 tonnes of a single myctophid species). Adult lanternfish are thought to comprise some 65% of all mesopelagic fishes in the world (Stiassny 2001).

Few myctophids are currently considered palatable but with the worldwide decline in traditional marine fisheries, there is obvious potential for increased exploitation of myctophids. The rapid development of intensive aquaculture fisheries around the world has increased the demand for fish-meal and could trigger a shift towards the harvesting of myctophids for this purpose. Caution has been expressed that with the large biomass of myctophids undergoing regular vertical migration these animals play a pivotal role in oceanic energy dynamics and the overfishing of such a resource could have truly dire consequences (Stiassny 2001).

Squid

Many species of squid have a circumpolar distribution and are associated with the Antarctic Polar Front current. There are large squid fisheries in waters adjacent to the Antarctic and exploratory fishing for them has already taken place. If full-scale fishing develops, it will require precautionary management because of the risk to dependent predators (British Antarctic Survey 2001).

Crabs

Deep-water crab fisheries have been established in waters of the Pacific region at latitudes similar to those of the Macquarie Island region. Surveys during a recent developmental fishery for the deepwater grooved Tanner crab, a large spider crab, investigated its distribution, biomass and potential for commercial harvesting. Since these crabs contain little meat, a new market would need to be developed (Fisheries and Oceans Canada 2001).

Biotechnology

The commercial potential of natural compounds produced by different species is attracting increasing interest. A relatively small number of sites within the Domain are providing specimens for the biotechnology industry. It is likely that bioprospecting will expand in the future.

Tourism

Tourism in the region is mainly in the Antarctic. There is limited potential for the expansion of tourism in the Macquarie Large Marine Domain due to its isolation, the time required in getting there and the strict controls on numbers of tourists. Travel time is three days from Hobart to Macquarie Island across extremely rough waters. There is the potential to develop joint ventures between Australia and New Zealand providing round trips between Macquarie Island and New Zealand's Campbell Islands.

Major works, such as sewage facilities and wastewater treatment, would need to be undertaken on Macquarie Island to allow more visitors. Development proposals and environmental management plans would also need to be prepared and assessed.

Other uses

The AAD has been researching the feasibility of installing wind turbines on stations since 1993, and developments are now well under way. The particular difficulties in getting fuel ashore at Macquarie Island further increase the motivation for using wind power. Electricity could be derived from sources such as tidal power and wind energy. Given the low elevation of Macquarie Island (300 m) wind energy in particular has the potential to provide power to the Island. An 80 kw wind turbine at Macquarie Island could provide 40% of the station load and pay for itself within two years. However, plans to generate renewable energy for Macquarie Island are currently on hold, pending further investigations (AAD, 2001e).

Other uses such as pipelines, cables, ports, aquaculture, recreational fishing and charted fishery have been identified within the South-east Marine Region, however, these are not likely in the foreseeable future in the Macquarie Island Large Marine Domain.

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