Role of marine reserves in sustainable management of Australia’s ocean estate – a critical review of the Heard Island and McDonald Islands Marine Reserve expansion

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Abbreviations

AAD	Australian Antarctic Division
ABARES	Australian Bureau of Agriculture and Resource Economics
AFMA	Australian Fisheries Management Authority
AFZ	Australian Fishing Zone
ANZECC	Australia and New Zealand Environment and Conservation Council
ASO	Antarctic and Southern Ocean
CAR	Comprehensive, Adequate, Representative
CBD	Convention on Biological Diversity
CCAMLR	Commission for the Conservation of Antarctic Marine Living Resources
CCRF	Code of Conduct for Responsible Fisheries
CM	Conservation Measures
CMRs	Commonwealth Marine Reserves
CSIRO	Commonwealth Scientific Industry Research Organisation
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DST	Decision Support Tools
EAF	Ecosystem Approach to Fisheries
EBFM	Ecosystem Based Fisheries Management
EBM	Ecosystem Based Management
EEZ	Exclusive Economic Zone
EPBC Act	Environmental Protection and Biodiversity Conservation Act 1999
ERA	Ecological Risk Assessment
ERAEF	Ecological Risk Assessment for the Effects of Fishing
ERM	Ecological Risk Management
ESD	Ecologically Sustainable Development
FAO	Food and Agriculture Organisation
FRDC	Fisheries Research Development Corporation
GBF	Kunming-Montreal Global Biodiversity Framework
HIMI	Heard and McDonald Islands
HPZ	Habitat Protection Zone
HSG	Head and McDonald Island Stakeholder Group
IMCRA	Integrated Marine and Coastal Regionalisation of Australia v4.0
IUCN	International Union for Conservation of Nature
IUU	Illegal, Unreported and Unregulated
MACC	Marine and Coastal Committee
MARPOL	International Convention for the Prevention of Pollution from Ships
MPAs	Marine Protected Areas
MSC	Marine Stewardship Council
MSP	Marine Spatial Planning
NESD	National Strategy for Ecologically Sustainable Development
NESP	National Environmental Science Program
NRMMC	Natural Resource Management Ministerial Council
NRSMPA	National Representative System of Marine Protected Areas
RCP	Regions of Common Profile

RSTS	Random Stratified Trawl Survey
SAFS	Status of Australian Fish Socks
SD	Sustainable Development
SICA	Scale, Intensity, Consequence Analysis
SIOFA	Southern Indian Ocean Fisheries Agreement
TAC	Total Allowable Catch
TEPs	Threatened, Endangered and Protected Species
UN	United Nations
UNCLOS	United Nations Convention on Law of the Sea
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
WCED	World Commission on Environment and Development
WSSD	World Summit on Sustainable Development
WTO	World Trade Organisation

Executive summary

The statutory requirement to undertake a 10-year review of the Heard and McDonald Islands (HIMI) Marine Reserve led to a proposal to expand the HIMI marine reserve and include new National Park Zones (IUCN II) and Habitat Protection Zone (IUCN IV) arrangements. Subsequently, the total area of the HIMI Marine Reserve has been increased to 379,070 square kilometres, a 400% increase over the previous marine reserve.

This report aims to assess how current (and proposed) management frameworks relate to the National Representative System of Marine Protected Areas (NRSMPA) objectives, but also the extent to which they meet the overarching principles of Ecologically Sustainable Development (ESD) which requires holistic consideration of all relevant environment, social and economic objectives, as well as meeting obligations under various international legislation and conventions. As the expansion incorporates the area within which Australia's Heard Island and McDonald Islands Fishery operates, this report explores the basis of the expansion with particular reference to the implications for future fishery arrangements, management frameworks and longer-term fishery viability.

The *Environment Protection and Biodiversity Conservation Act 1999* and the *Fisheries Management Act 1991* provide the foundational legislation for sustainable management of HIMI natural resources. These Acts (and subordinate legislation) set the objectives and framework around development of natural resources under the principles of ESD and the considerations that must apply in decision making processes. The recent expansion of the HIMI reserve demonstrates that either i) certain aspects of ESD principles have been omitted from the decision-making process, or ii) there is a policy shift away from ESD principles and processes.

Over the past two decades several national initiatives have developed a series of risk-based ESD frameworks for use with marine based sectors and regions which form a clear and comprehensive hierarchy from the Activity level (Fishery ESD) - Sector level (Multi fishery EBFM) - Region level (Multi Sector EBM) to collectively deliver on ESD. The use of the fishery-level ESD assessments facilitated most Australian fisheries, including the HIMI fishery, maintaining their WTO accreditation under the EPBC Act. In addition, many fisheries, including the HIMI fishery, have successfully obtained international, third-party sustainability certification through schemes such as the Marine Stewardship Council. The comprehensive and independent assessments completed to meet these requirements found the risks to the Ecological Wellbeing components generated from the HIMI fishery are at very low or acceptable level and therefore pose minimal threat to the ecological assets located within the HIMI region.

With respect to the Human Wellbeing and Governance components of ESD, the HIMI fishery generates economic, social and governance benefits for Australia. These include:

- An annual average of over 3,500 tonnes of high-quality toothfish and mackerel icefish.
- Direct and indirect employment of both Australian and international workers.
- Internationally recognised for best practice in ensuring safe and decent working conditions for fishers.

- Providing important governance benefits, such as eliminating foreign IUU fishing, and providing a significant contribution to the collection of scientific data and consequent understanding for the region.

At the EBFM-Sector level, the HIMI fishery falls under the international Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR). The objectives of this Convention are consistent with ESD principles and require the fishery to ensure the conservation of Antarctic marine living resources in which the term "conservation" includes rational use. CCAMLR also adopts an ecosystem-based management approach which requires harvesting to be carried out in a sustainable manner with a mandate to conserve populations or ecosystems that are not only directly related to harvested marine resources, but also conserve dependent and related populations. The HIMI fishery plays a key role in the promotion of sustainable fishery practices within the CCAMLR region by using world's best-practice and continuing to undertake leading edge initiatives across the full spectrum of ESD components.

The multi-sector EBM framework is the level where development of marine protected areas for the region should be embedded. As this level requires a whole of government approach covering all sectors that operate within the region, the National EBM framework developed in 2010 by the Marine and Coastal Committee working group included the following steps:

i. Establish a group with overall responsibility for implementing EBM.
ii. Define the scope, including the boundaries of the ecosystem, and establish the overall ecological, social and economic values.
iii. Agree on relevant objectives for the ecosystem and each asset based on the values.
iv. Generate individual risk values and consolidate to asset level.
v. Prioritise assets across the ecosystem.
vi. Determine actions to meet the objectives of the governing body and establish a monitoring evaluation and reporting framework for the ecosystem and assets.

This review found that the expansion of the HIMI Marine Reserve does not follow the steps needed to be consistent with ESD principles.

The primary purpose of the NRSMPA is to ensure that the reserve system reasonably represents the biotic diversity of the marine ecosystems from which they derive. The NRSMPA was not established to mitigate threats to biodiversity, although threat mitigation within reserves is considered in decisions on reserve zoning and the activity matrices that determine what activities can be permitted within zones.

Recent research commissioned by the Australian government presented a case for more of the HIMI bioregion to be included in the reserve to comply with the Comprehensive Adequate and Representative (CAR) principles more fully. While this has merit, the increase in the HIMI Marine Reserve goes well beyond Australia's commitment to the Global Biodiversity Framework (GBF), which calls for at least 30 percent coastal and marine areas to be effectively conserved and managed through ecologically representative, well-connected and equitably governed systems of protected areas 2030 (so called 30x30).

An analysis of the HIMI reserve prior to the expansion shows that with a few exceptions, most conservation values in the HIMI EEZ were well represented in terms of spatial coverage. While there was justification for the inclusion of a representative sample of some shallow water habitats and associated conservation values of the deeper waters surrounding HIMI, the need for such a significant expansion of the HIMI reserve is questionable on CAR grounds.

A large portion of the HIMI EEZ has been declared as Habitat Protection Zone (IUCN category IV), to be managed to protect pelagic habitats or species in the waters surrounding HIMI. Motivation to include areas based primarily on their importance as foraging areas for marine predators should have been made in the context of potential threats to this function. It is insufficient to argue that the mere act of including an area in the reserve affords 'protection' if it is not clear what pressures or threats are being mitigated.

In terms of the social and economic implications of the HIMI Marine Reserve expansion, the fishing industry is most directly affected because the Habitat Protection Zone (IUCN IV) largely corresponds to the fishing footprint of the existing fishery. Access security, fishing prospectivity and zone management decisions that exclude or constrain fishing gear types are perceived concerns. This is exacerbated by potential impacts on domestic and international markets due to negative perceptions associated with sourcing product from a marine reserve.

The zonation described is unwarranted based on the remote location of the area, the low level of impact of the fishery on the demersal habitat, and unimpeded access to the area as a foraging ground for seabirds and mammals. The GBF in line with current area-based management principles recognises the human dimensions associated with marine conservation. Under this scenario the declaration of the HPZ as a multiple use or special purpose zone (IUCN category VI) would seem more appropriate.

The HIMI Patagonian toothfish (*Dissostichus eleginoides*) and Mackerel Icefish (*Champsocephalus gunnari*) fisheries are currently certified by the Marine Stewardship Council (MSC) and classified as sustainable in the most recent Status of Australian Fish Stocks (2024) report. The Australian based fishing businesses that participate in the fishery are highly regulated by the Australian Fisheries Management Authority (AFMA) and incorporate management frameworks that combine harvest strategy, bycatch species, habitats and communities, as well as strategies for research, data collection, at-sea observers, and monitoring.

As a result of the strong and effective management systems that have been in place, detailed risk assessments that relate to Ecological Risk Management (ERM) and Ecological Risk Assessment for the Effects of Fishing (ERAEF) have found the fisheries to have low to minor risk from combined effects from fishing activities. This supports the continued operation of the HIMI fisheries in providing sustainable social and economic value to Australia and broader governance benefits to the Southern Ocean region.

Given the low threat levels generated by the fishery to Ecological Wellbeing components of the HIMI region and the current levels of area protection in place, there was no justification under ESD principles for the significant expansion in fishing closures, changes to zonation classification and associated gear restriction uncertainties. Significantly, these aspects of the reserve expansion are highly likely to generate significant negative impacts on the Human Wellbeing (food security, marketing issues, continuation of MSC Certification, future fishing operations) and Governance elements (monitoring of IUU, provision of scientific data) of ESD for the fishery and therefore the overall community outcomes generated from the region. This is a result of the planning processes used to generate the HIMI Marine Reserve expansion not being consistent with best practice EBM/MSP approaches as they did not include appropriate consideration of the human and governance objectives of ESD which is necessary to deliver the best overall outcomes for this region and the Australian Community.

To effectively balance conservation values and a sustainable HIMI fishery, Marine Spatial Planning (MSP) processes have played a pivotal role through previous iterations of the Marine Reserve while ensuring the principles of ESD were maintained. However, the MSP processes used for the current HIMI Marine Reserve review are not clear, nor was it clear if decision support tools were used to determine the expansion boundaries and zoning. The proposal to expand HIMI Marine Reserve public consultation paper describes the "rationale for design and zoning as being based on the Goals and Principles of the NRSMPA", indicating limited input from decision support tools, although this remains unclear.

The HIMI Marine Reserve expansion area is divided into two classes of zones i) National Park Zone (IUCN II) and ii) Habitat Protection Zone (IUCN IV). Each zone prescribes permitted activities based on objectives of the relevant IUCN zonal category. These permitted activities can vary based on interpretation of the IUCN guidelines and the relevant Marine Park. The zonation scheme is designed to protect areas from identified threats at different levels dependent on values that have been identified within that area. The consultation paper lists a range of pressures in the Marine Reserve expansion area, however, there is no clear specification of the formal threat and risk levels generated by the current set of activities in each of the proposed zone areas. Consequently, there is no description as to how the proposed zonation changes would address each of the objectives, nor the metrics for assessment of success or failure.

The HIMI Marine Reserve zonation is especially relevant to the HIMI fishery which collects much of the data in these remote areas through the Random Stratified Trawl Survey (RSTS) and general fishery operations. The RSTS uses commercial trawl fishing methods which is prohibited in areas declared as Habitat Protection Zone (IUCN IV) under the zoning scheme and may have implications for data collection. Given this risk, it is important to acknowledge that the HIMI marine reserve expansion could negatively impact future governance outcomes through potential reductions in available scientific information.

While establishing Marine Reserves may provide safeguards for habitats and species that have predictable patterns, the design of the reserve needs to consider the dynamic nature of marine environments. Climate driven changes have been shown to have significant impacts on local productivity through shifting populations and changing marine ecosystems. While reserves have been shown to offer some resilience to climate change, it is inevitable that static frameworks will become less effective over time as climate change impacts become more pronounced, creating a mismatch between putative conservation objectives and reserve boundaries. In the same way, fisheries management frameworks need to be adaptive and responsive to changes in the distribution and/or abundance of target species. Considering this, flexible frameworks that can adapt to environmental changes may be more able to rapidly respond to ecological shifts. If a redesign of marine reserve zones is to take place, a dynamic management approach should be considered for spatial protection to be more effective.

In summary the findings of this review lead to the following conclusions:

- That the expansion of the HIMI Marine Reserve does not meet the steps needed to be consistent with ESD principles.
- That the expansion of the reserve by 400% represents a considerable over-reach in terms of Australia's commitment to GBF objectives.
- That the HIMI fishery, which meets CCAMLR objectives and independent third-party sustainability objectives is not a primary threat to the biodiversity of the region but plays an important role in both scientific understanding and protecting the area against IUU fishing.
- That Australia's approach to marine conservation, based on NRSMPA principles established more than a quarter of a century ago, is urgently in need of review. The pursuit of spatial targets (currently 30x30), while providing a representation of biodiversity within reserves, is doing little to protect this biodiversity against the key threats, the least of which is commercial fishing. Paramount amongst these threats is the pervasive impact of shifting distributions of populations from climate induced global warming. The expansion of the HIMI reserve, and marine reserves in general will do little to mitigate this threat.

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Objectives

Objectives of the project are to:

1) Examine the zoning and boundaries of the HIMI Marine Reserve in relation to NRSMPA Goals and Principles, and Ecologically Sustainable Development.
2) Understand the current HIMI fishery and effects on marine environment.
3) Evaluate the technical approach used in the design of the HIMI Marine Reserve with reference to scientific and policy objectives.
4) Understand climate change implications for HIMI fisheries management frameworks.
5) Provide recommendations in relation to review of the HIMI Marine Reserve.

Introduction

Australia's oceans are vast with a significant latitudinal gradient extending from warm shallow tropical areas to deep southern temperate habitats and supports many species of significant commercial, social and conservation value. As such, Australia has a responsibility to manage these values sustainably under domestic policy and legislation, but also values of global significance through international obligations under the United Nations Sustainable Development Goals, United Nations Educational, Scientific and Cultural Organisation (UNESCO), the International Union for Conservation of Nature (IUCN), the Convention on Biological Diversity (CBD) and Regional Fisheries Management Organisations such as the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR). Assigning IUCN protected area categories to Commonwealth reserves is integrated in legislation under the Environmental Protection and Biodiversity Conservation Act 1999 (the EPBC Act). The management and regulation of specific fishing activities in Commonwealth waters is developed in legislation under the Fisheries Management Act 1982 (FMA).

To meet the overarching Sustainable Development goals, the Australian Government, along with the states and territories, endorsed the *National Strategy for Ecologically Sustainable Development* (Commonwealth of Australia1992) to ensure that there was a balanced approach and that we should be *'using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased'*. Considerable progress has been made through various national working groups to develop a hierarchical set of ESD frameworks to implement the principles of ESD at levels from single activities (e.g. a single fishery), the sector level (e.g. Multi-fishery -EBFM level), up to the coordinated management of all activities and sectors within an entire marine region (termed Ecosystem Based Management). Through these processes it was acknowledged that ESD is the overarching goal of government and processes such as those used to develop sector level plans such as Marine Protected Areas (MPAs)[1] form only one component of the holistic management needed to effectively manage all sectors that operate within the marine environment.

Simultaneously, the Australian, state and territory governments have developed the National Representative System of Marine Protected Areas (NRSMPA) with the primary goal to establish and manage a comprehensive, adequate and representative system of Marine Reserves. The NRSMPA has been guided by the Integrated Marine and Coastal Regionalisation of Australia v4.0 (IMCRA v4.0), a spatial framework for classifying Australia's marine environment into bioregions that are useful for regional planning. This is based on pooled data as well as geomorphological surrogacy and inferred biogeography to provide discrete ecosystem boundaries to assist Marine Spatial Planning (MSP).

Therefore, NSESD, the EPBC Act, the various fisheries management Acts, international conventions (which for HIMI includes CCAMLR) form the legislative and policy basis for the Australian Government's commitment towards implementing ESD principles within the marine environment. This requires explicit consideration of social, economic and environmental impacts in all decision-making processes.

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[1] The terms Marine Protected Area (MPA) and Marine Reserve (MR) are used interchangeably in the literature, however, the latter has been used here to be consistent with current use by the Commonwealth.

Heard Island and McDonald Islands (HIMI) are part of a sub-Antarctic island group in the southwest Indian Ocean approximately 4,000kms south-west of mainland Australia and around 1,700km north of Antarctica (Welsford *et al.*2024a). The French territory of Îles Kerguelen, an archipelago of islands around 450 kilometres to the northwest, shares a maritime boundary with HIMI. Both sit on the Kerguelen Plateau, which is a large submerged continental plateau that extends more than 2,200km in a northwest–southeast direction in the southern Indian Ocean covering an area of approximately 1,226,230km^2.

Heard Island (368km^2) and McDonald Island (3km^2), the two largest islands in the HIMI archipelago, are the only two active volcanoes in Australia. The McDonald Islands have doubled in size from volcanic activity since the 1980s (Constable *et al.* 2024).

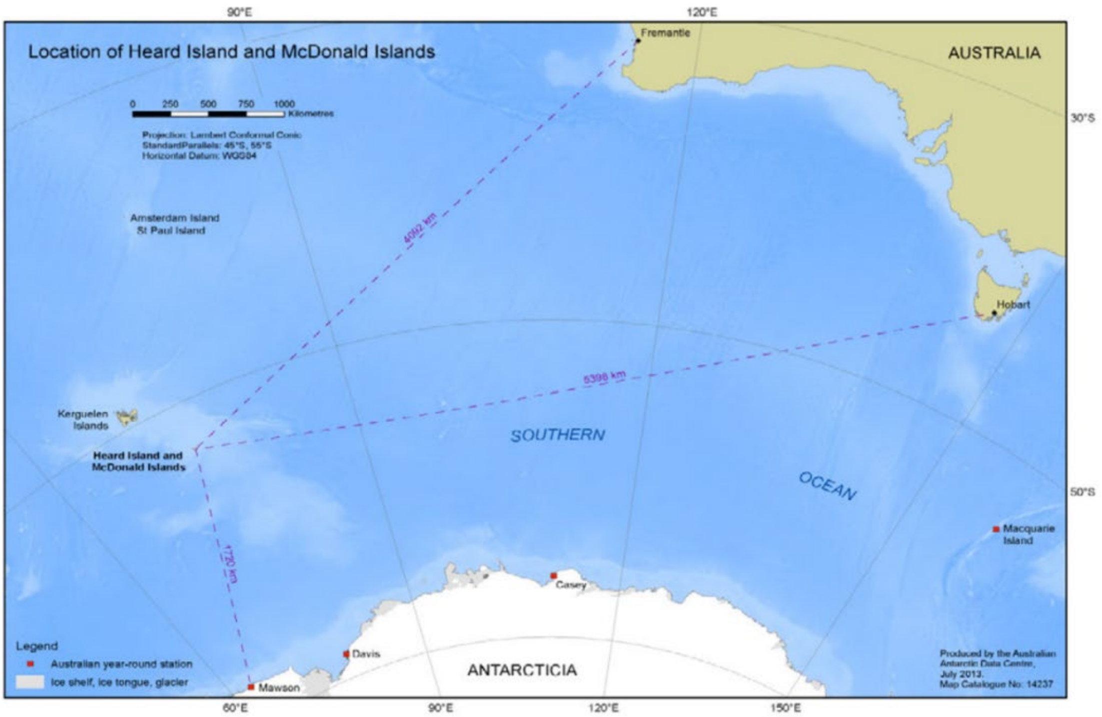


Figure 1: Location of the Heard Island and McDonald Islands (Commonwealth of Australia 2014).

Located in the southern latitudes (~53°S), the area is subject to low temperatures and persistently strong winds form a severe climate where maximum daily wind gusts of 180 kilometres per hour can occur. Due to the extreme weather conditions and significant distances from permanent human populations, the HIMI are considered very remote and largely devoid of human activity. Discovered in the mid-1800's, sovereignty of the islands was not claimed by any nation until 1910, when the British laid formal declaration. In 1947, all rights were transferred to Australia and the area forms part of the Australian Exclusive Economic Zone (EEZ). HIMI is an external Territory of Australia managed by the Australian Government where jurisdiction extends from the islands to the territorial waters and EEZ and is also known as the HIMI bioregion (DCCEEW 2024a).

The HIMI bioregion supports significant marine conservation values (Constable *et al.* 2024) as well as a highly sustainable (Marine Stewardship Council certified), and productive Australian commercial fishing industry (Commonwealth of Australia 2007). Located on the Kerguelen Plateau at the confluence of key oceanographic features, the area is surrounded by deep water environments and supports significant biological productivity (Meyer *et al.* 2000). The HIMI Marine Reserve is managed by the Australian Antarctic Division (AAD), a Division of the Department of Climate Change, Energy, the Environment and Water (DCCEEW). The HIMI fishery in this region is also one of the many fisheries that falls within the scope of the conservation and management requirement of CCAMLR.

Evolution of HIMI Marine Reserve

The HIMI Marine Reserve was established in 2002 under the *Environmental Protection and Biodiversity Conservation Act 1999* (the EPBC Act), following a comprehensive review of geophysical, oceanographic and biological data (Meyer *et al.* 2000). It covered 64 000 km^2 of area classified as no-take Marine Reserve (Figure 2). Following the comprehensiveness, adequacy and representativeness (CAR) principles, the design incorporated a portion of nearly all biophysical local units identified by Meyer *et al*. (2000), as well as featuring a number of 'spokes' radiating out from the HIMI Territory, to provide connectivity between areas (e.g., to allow migration of juvenile fish from shallow nursery areas to deeper waters) as well as to provide long term protection even as species distributions change due to factors such as climate change (Welsford *et al.* 2011).

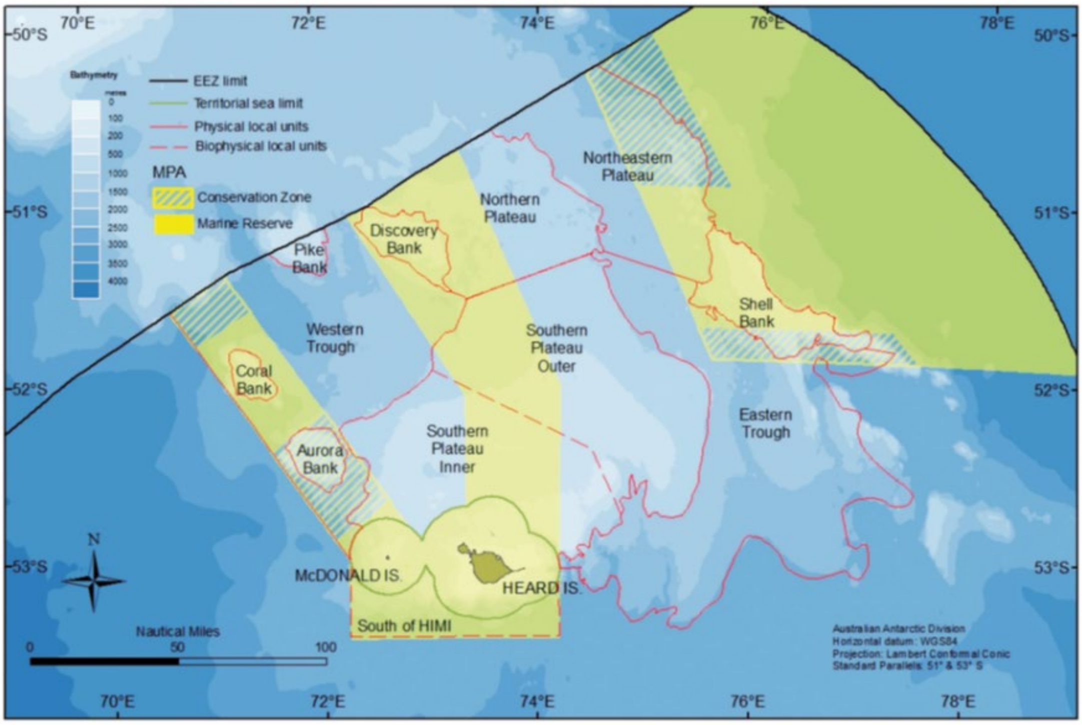


Figure 2: The initial configuration of the HIMI Marine Reserve (Welsford *et al.* 2011).

In addition to the reserve, four areas adjoining the reserve were declared as Conservation Zones to be further assessed for their conservation and fishing resource values by the HIMI stakeholder group (HSG) comprising members from AAD, the fishing industry and non-government conservation organisations (Commonwealth of Australia 2002a, Welsford *et al.* 2011).

Heard Island, McDonald Islands and the surrounding territorial sea (12 nm from shore) comprise a Wilderness Reserve, managed as an IUCN Protected Area Management Category Ia according to the Heard Island Wilderness Reserve Management Plan (Commonwealth of Australia 2014). To reduce the possibility of interaction between values protected in the Wilderness Reserve and commercial fishing activities, there is a further 1 nm buffer zone surrounding the Wilderness Reserve, where fishing is prohibited (AFMA, 2024).

The Australian Fishing Zone (AFZ) and the Australian Exclusive Economic Zone (EEZ) surround the Territory. The AFZ and EEZ boundaries extend from 12 to 200 nm from the islands, except for an area to the northwest which is separated by the Australia France Maritime Delimitation Agreement boundary (Meyer *et al.* 2000).

The knowledge regarding the status of benthic biodiversity in the Conservation Zone adjacent to the Marine Reserve has progressed since 2006, utilising datasets collected during 2012. This resulted in the identification of highly diverse assemblages in parts of the Conservation Zone, in particular, areas with high densities of benthic invertebrates or high levels of endemic taxa and led to the recommendation that these areas be added to the Marine Reserve (Welsford *et al.* 2014).

Consequently, the HIMI Reserve was expanded on 28 March 2014 following a comprehensive scientific assessment of the region's conservation values and extensive consultation with key stakeholders (Commonwealth of Australia 2014). This expansion increased the reserve to 71,000km^2 all of which was assigned IUCN category 1a (Figure 3).

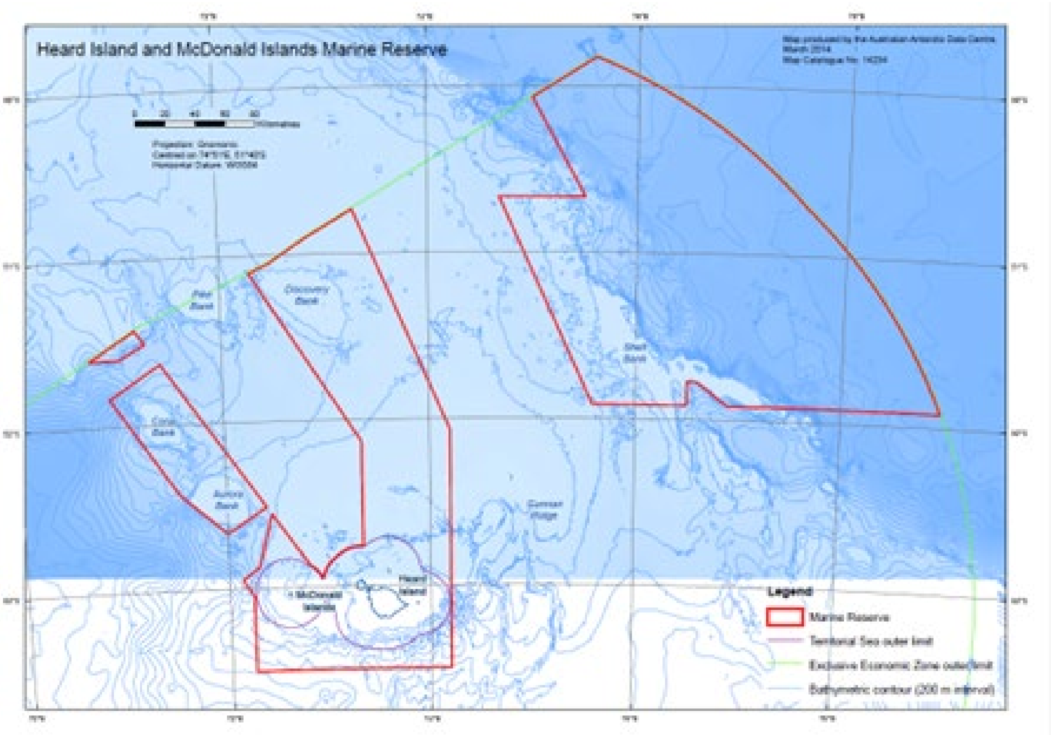


Figure 3: The 2014 configuration of the HIMI Marine Reserve.

The statutory requirement to update the current management plan has led to a proposal to expand the HIMI marine reserve and to alter the zoning of the reserve (DCCEEW 2024a). The proposed reserve design aims to:

- Expand protection of globally important breeding and foraging areas for threatened and migratory seabird and marine mammal species, and other significant populations of birds, fish, known endemic invertebrates and mammals that live on the submarine plateau and banks near the islands.
- Include seafloor features not represented in the current design, such as unique plateau, slope, banks, canyons, ridge and seamounts features.
- Expand protection for the diverse and vulnerable benthic assemblages present on the shallow plateau, banks and upper slopes around Heard Island and McDonald Islands by including

examples of all depth ranges and associated demersal fish assemblages on the Kerguelen Plateau.

- Include the deepest point of the EEZ in the marine reserve.
- Include corridors that account for movements in ecosystems or species distributions and changes in oceanographic features and currents, anticipated in response to climate change.
- Expand protection across the Kerguelen Plateau by complementing the adjoining marine reserve in the French EEZ along the majority of the mutual boundary.
- Exclude mining and associated exploration activities.
- Align management arrangements and zoning rules with Australian Marine Parks as far as practicable.
- Protect and conserve biodiversity, while supporting compatible ecologically sustainable use by enabling the continuation of a sustainable fishery aligned with its historical footprint.

The total area of the proposed design for an expanded HIMI Marine Reserve (Figure 4) is 379,070 square kilometres, a 400% increase over the current marine reserve (DCCEEW 2024a).

This review aims to explore and provide recommendations on the framework used for Marine Reserve design in the context of the current HIMI Marine Reserve expansion proposal and consider potential implications for MSP and unintended consequences. A structured and data-driven approach to developing marine parks/reserves ensures that the objectives of preserving and promoting areas of high conservation are achieved and that opportunities for economic benefit from Australian EEZ are considered.

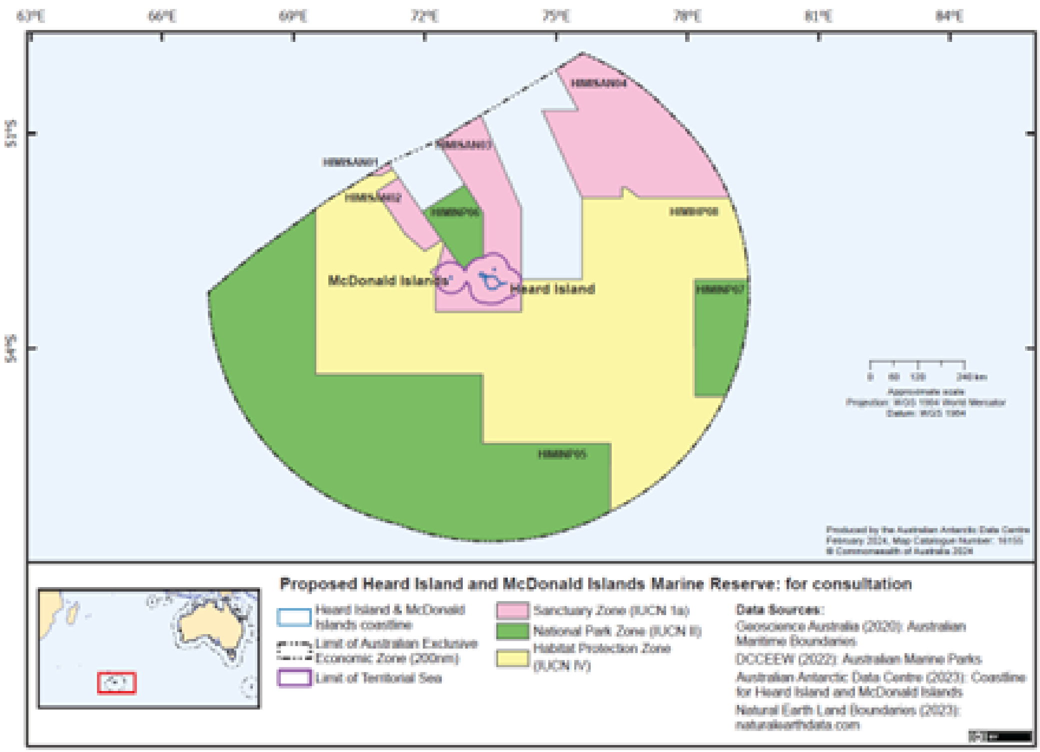


Figure 4: Proposed design for the Heard Island and McDonald Islands Marine Reserve (DCCEEW 2024a).

Sustainable ocean management - Goals and Principles

This section is included to outline Australia's international obligations to sustainable ocean management and the principles adopted by Australia in the development of a national systems of marine reserves.

Historical perspectives

A key result from the adoption of the WCED Sustainable Development goals in 1987 was that in 1992 the United Nations Conference on Environment and Development (the Rio Earth Summit) saw the establishment of the United Nations Convention on Biological Diversity (CBD). The CBD was established in recognition that biodiversity is globally important with immense intrinsic, social and economic value, and is of vital importance to the survival and wellbeing of present and future generations

Australia's commitment to the CBD included the development of The National Strategy for the Conservation of Australia's Biological Diversity (Commonwealth of Australia 1996). This strategy included an objective to develop a National Representative System of Marine Protected Areas (NRSMPA), the primary goal of which was:

> *to establish and manage a comprehensive, adequate and representative system of MPAs to contribute to the long-term ecological viability of marine and estuarine systems, to maintain ecological processes and systems, and to protect Australia's biological diversity at all levels.*

The NRSMPA guidelines (ANZECC 1998) aimed to represent provincial-scale bioregions recognised in Commonwealth waters, as identified by IMCRA v4.0 (Commonwealth of Australia 2006), against the 'CAR' principles:

Comprehensive: include the full range of ecosystems recognised at an appropriate scale within and across each bioregion.
Adequate: have the required level of reservation to ensure the ecological viability and integrity of populations, species and communities.
Representative: reasonably reflect the biotic diversity of the marine ecosystems from which they derive.

The goals and principles for the establishment of the NRSMPA (DCCEEW 2024b) seek to draw on available science and the use of biological surrogates, recognising from the outset that knowledge of the biodiversity in some areas is limited. Surrogates include depth, temperature, substrate and geomorphology (Beeton *et al*. 2015).

Key inputs to the design of Commonwealth Marine Reserves include (DCCEEW 2024b);

- existing scientific information underlying IMCRA v4.0 (for example, bathymetry, geomorphic features and distribution of endemic biota),
- additional regional information on habitats, species distribution and ecology,

- data on the location and distribution of human activities in the region,
- perspectives of ocean users and other stakeholders in the region,
- consideration of the contribution that existing spatial management measures can make to the NRSMPA, and,
- consideration of potential management effectiveness (for example, practicality and feasibility of compliance).

Four goals and 20 principles provide direction on how to ensure that all types of marine ecosystems and their biodiversity are represented within the national network of marine reserves. The goals are:

Goal 1 - Each **provincial bioregion** occurring in the marine region should be represented at least once in the marine reserve network. Priority will be given to provincial bioregions not already represented in the National Representative System.
Goal 2 - The marine reserve network should cover all **depth ranges** occurring in the region or other gradients in light penetration in waters over the continental shelf.
Goal 3 - The marine reserve network should seek to include examples of **benthic/demersal biological** features (for example, habitats, communities, sub-regional ecosystems, particularly those with high biodiversity value, species richness and endemism) known to occur in the marine region at a broad sub provincial (greater than hundreds of kilometres) scale.
Goal 4 - The marine reserve network should include all **types of seafloor** features. There are 21 seafloor types across the entire Exclusive Economic Zone. Some provincial bioregions will be characterised by the presence of a certain subset of features, such as continental slope or seamounts.

The goals and principles provide guidance in considering potential impacts on people when the locations of new Commonwealth marine reserves are being identified. In particular, the principles require that the selection and design of marine reserve networks is done in a way that minimises potential socio-economic impacts on marine users and coastal communities (DCCEEW 2024b). Of particular relevance are those that relate to zoning (that is, the allocation of appropriate management regimes to different areas), because zoning of marine reserves has the potential to affect the socio-economic costs associated with the establishment of any marine reserve.

The following **zoning principles** will be applied in developing the regional systems of marine reserves:

1. Zoning will be based on the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)/the World Conservation Union (IUCN) categories of protection (see below).
2. The regional marine reserve network will aim to include some highly protected areas (IUCN Categories I and II) in each provincial bioregion.
3. Zoning will be based on the consideration of the threat that specific activities pose to the conservation objectives of each marine reserve.
4. Zoning of marine reserves will seek to ensure that the conservation objectives of the area are protected, taking into account a precautionary approach to threats as well as the relative costs and benefits (economic, social and environmental) of different zoning arrangements.

The EPBC Act (section 346) requires that areas within reserves are assigned to one of the categories defined by the International Union for Conservation of Nature (IUCN). Table 1 shows how Australia applies IUCN zoning to its Commonwealth Marine Reserves (CMRs).

Table 1: Commonwealth marine reserve zone types and International Union for the Conservation of Nature Categories (modified from Beeton *et al.* 2015 after DEECCW 2024b).

CMR zone types	IUCN Category assigned	Assigned IUCN Category description
Sanctuary Zone	IUCN Ia – Strict nature reserve	Managed mainly for scientific research or environmental monitoring
Marine National Park	IUCN II – National Park	Protected and managed to preserve its natural condition
Habitat Protection Zone Recreational Use Zone	IUCN IV – Habitat/species management area	Managed primarily, including (if necessary) through active intervention, to ensure the maintenance of habitats or to meet the requirements of specific species
Multiple Use Zone General Use Zone Special Purpose Zone	IUCN VI – Managed resource protected area	Managed to ensure long-term protection and maintenance of biological diversity with a sustainable flow of natural products and services to meet community needs

CBD's Strategic Plan for Biodiversity 2011-2020 and its Aichi Targets

Following a recommendation of CBD signatories, the UN declared 2011 to 2020 as the United Nations Decade on Biodiversity in December 2010. The Convention's *Strategic Plan for Biodiversity 2011-2020* (CBD 2010a), which included the Aichi Biodiversity Targets, aimed to arrest global biodiversity loss. Target 11 stated:

> *By 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes.*

Australia's Strategy for Nature 2019-2030

Australia's Strategy for Nature coordinates national delivery of Australia's commitments to the CBD, it's Aichi Targets, and other international agreements including the Sustainable Development Goals, Ramsar Convention on Wetlands and the Convention on Migratory Species (DEECCW 2024c). A precautionary approach and adaptive management are key principles underpinning the strategy.

Kunming-Montreal Global Biodiversity Framework (GBF)

In December 2022 the Parties to the CBD adopted the Kunming-Montreal Global Biodiversity Framework (GBF) which replaced the CBD's Strategic Plan for Biodiversity 2011-2020 and its Aichi Targets, setting 23 global targets for urgent action over the decade to 2030. Target 3 of the GBF states:

> *Ensure and enable that by 2030 at least 30 per cent of terrestrial and inland water areas, and of marine and coastal areas, especially areas of particular importance for biodiversity and ecosystem functions and services, are effectively conserved and managed through ecologically representative, well-connected and equitably governed systems of protected areas and other effective area-based conservation measures, recognizing indigenous and traditional territories, where applicable, and integrated into wider landscapes, seascapes and the ocean, while ensuring that any sustainable use, where appropriate in such areas, is fully consistent with conservation outcomes, recognizing and respecting the rights of indigenous peoples and local communities, including over their traditional territories.*

DCCEEW is currently updating the strategy to show how Australia will contribute to the goals of the GBF. National targets aim to provide a focused and sustained approach to address biodiversity priorities.

On 10 November 2023, Australia's environment ministers agreed on six priority areas for national targets under the strategy (DCCEEW 2024c). These are;

- protecting and conserving 30% of Australia's land and 30% of Australia's oceans by 2030,
- working towards zero new extinctions,
- effective restoration of degraded terrestrial, inland water, marine and coastal ecosystems,
- tackling the impact of invasive feral species,
- building a circular economy and reducing the impact of plastics on nature, and,
- minimising the impact of climate change on nature.

The International Union for Conservation of Nature (IUCN) defines a protected area as "a clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values" (Dudley, 2008). Marine protected areas are seen as a key tool for marine conservation and signatories to the CBD have pursued the establishment of a global network of comprehensive, representative and effectively managed national and regional protected areas (CBD 2006, 2007). The initial target of 10% by 2012 (CBD 2006) has been amended to 17% by 2020 (CBD 2010b) and most recently to 30% by 2030 (CBD 2022), even though less than 10% of the global ocean is currently protected (Pike et al. 2024). One response has been an increase in the number and size of large marine protected areas (MPAs) designated by nation states to meet such targets, often without a firm understanding of the ecosystem and ecological processes that exist or the feasibility of the targets (Agardy *et al.* 2003, Wood *et al.* 2008, Leenhardt *et al.* 2013). As such, large marine protected areas, particularly those that are in remote areas, risk being no more than 'paper parks' due to difficulty in monitoring and management (de Santo 2013, Pressey 2013, Devillers *et al.* 2014, Pressey *et al.* 2017). Pursuing CBD targets are also thought to undermine sustainable long-term conservation objectives, particularly when 'political' imperatives tend to over-ride 'ecological' ones (de Santo 2013).

The global expansion of marine protected areas gives rise to a risk that they will be biased towards places that are remote or unpromising for extractive activities (eg mining, oil& gas, fishing), hence following the trend of terrestrial reserves in being ‘residual’ to commercial use (Devilliers *et a*l. 2014). This concern has polarised opposing views on marine protection leading to the perception in some circles that only no-take areas are of any conservation value (Costello & Ballantine 2015, Sala & Giakoumi 2018).

The Goals and Principles used to establish Australia’s NRSMPA prioritise the placement of reserves in areas that should best represent marine biodiversity but have the least impact on resource users (Beeton et al. 2015). For example, the Principles state that socio-economic impacts should be minimised and that the regional network should aim to include some highly protected (IUCN I and II) zones within each provincial bioregion. Despite this the Australian Commonwealth network of marine reserves has not escaped criticism of being strongly residual, making almost no difference to ‘business as usual’ for most ocean uses (Devillers *et al*. 2014).

The Kunming-Montreal Global Biodiversity Framework (GBF) target relating to spatial protection of land and sea “30X30” is often interpreted as a zero-extraction target that excludes activities such fishing and mining. However, this is not what is intended. Target 3 of the GBF, calls for at least 30 percent of terrestrial, inland water, and of coastal and marine areas, to be effectively conserved and managed through ecologically representative, well-connected and equitably governed systems of protected areas. It encourages a more diverse range of protection measures while allowing for sustainable use that is consistent with conservation outcomes. It specifically recognises the rights of indigenous people and local communities.

The GBF, is a more nuanced approach to biodiversity conservation more akin to Marine Spatial Planning (MSP) which aims to manage the use of the ocean coherently ensuring that human activities which are part of the system take place in an efficient, safe and sustainable way. Under the GBF marine protection varies significantly across the protected area, ranging from strict protection for biodiversity where no exploitation is permitted (‘no-take MPAs’; IUCN Categories IA and II) to areas that allow for a range of extractive uses, such as commercial fishing (‘multi-use MPAs’; IUCN Categories IV and VI).

To overcome the misconceptions about zero-extraction one must be able to demonstrate the value of reserves that provide for multiple uses with a mosaic of management categories. In this regard Australia frequently suggests the Great Barrier Reef Marine Park as an example of a multiple-use MPA. There, in the world’s largest World Heritage site, careful planning and management succeeds in achieving a balance between conservation, scientific research and sustainable industries, such as fishing and tourism (Osborn 2011, Spalding *et al.* 2016). Similarly, in other parts of the world, fisheries and marine protected area management is transitioning towards a more inclusive and broader ecosystem approach (Barreto et al. 2020), away from the over-centralised biologically driven approach to reserve management. This recognises the human dimensions of planning and management in marine systems and is a transition that has already been recognised in terrestrial management (Zoomers 2010, Ban *et al.* 2013, Dudley *et al.* 2018).

Ecologically Sustainable Development

This section is included to outline the principles of Ecologically Sustainable Development (ESD), how these have been applied in Australia and internationally to fisheries management, including the HIMI fishery, as well as how they should be applied at the regional-level, ecosystem-based management scale to provide a basis for assessing if the planning processes used for the HIMI proposal meet ESD obligations.

Key findings:

- The 1992 *National Strategy for Ecologically Sustainable Development* (ESD) requires the balanced consideration of all relevant environment, social and economic objectives for management planning processes such as the HIMI.
- The set of risk-based ESD frameworks now developed for use in marine regions form a clear hierarchy from the activity (Fishery ESD), sector level (multi-fishery - EBFM) to the regional level (Multi Sector - EBM) to collectively deliver on ESD.
- The use of the fishery-level ESD assessments has facilitated most Australian fisheries maintaining their export accreditation with many, including the HIMI fishery, also obtaining international, third-party sustainability certification.
- The suite of assessments conducted for the HIMI fishery have found while it poses minimal threats to the ecological wellbeing of the HIMI region it generates clear economic, social and governance benefits for Australia.
- At the multi-fishery EBFM level, the HIMI fishery is also successfully meeting the conservation requirements of international Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR).
- To apply the multi-sector EBM framework to a region, such as the HIMI, requires a whole of government approach that develops a full set of ESD objectives covering all sectors operating within the region plus the use of transparent and inclusive processes to identify and prioritise threats and issues.

As outlined in the Introduction, the completion of the marine protected area planning processes for the HIMI to meet the requirements of the NRSMPA guidelines (ANZECC 1998) under the EPBC Act are not the only assessment and planning processes relevant to the operation and management of human activities within this area of Australia's marine estate. To ensure any planning outcomes generate the best overall outcome for the Australian community, other relevant legislative instruments, conventions, policies, management systems and stakeholder expectations must also be considered.

In this context, it is important to reiterate that the CBD outcomes generated at the 1992 UNCED conference, including those related to MPAs, reflect only some of the initiatives undertaken to pursue the overarching concept of "Sustainable Development". This concept was formalised by the World Commission on Environment and Development (WCED 1987) to reflect recognition during the 1970s and 80s of the need to ensure that: *"development…meets the needs of the present without compromising the ability of future generations to meet their own needs"*.

The WCED concept of Sustainable Development was formally adopted by all Australian Governments through the Federal, State and Territory governments endorsing the *National Strategy for Ecologically Sustainable Development* (Commonwealth of Australia 1992). To ensure that there was a balanced approach in dealing with environmental, social and economic issues, the National Strategy's definition of ESD was that we should be *'using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased'*. Therefore, whilst ESD can often wrongly be assumed to address only environmental issues, both the definition and the seven guiding principles within the NESD recognise that continued use and development of resources in a sustainable manner is a necessary element in meeting the long-term objectives of the Australian community. The integrated approach requires explicit consideration of the wider economic, social and environmental implications within all decision-making processes is still the cornerstone, and major innovation of ESD.

Given its overarching stature, ESD was designed to cover all activities of all Australian, state and territory governments and their agencies and has subsequently been included in many legislative instruments at Commonwealth and state levels. It was expected that ESD principles would be explicitly considered and incorporated into the delivery of all relevant legislation, regulations, policies, international conventions and treaties. Consequently, the management planning processes undertaken for the HIMI should, in addition to addressing the specific objectives within the EPBC and the MPA related policy expectations within the CBD (including the recent GBF update), also include explicit consideration to addressing the specific objectives contained within the *Fisheries Management Act 1981*, which in addition to directly referencing ESD principles includes an objective for *maximising the net economic returns to the Australian community from the management of Australian fisheries*, plus other relevant treaties (e.g. UNCLOS, MARPOL, CCAMLR), relevant international policies (FAO 1995) and other Sustainable Development Goals.

Given the potential complexity associated with efficiently identifying, assessing and linking the various set of objectives, threats, risks, management systems and stakeholder expectations, significant efforts have been made over the past two decades to develop methods for the practical application of the holistic principles of Ecologically Sustainable Development (ESD) specifically for use with marine based sectors and regions. This has resulted in the development of a series of ESD based processes and frameworks which effectively operate at three different levels of complexity. It is instructive to understand how these frameworks were developed and how the planning processes undertaken for HIMI align with those required to meet the overarching requirements of ESD.

Current ESD Frameworks and Their Uses

The broadscale agreement by governments in Australia and world-wide during the 1990s of the need for the adoption of the principles of Sustainable Development, resulted in many differing terms and concepts being proposed in the early 2000s to describe the holistic management of natural resources. Specifically for fisheries and marine resources, a variety of terms was proposed, these included Ecosystem Based Management (EBM; e.g. Ward *et al.* 2002, McCloud *et al*. 2005), Ecosystem Based Fishery Management (EBFM; e.g. Brodziak & Link, 2002, Smith *et al.* 2007), Ecosystem Approaches to Fisheries (EAF; e.g. Garcia *et al.* 2003), Integrated Oceans Management (IOM; e.g. NOO, 2004), Marine Spatial Planning (e.g. Day *et al.* 2008, Douvere, 2008).

Within Australia, a result of this plethora of similar terms was that a number of government initiatives for the adoption of the principles of the sustainable use of resources were being undertaken through a series of independent initiatives. These included the formal adoption of ESD principles into the management of individual fisheries and aquaculture (e.g. Fletcher *et al.* 2002, 2004), the development of a national system of marine protected area (e.g. ANZECC, 1998) and various state level marine area planning (e.g. DEHSA 2004). As these initiatives were not coordinated, there was often duplication and competing processes which generated a high level of confusion among stakeholders about what the different initiatives covered and if they fitted together. Without effective coordination, this confusion was increasing the challenges facing governments to effectively manage the collective 'use' of marine, coastal and estuarine resources in order to achieve the most appropriate ESD based outcomes for the entire community.

To deal with the issues being generated from multiple and potentially overlapping 'sustainability' concepts, a National ESD Reference Group was established in 2004. This Reference Group included representatives from all state, territory and Commonwealth jurisdictions which held a workshop to determine how to reconcile all the different terminologies that were being used amongst sectors and agencies. The outcome from these discussions was that it was determined that "*ESD should be seen as the overall goal of Government and that other terms (e.g. EBFM, EBM, MSP etc.) described strategies that should be used by various sectors and agencies to work towards the goal of ESD*" (Fletcher 2006).

The Reference Group also agreed that every ESD related framework must consider and assess all relevant environmental impacts, social and economic outcomes along with the governance systems in a holistic and coordinated manner. It was also recognised that while each of these concepts and terms reflected the same set of ESD based principles, the scope of the issues being addressed varied greatly depending upon the scale and number of sectors involved. To ensure there was consistency and coordination, not only was the scope and consistent name for each of these concepts covered clarified but they were structured in a manner so that they formed a clear and comprehensive hierarchy which all worked together within an overall ESD framework (see Figure 5).

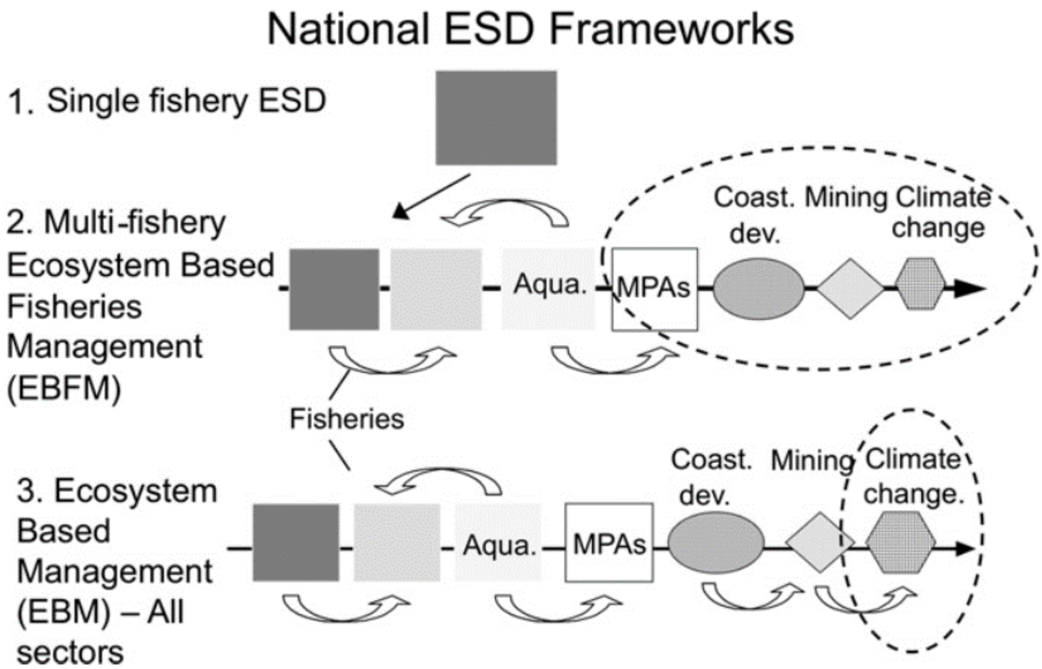


Figure 5: Relationship between the three ecosystem-based framework levels for the marine environment. The elements included in the dashed ovals represent the difference in external drivers between EBFM compared to EBM (modified from Fletcher 2006).

Over the subsequent 20 years there has been substantial use and ongoing development and extension of each of these ESD frameworks which has generated significant benefits for the effective and efficient management of Australian and global marine resources. A short description of the development and the level of implementation of each of these ESD frameworks is summarised below.

Fishery Level ESD Framework – single fishery management

For individual fisheries, such as the fishery that operates in the HIMI region, there was a major impetus to develop a practical ESD framework in the early 2000s from the new requirement for all export-based fisheries to submit applications against the Federal Government's guidelines for sustainable fisheries (e.g. Commonwealth of Australia 2007). This resulted in a series of FRDC projects from which the National Fisheries ESD Framework was developed for fisheries and aquaculture (Fletcher *et al*. 2002, 2004, 2005). This framework not only assisted all Australian jurisdictions meet the requirements for the reporting and assessment of wild capture fisheries to demonstrate their ecological sustainability and retain their WTO exemptions, but it also generated the methods needed to identify and assess social values (e.g. Schirmer & Casey 2005) and economic outcomes and risks (e.g. Hundloe 2002, Vieira *et al.* 2009).

The National ESD framework is a four step, risk-based process that assists with the generation of reports and management systems covering the full spectrum of relevant ESD issues for an individual fishery. The process involves identifying issues by dividing ESD into eight major components (within three main categories) relevant to fisheries: including impacts on target species, bycatch, habitat and the broader ecosystem, the social and economic outcomes and the current governance systems (Figure 6).

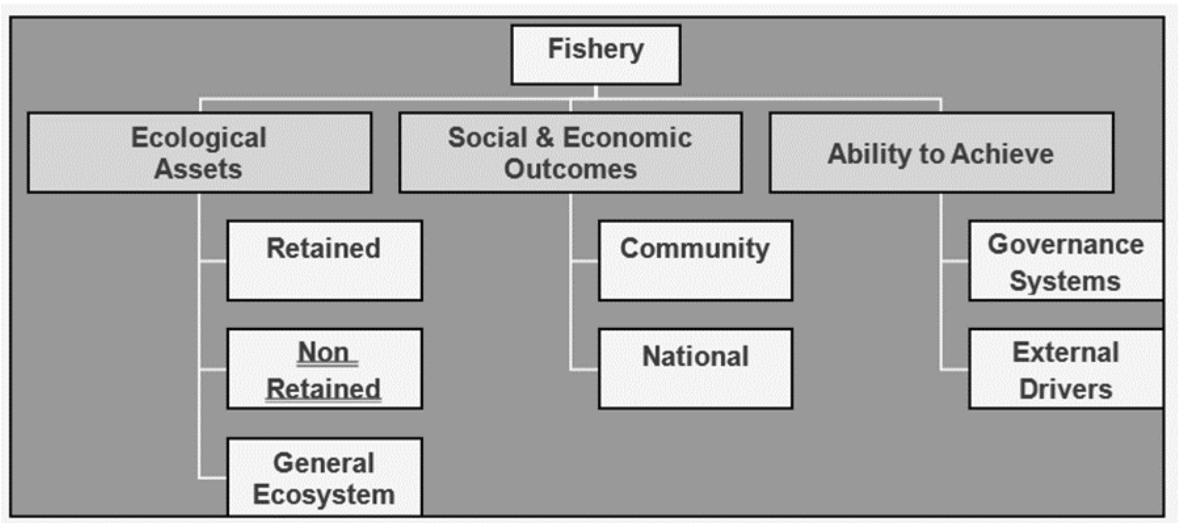


Figure 6: The fishery level ESD component tree (Fletcher et al., 2002).

A critical part of the framework was the inclusion of a formal risk assessment process to determine objectively which issues needed management and at what level (Figure 7). It also requires developing clear performance levels and indicators to monitor if the management arrangements are working effectively, which were often used as the precursors for the development of formal harvest strategies.

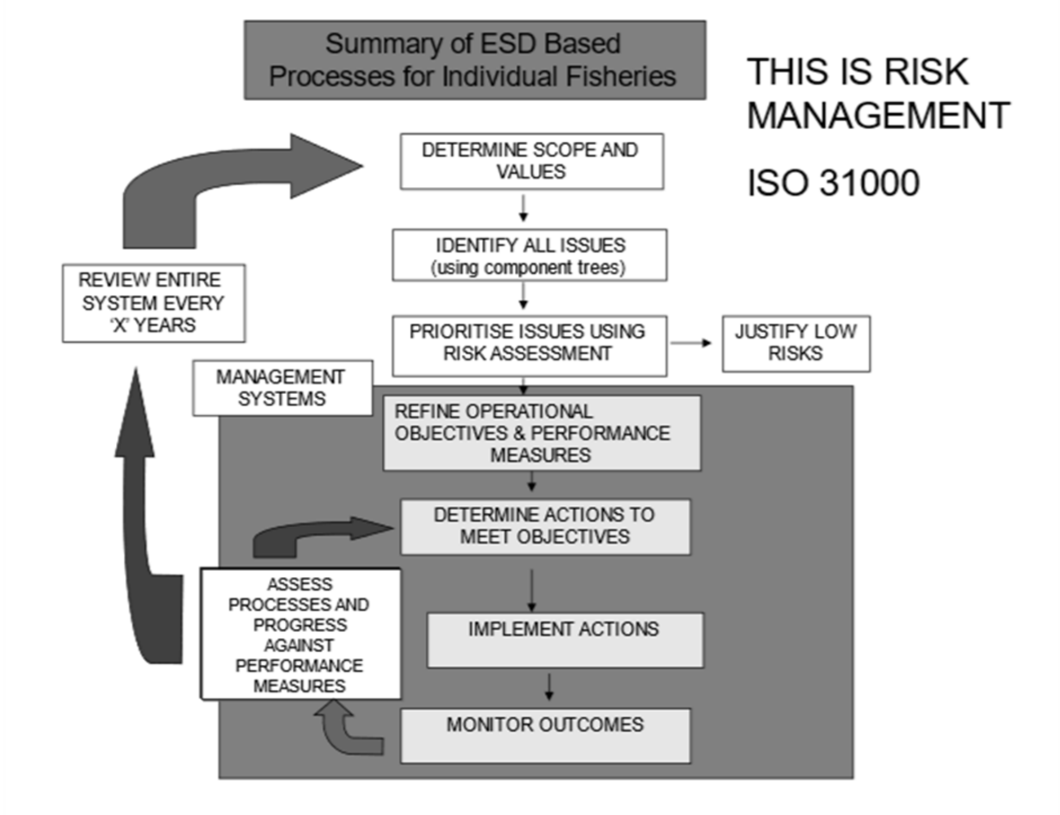


Figure 7: Summary of the Fishery Level ESD Processes (modified from Fletcher *et al.* 2002).

Implementation

Adoption of the National ESD Framework or other equivalent risk-based systems (e.g. Hobday *et al*. 2007) greatly assisted in the generation of successful EPBC applications for most Australian export fisheries. The reports that have been generated using the full national framework provide a comprehensive assessment of the impacts, both positive and negative, associated with an individual fishery and directly link the performance of the fishery to the objectives and arrangements within the management plan (Figure 4).

Over the subsequent decade, through the application of ESD framework most of the major ecological problems for individual fisheries in Australia were identified and appropriately addressed (Fletcher 2008). The ESD process also resulted in a substantial increase in the development of explicit harvest strategies for target species that specify, based on the current and likely future status of the indicators compared to agreed reference levels, what level of management action is required to ensure that stocks remain at, or recover to, sustainable levels in a timely manner. This significant improvement to fisheries management is reflected by the large proportion of Australian fish stocks that are currently considered to be at sustainable levels and the rapid implementation of additional management where necessary (SAFS 2024).

The adoption of these comprehensive, risk-based ESD assessments and management systems, facilitated the majority of Australian fisheries being able to maintain their WTO accreditation under the EPBC Act. Furthermore, a large proportion of Australian fisheries have subsequently obtained and maintained international, third-party sustainability certification schemes such as the Marine

Stewardship Council (Bellchambers *et al.* 2016). This includes the HIMI fishery (Brand-Gardner *et al.* 2022).

There has also been a high level of international success in the adoption of the ESD framework including by the UN as basis for the practical application of its Ecosystem Approach to Fisheries (FAO 2003) in order to efficiently address the Code of Conduct for Responsible Fisheries (FAO 1995, Fletcher & Bianchi 2014). It was also adopted by the Forum Fisheries Agency for the EAFM assessment of the tuna fisheries in Western Central Pacific Region (Fletcher 2010).

With specific reference the ESD performance of the HIMI fishery, a summary of this fishery's assessments against each of the ESD principles is outlined below based on the comprehensive and independent reports that have been completed for this fishery to meet the requirements of ABARES, EPBC and MSC assessment schemes.

Ecological Well Being Elements of ESD

ABARES - In terms of the status of the two target species, the fishery continues to be classified by the Australian Bureau of Agriculture and Resource Economics (ABARES) as not overfished and not subject to overfishing (Patterson & Curtotti 2023).

EPBC/WTO - The most recent formal assessment of the HIMI fishery by the Department of Environment and Energy (2016) against the Guidelines for the Ecologically Sustainable Management of Fisheries (2nd edition), which evaluates the ecological sustainability of fishery management arrangements and covers assessments of target species, bycatch, TEPs, Habitat and Ecosystem impacts, found that the fishery appears to be relatively well managed and consistent with the objects of the EPBC Act. The final recommendation for the Heard Island and McDonald Islands Fishery was that the fishery was considered low risk and is recommended for 10-year approval (2016 to 2026).

MSC - Similarly, the HIMI fishery has also had third party sustainability certification through the Marine Stewardship Council (MSC) since 2012. This has been extended through recertification several times with the fishery was last recertified in 2022 under v 2.01 of the MSC Standard and, unlike many fisheries, there were no conditions imposed at this reassessment (Brand-Gardner *et al.* 2022).

The most recent annual audit in 2024 by bio.inspecta found that the HIMI toothfish and icefish fishery continues to meet the MSC standard v 2.01 and recommends the continued use of the MSC certificate through to the next surveillance audit (Bellchambers 2024). Importantly, in the last MSC assessment this fishery scored very highly across all three MSC principles (Target Species, Ecosystem Impacts; Management) with outcome scores between 90-100 out of 100. Extracts from the MSC report (Brand-Gardner *et al.* 2022) stated the following:

Principle 1 (Target Species): The harvest strategy contains all of the required elements (monitoring, stock assessment, harvest control rules, and management actions that follow the agreed rules). It is designed to meet stock management objectives, and its elements work together to achieve this. The strategy is also responsive to the state of the assessed component of the stock, as catch limits are determined based on a range of data sources that will reflect stock status including the results of the annual fishery-independent survey of abundance.

The management objectives that the harvest strategy is designed to achieve are articulated in the precautionary approach that was adopted by CCAMLR in the mid-1990s and include the objective of maintaining a stock at a proportion of its pre-exploitation abundance as specified in the reference points;

1) escapement of the spawning stock must be sufficient to avoid the likelihood of declining recruitment, and
2) abundance under exploitation must maintain a sufficient resource for the needs of dependent species (usually predators).

The undertaking of annual biomass surveys each year as the basis for setting TACs, and the adoption of a relatively low exploitation rate with a high degree of certainty, indicate that the elements of this harvest strategy are designed to achieve these objectives. The harvest control rules are also able to respond quickly to changes in stock abundance levels generated from environmentally induced recruitment changes.

Principle 2 (Ecosystem Impacts) - Ecological Risk Assessments (ERA) have been undertaken on the key gear types used in the HIMI Fishery; demersal trawl (Sporcic *et al.* 2018a), midwater trawl (Sporcic *et al.*, 2018b) and demersal longline (Bulman *et al*. 2018). The ERAs concluded that there were no target, bycatch, byproduct or protected species considered to be at high risk from the effects of fishing across the different gear types given the suite of management and conservation initiatives that are in place for the fishery. More details on these assessments are provided in the HIMI Fishery Section.

With respect to **TEPS interactions**, the fishery must comply with CCAMLR conservation measures (CM) (CM 25-03 for trawl and CM 25-02 for longline) for seabirds and marine mammals. There is 100% observer coverage and there are only very few interactions with any of these species each season.

Specifically in relation to **benthic impacts**, the assessment model developed by Welsford *et al.* (2014) estimated the amount of disturbance caused by demersal fishing operations (longline and trawl) that due to the restricted footprint of commercial fishing, less than 1.5% of the biomass is impacted in waters less than 1200 m.

The study also found that the HIMI Marine Reserve at that time was already estimated to contain over 40% of the biomass of the groups of benthic organisms considered as most vulnerable to demersal fishing at HIMI. The study showed that it is unlikely that disturbance due to demersal fishing has caused a significant impact to benthic biodiversity in the Australian EEZ at HIMI, even for the most vulnerable taxa such as sponges, corals and bryozoans.

Overall, the study found that only 0.7% of the seafloor area within the EEZ at HIMI was estimated to have had some level of interaction with bottom fishing gear between 1997 and 2013. Since that study was completed the boundaries of the Reserve were expanded on 28 March 2014 to 71,000 square kilometres making even less of the area available for fishing.

In terms of **ecosystem structure impacts**, Subramaniam *et al.*, (2020a) used an existing Ecopath model to describe food web dynamics on the Kerguelen plateau and investigate food web interactions with the HIMI fishery and found that the lack of responses was due to the fishery not removing biomass at a level that impacts food web dynamics.

Overall: The risks to the ecological components from the HIMI fishery are all considered to be at very low or acceptable levels (see also details in the HIMI Fishery Section). Consequently, based on these assessments, the HIMI fishery poses very minimal threats to the ecological assets located within the HIMI region, the areas currently closed to fishing within marine reserve zones are already substantial and therefore there is no clear basis to justify a significant expansion in fishing closures or gear-based restrictions which may have a significant impact on the Human Wellbeing elements for the fishery.

Human Wellbeing (Social-Economic) and Ability to Achieve Elements of ESD

From the broader ESD perspective it needs to be recognised that the HIMI fishery generates significant economic, social and governance benefits for Australia. In summary the fishery produces:

- An average of over 3,500 tonnes of high-quality finfish (Toothfish and Icefish) have been captured annually since the fishery began in 1997.
- Product marketed for sale in both domestic and international markets.
- Significant income (tens of $million/year) with some of these products fetching up to $100/kg in retail markets due to the high standing of the quality and the high level of sustainability credentials.
- Carbon offsets generated to cover the activities of both the fishing and processing operations.
- Direct and indirect employment in fishery operations, through the supply chain, wholesale, retail and hospitality outlets.
- A strong record of crew and staff safety with part of the fishery certified against the Fairness, Integrity, Safety and Health (FISH) Standard for Crew as an organisation that meets internationally recognised best practice for ensuring decent working conditions for fishers, and the other part certified against the Responsible Fishing Vessel Standard (RFVS) from Global Seafood Assurance.
- Important governance benefits for Australia and the Antarctic region in general. This includes assisting the compliance of fishing activities in this remote region as IUU fishing has been eliminated from significant levels (7,000t per year) in the late 1990s to early 2000s.
- A significant amount of the scientific knowledge that is available for this region with the majority of the fishery and ecological information generated from the vessels operating in this region.
- A key role in the management of the entire Southern Ocean and Antarctic Region through its involvement in CCAMLR (see below).
- An important role in the promotion of sustainable fishery practices that fall within the CCAMLR convention, where they are seen as operating under world's best-practice and continue to undertake leading edge initiatives across the full spectrum of ESD components.

Ecosystem Based Fishery Management (EBFM) – multi-fishery management

While the fishery level ESD framework was successful in meeting the requirements of the EPBC legislation, the ESD reference group identified that it was not adequate to deal with the assessment and management of the impacts and outcomes that relate to all the fisheries sectors accessing the same resource, especially dealing effectively with the social elements (Millington and Fletcher 2008). A higher level of management, which was termed EBFM, was adopted to deal with the coordinated management of all commercial, recreational, charter, indigenous sectors that access the same resource/region.

EBFM level assessments assimilate the individual fishery level ESD assessments to cover the cumulative impacts on the environment. They also address the current resource allocations amongst the various fishing sectors that are accessing a resource or region. Furthermore, they document the overall social and economic outcomes that arise from the current suite of activities and access arrangements operating on the same resource and within the region. This ensures that the management of all relevant fisheries and sectors is done in a coordinated manner.

To undertake EBFM effectively requires integrating the management arrangements of all individual fishing activities within a region to ensure that collectively they are achieving whole of resource objectives (Figure 8). In the EBFM context, the development and declaration of MPAs within a region is recognised an external driver because it may impact on the access level of one or more fishery sectors. Where there is loss of access, this must be appropriately reflected in altered management settings of the affected fisheries including reductions in overall catch levels and change allocations of the overall catch among each of the catching sectors, which impacts the achievement of their social and economic objectives.

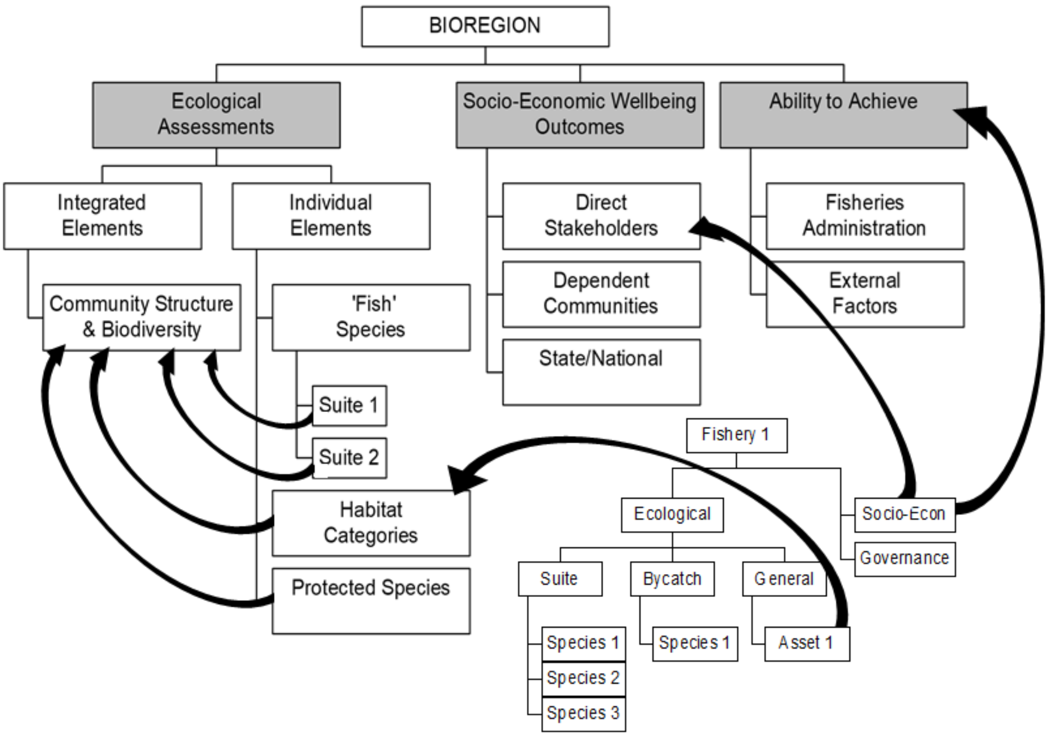


Figure 8: The mid-level EBFM component tree framework showing how each of the fishery level ESD issues are mapped into cumulative, regional-level components. Furthermore, the component tree shows how ecosystem elements are composed of the integrated set of individual elements (Modified from Fletcher et. al. 2010).

EBFM Implementation

The EBFM framework has been applied extensively in coastal jurisdictions of Australia where there are often many different fishery sectors (commercial, recreational, charter, customary) that want to access the same fish resource (see Fletcher *et al*. 2012) and therefore use expanded risk assessment methods that cover the full range of ecological risks plus potential social, economic and governance risks (Fletcher, 2014). While the HIMI region has no recreational, charter or indigenous fishing sectors, the HIMI fishery does fit into the EBFM level of ESD framework as it is one of the 20 participant fisheries that comes under regional management coordinated by CCAMLR.   This body which was established by international convention in 1982 with the objective of conserving Antarctic marine life within the high seas and national waters of the Antarctic and Southern Ocean (ASO).

CCAMLR is made up of 25 participating member countries, including Australia. Consequently, while, the HIMI is primarily managed by the Australian Fisheries Management Authority, it must do this in accordance with the Conservation Measures as adopted by the CCAMLR.

The objectives of the Convention are the conservation of Antarctic marine living resources, but importantly, the term "conservation" includes rational use. Any harvesting and associated activities must be conducted in accordance with the following principles of conservation:

- Ensure any harvested population does not fall below levels that enable stable recruitment or the restoration of depleted populations to these levels.
- Maintenance of the ecological relationships between harvested, dependent and related populations of Antarctic marine living resources.
- Prevention of changes or minimization of the risk of changes in the marine ecosystem which are not potentially reversible within reasonable time frames.

Based on these principles, CCAMLR practises an ecosystem-based management approach which requires harvesting to be carried out in a sustainable manner with a mandate to conserve populations or ecosystems that are not only directly related to harvested marine resources, but also conserve dependent and related populations.

The fisheries in the convention area currently target Patagonian toothfish (*Dissostichus eleginoides*), Antarctic toothfish (*Dissostichus mawsoni*), mackerel icefish (*Champsocephalus gunnari*) and Antarctic krill (*Euphausia superba*). Each of the fisheries operating in CCAMLR is reviewed annually by the CCAMLR working group on Fish Stock Assessment and the Scientific Working Group. Each year the CCAMLR recommends an annual total allowable catch limit for each member country and AFMA sets Australia's total allowable catch limit each year for the Heard Island and McDonald Islands Fishery.

The Sub-Antarctic Management Advisory Committee and the Sub-Antarctic Resource Assessment Group are multi-stakeholder groups who review the international and domestic science and management of the HIMI Patagonian toothfish and mackerel icefish and provide advice to the AFMA Commission. In addition, CCAMLR also regularly develops conservation measures to address any unacceptable impacts on other components of the ecosystem including bycatch, seabird/mammal interactions, benthic impacts and ecosystem effects.

Based on CCAMLR's s comprehensive EBFM approach, in a review of all Regional Fisheries Management Organisations operating in Areas Beyond National Jurisdiction undertaken by FAO-UNEP, it was concluded that CCAMLR was mostly to fully addressing all of the ecological components of EAF (Fletcher 2020; see Figure 9).

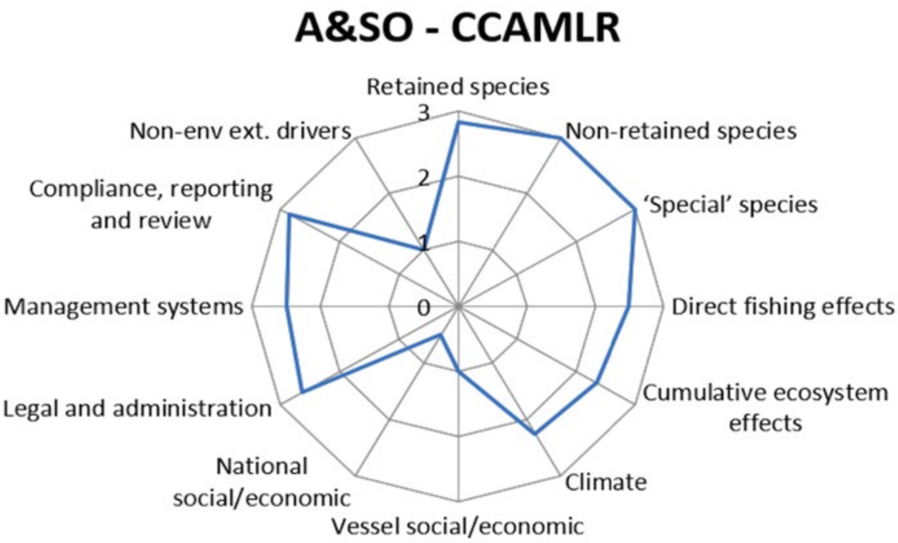


Figure 9: Summary of EAF implementation by CCAMLR for the Antarctic and Southern Ocean (ASO) region (where 1 = partly met; 2 = most met; and 3 = fully met) (from Fletcher 2020).

Ecosystem Based Management (EBM) – Multi-sector Management

The ESD reference group termed the highest level (multi-sector) ESD framework as EBM which was designed to deal collectively with the aggregate management of all sectors (fishing, shipping, tourism, mining, MPAs etc) operating within a single region to achieve ESD outcomes. Therefore, in the EBM framework, commercial fisheries, recreational fisheries and MPAs in the region each form one of the many sectors involved; other industries and stakeholders plus their objectives, along with the associated government agencies, must be included in this process, which can include the use of MSP.

Historically, many of the access and allocation arrangements amongst different sectors and users of the marine environment have generally occurred either implicitly or through independent decision-making processes. This approach can often result in outcomes that are adverse to one or more of the other sectors without there having been a clear assessment that this is the optimum outcome for society.

EBM is the framework that explicitly recognises that these different sectors (including relevant government agencies) are often competing for allocation of access to and/or utilisation of the space and resources located within this region. Therefore, the EBM processes must be effective in setting overall goals across the ESD spectrum to ensure that all marine industries are economically sustainable, meet societal needs, and that the individual or cumulative impacts of all ocean and relevant land-based activities do not generate unacceptable threats to marine ecosystem integrity or intergenerational equity. This is not the same as having no impact, which is not possible if a resource is to be utilised.

To progress the EBM initiative during the 2000s, the Marine and Coastal Committee (MACC) was established as the body with the responsibility to coordinate national policy development among all Australian governments and agencies that have jurisdiction within the marine and coastal areas. The MACC reported to the Natural Resource Management Ministerial Council (NRMMC) and included the heads of all federal, state and territory agencies from marine portfolios including fisheries, environment and transport.

In 2008, a report (MACC 2010) commissioned by MACC noted the progressive incorporation of ESD related approaches into marine policy in Australia and that there were several initiatives underway nationally and within jurisdictions but concluded that to provide a more coordinated response to issues facing marine biodiversity, that a multi-sectoral, Ecosystem Based Management (EBM) approach should be adopted by Australia. Such a policy framework would assist contribute to achieving ESD in the marine environment because it would integrate management of all the uses into a single, comprehensive and coordinated system. The report acknowledged that the sectorial level frameworks, such as has been developed for fisheries (EBFM) were already contributing to the government goal of achieving ESD with the EBM approach attempting to integrate and link the management of this sector with the management of other sectors and users of the marine environment to improve consistency of policy outcomes, minimize conflicts and wasteful actions. The MACC concluded that to be effective and efficient, each of the various management frameworks used by government should form an integrated hierarchy within an overall ESD context, with each level providing the building blocks for the next level (Figure 10).

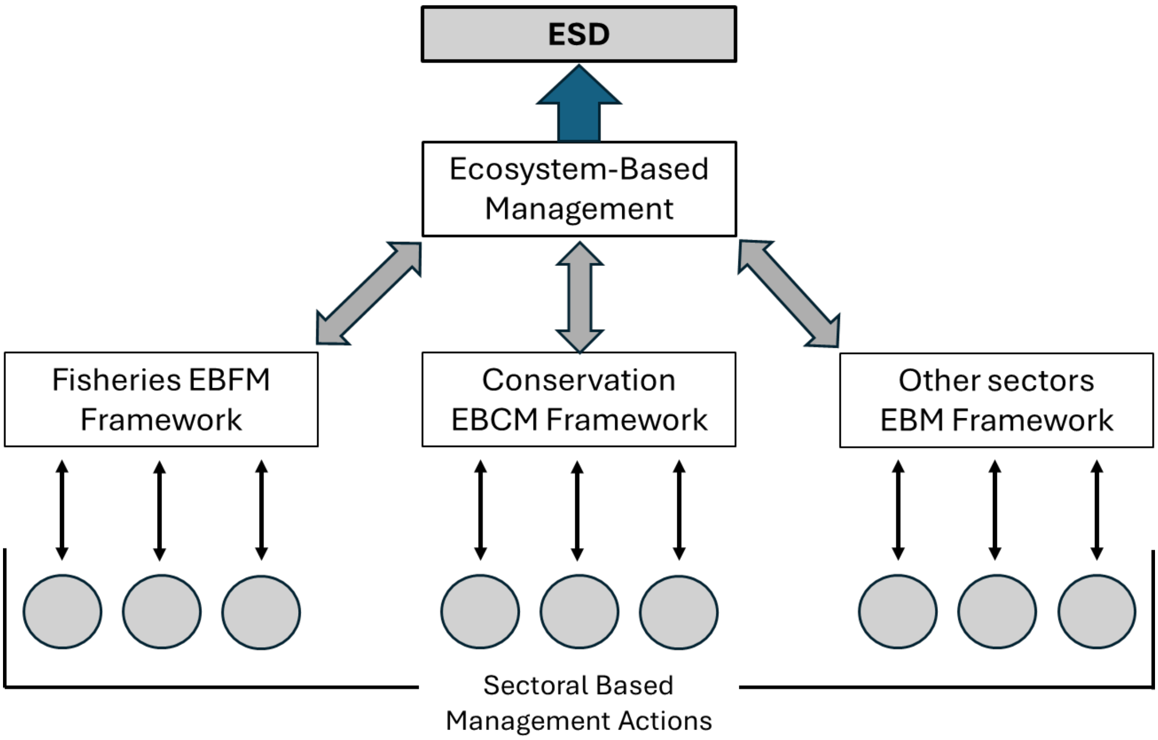


Figure 10: An integrated ecosystem approach in order to achieve ESD (MACC 2010).

To be effective, therefore, EBM required a process whereby whole of government objectives and performance measures for the region could be generated with the key challenge being to resolve trade-offs equitably.

The second key element for success was the use of transparent and inclusive processes to identify and prioritise issues. This was to be achieved by having processes that can effectively break down the broad themes covered by each of these concepts into appropriately sized units that are relevant to the scope and circumstances of the sector/region being examined and can be managed. This step needed to be linked to a risk assessment process that sorted the identified issues into those that require direct management and those that do not.

The final requirement was that every issue needing management must have an operational objective for which performance could be measured that is clearly linked to the current management arrangements. Such feedback systems greatly enhance the chance that decision-making can be based on data rather than rhetoric.

Once the main principles of EBM had been agreed by the NRMMC in 2009, the MACC was instructed to develop a National EBM framework that would be suitable for use within the Australian context. The steps outlined below define the key elements of the National EBM framework which were developed by the MACC working group for use in developing an EBM based plan for any region in Australia (MACC, 2010).

i. **Establish a group with overall responsibility for implementing EBM.** A governing body is required that includes government and community representatives that have a clear mandate from government or under regulations. The group could be supported by advisory groups such as an ecosystem coordination board or a science group.
ii. **Define the scope, including the boundaries of the ecosystem**, and establish the overall ecological, social and economic values. What are the specific IMCRA v4.0 ecosystems that are covered? Identify what are the ecological assets within each IMCRA v4.0 ecosystem and their associated social/economic issues. The component assets of the ecosystem include the exploited species, habitats and other species and processes that maintain ecosystem functioning.
iii. **Agree on relevant objectives for the ecosystem and each asset based on the values.** Objectives can be established for each asset and the ecosystem as a whole. Activities within the ecosystem will be managed towards achieving the objectives established. This step will ensure the integration of impacts of different activities as they are taken into account as cumulative impacts on the ecosystem.
iv. **Generate individual risk values and consolidate to asset level.** Complete risk assessments of the ecological, social or economic objectives associated with each of the identified issues. Consolidate the individual issues and risks into broader asset categories at a level that can be used for regional management planning purposes.
v. **Prioritise assets across the ecosystem.** Integrate the various ecological, social and economic risks and value scores associated with each of the regional level asset into a set of overall priorities for the whole ecosystem. Criteria for prioritisation must be determined as a first step to this process.
vi. **Determine actions to meet the objectives of the governing body and establish a monitoring evaluation and reporting framework for the ecosystem and assets**. For each of the priority issues, a set of actions to achieve clear operational objectives which have measurable specified targets need to be developed. These management systems should outline the methods to review performance and include what actions will be taken if performance is not acceptable.
vii. **Develop and implement an action plan.** Based on all the management systems developed, generate a work plan and priorities for implementation that outlines the specific activities that will need to be done by each of the relevant agencies and sectors to deliver the EBM outcomes.

viii. **Regularly review outcomes, make necessary changes and communicate.** At appropriate intervals, review the management system for each of the ecological assets and the entire EBM framework to ensure it is continuing to deliver the required outcomes for both government and the community.

EBM Implementation

With the removal of the national committees in the early 2010s, the MACC was disbanded, no further national progress was made in implementing the full EBM approach (Cochrane *et al.* 2014). Nonetheless, it was expected that the principles outlined in the EBM approach above would be adopted for all future regional marine initiatives.

Significantly, these EBM principles have been adopted and utilised within NSW for the implementation of its Marine Estate planning process which has involved the use of a comprehensive and coordinated threat and risk assessment covering all assets, ecological, social and economic objectives (e.g. NSW MEMA, 2017) which is equivalent to an EBM/MSP approach (see Figure 11)

Step 1	HOW THE COMMUNITY BENEFITS FROM THE ESTATE	Identify key economic, social and environmental benefits, and perceived threats and opportunities derived from the Estate	Develop ongoing engagement strategy: ■ community consultation ■ expert input ■ stakeholder surveys	*Principle 1*
Step 2	ASSESS THREATS AND RISKS TO BENEFITS	Expert assessment of threats and opportunities to the key economic, social and environmental benefits	Prioritise threats based on their likelihood and consequence and consider relevant scale: ■ local ■ regional ■ state-wide	*Principle 2*
Step 3	ASSESS MANAGEMENT OPTIONS TO MAXIMISE BENEFITS	Identify and assess current and potential management settings in delivering benefits to the community	Apply values to economic, social and environmental benefits of alternative uses. Assess which options deliver maximum benefit to the community.	*Principles 1, 3, 4, 5, 6 & 7*
Step 4	IMPLEMENT PREFERRED MANAGEMENT OPTIONS	Implement options that maximise overall benefits to the NSW community as a whole	Identify the most efficient and cost-effective management options. Design measurable performance indicators. *Develop strategic monitoring program to measure outcomes relative to the vision.*	*Principles 1 & 8*
Step 5	BE ACCOUNTABLE	Monitor, measure and report on performance *Review progress*	Report transparently to the community. Promote strategic research to inform management and enhance future outcomes. *Examine performance, including benefit, threat and risk status periodically.* *Review management arrangements for those not achieving adequate performance.*	*Principles 1, 9 & 10*

Figure 11: The Threat and Risk Framework developed for NSW Marine Estate Management (NSW MEMA 2015).

Marine Spatial Planning

This section is included to demonstrate best-practice marine spatial planning to effectively achieve and bring together the principles of ESD.

Key findings:

- Marine Spatial Planning should play a pivotal role in the development and review marine reserves.
- Quantitative spatial assessment of existing values, uses and threats must be considered to ensure effective and balanced management.
- It is not clear if the HIMI Marine Reserve expansion used effective Marine Spatial Planning processes or Decision Support Tools to develop established boarders or zoning.
- The review process did not adequately assess the ‘success’ or ‘failure’ of previous management plan to identify improvements in frameworks.

The development and review of the NRSMPA involves several processes that relate to statutory obligations, review of all available scientific information and Marine Spatial Planning (MSP) to guide decision making for an integrated and coordinated approach towards management. MSP processes consider how human activities occurring in the marine environment are spatially organised and seeks to find a balance between current use, conservation values and potential future use of significantly important areas (Stephenson *et al*. 2021). The development processes of marine spatial plans or Marine Reserves across time and space are generally heterogeneous, incorporating procedures that are contemporary at the time of development.

In 2009, the Nature Conservancy released a report (Beck et al. 2009) describing best practises for marine spatial planning and evidence-based decision making. This broadly involves consideration of the following categories in planning exercises:

- Geographic planning boundaries.
- Planning scale and resolution.
- Data collection and management.
- Multi-objective planning including aims and outcomes.
- Interactive decision support (tool).

These categories form the foundational basis for sustainable, effective, and efficient MSP. Perhaps the most important challenge for MSP is to explicitly consider multiple management objectives (e.g., energy production, environmental conservation, fishery production, transportation), deliberate the trade-offs among these and examine alternative scenarios for meeting them (Beck *et al.* 2009).

Typically, the process by which many organisational decisions are made is unstructured and the most common form of decision-making is through open conversation at a group meeting. Even where detailed information and analyses are presented, unstructured conversation can lead to cognitive biases within the process. The advent of Decision Support Tools (DST) and predictive models has greatly assisted in developing quantitative MSP processes that are clear and accountable. Decision-support tools promote transparency in decision-making by providing an approach where the input of information (data) is rigorously detailed, assumptions are explicit, and caveats are identified (Lacharité *et al*. 2021).

Walshe et al. (2019) released a report reviewing DST and their potential application in the management of Australian Marine Parks. The review was undertaken by the Australian Government's National Environmental Science Program (NESP) to provide an appraisal of the strengths and weaknesses of different DST for the kinds of problems encountered by marine park policy-makers and managers. The report demonstrated many quantitative approaches towards MSP and risk assessment under varying degrees of uncertainty and concluded that the specific tool to be used should be guided by the anticipated obstacles to a successful and lasting outcome. Sometimes those obstacles pertain to insufficient scientific understanding, or a reluctance to entertain creative alternative solutions, or difficulty in articulating and capturing stakeholder concerns (Walshe *et al*. 2019). Nonetheless, a structured approach and use of DST can contribute to wider adoption of decision making and provide for greater acceptance of outcomes.

MSP processes have significantly improved over recent years to provide for a quantitative approach in planning exercises. However, less detailed are the evaluation processes of existing marine spatial plans or management plans for Marine Reserves. Key questions for review of any marine plan should include:

- What constitutes success?
- How is success measured?
- Are the plans achieving their goals and objectives both in terms of representation of biodiversity and threat mitigation?
- Where and what are the shortcomings?
- How can the shortcomings be addressed?

These questions were not adequately addressed in the proposal to expand the HIMI Marine Reserve. Prior to the current expansion, a previous HIMI Marine Reserve management plan was implemented to guide management towards objectives, however, it is not clear if the previous management plan was deemed inadequate in achieving objectives set. Prior to implementation of a new management plan, comprehensive assessment of the metrics of success or failure needs to take place in order to understand how substantive improvements can be made.

The Heard Island and McDonald Island fishery

This section is included to describe the HIMI fishery and the management framework. Ecosystem effects in relation to commercial fishing are also defined.

Key findings:

- The HIMI fishery is managed by the Australian Fisheries Management Authority (AFMA) in accordance with the conservation measures adopted by CCAMLR and Australian law and catch limits are considered to be precautionary
- The fishery has independent third-party MSC accreditation
- Illegal, unreported and unregulated (IUU) catches in the region were historically large but no IUU vessels have been sighted since 2005. This is thought to be a result of the presence of Australian fishing operations in the region.

Description of the fishery

Australian commercial fishing within Australia's exclusive economic zone (EEZ) around HIMI has operated since April 1997 (Commonwealth of Australia 2002b). The fishery comprises demersal fishing (trawl, longlining and traps) targeting Patagonian toothfish (*Dissostichus eleginoides*) and demersal and pelagic trawling for mackerel icefish (*Champsocephalus gunnari*) (Welsford *et al*. 2014).

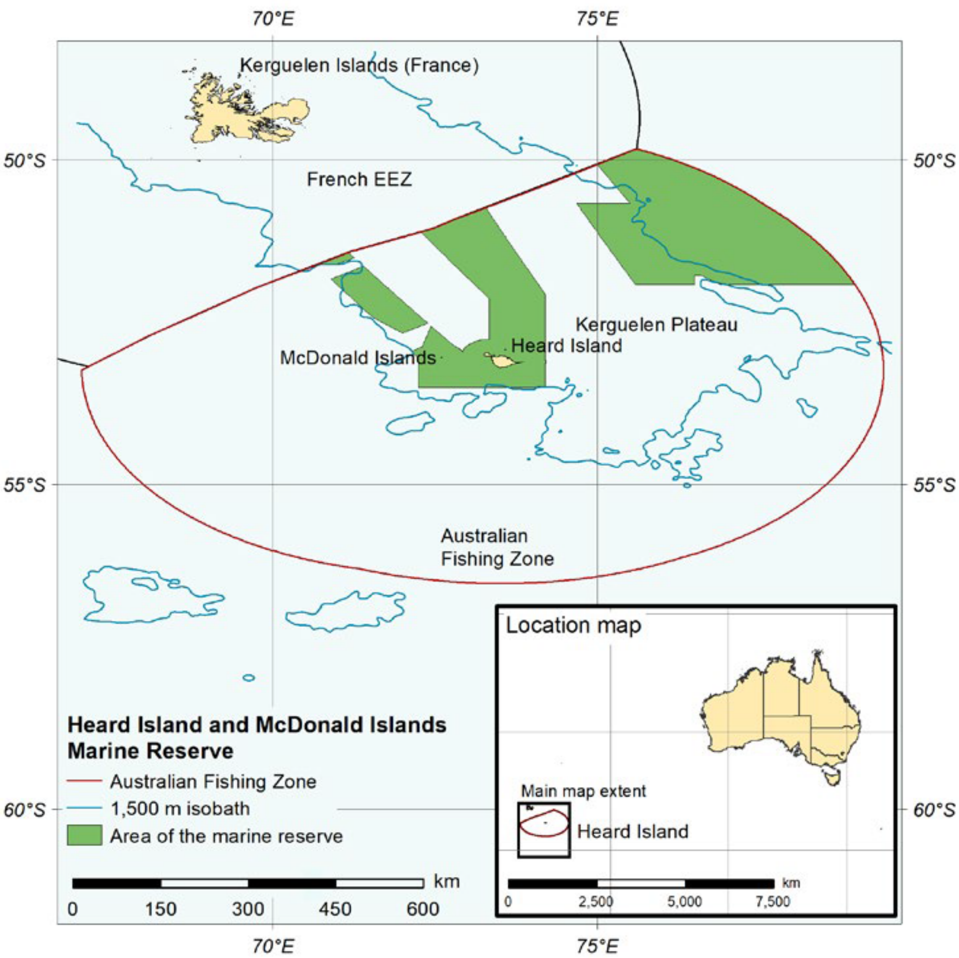


Figure 12: Location of the Heard Island and McDonald Islands fishery (Patterson & Curtotti 2023).

The Heard Island and McDonald Islands fishery occurs in the area covered by the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR) statistical division 58.5.2 with only a small extension, William's Ridge, on the eastern side of the northern part of the Plateau extending into the Southern Indian Ocean Fisheries Agreement (SIOFA) Statistical Area 7. (Figure 12). The islands and their surrounding territorial waters out to 12 nautical miles are closed to fishing and regulated under the *Environment Protection and Management Ordinance 1987*, administered by the Australian Antarctic Division (AAD) of the Australian Government Department of Climate Change, Energy, the Environment and Water (DCCEEW). Waters between 12 and 200 nm from HIMI are part of the Australian Fishing Zone (AFZ). A 1 nautical mile buffer zone around the territorial waters of HIMI extends the area closed to fishing to 13 nautical miles.

The fishery is managed by the Australian Fisheries Management Authority (AFMA) in accordance with the Conservation Measures adopted by CCAMLR and Australian law. The annual catch limit is based on the management advice from CCAMLR (CCAMLR 2023a,b). Currently, two Australian-owned companies participate in the fishery.

The catch limits are regularly reviewed by the Australian Fisheries Management Authority (AFMA) Sub-Antarctic Resource Assessment Group and Sub-Antarctic Management Advisory Committee, the CCAMLR Scientific Committee and the CCAMLR Commission, and determined by the AFMA Commission, and are considered precautionary (Patterson & Curtotti 2023).

Target species and bycatch

Patagonian toothfish (*D. eleginoides*)

D. eleginoides is a large long-lived species belonging to the family Nototheniidae, or Antarctic cods, characterised by slow growth, low fecundity and late maturity. They can reach 2m in length and weigh around 200kg. Females grow larger than males and individuals may live for up to 50yrs. *D. eleginoides* has a protracted spawning period, taking place mainly in winter, but which may start as early as late autumn and extend into spring. They are thought to spawn in deep water around sub-Antarctic islands and show distinct depth preferences with age, with juveniles (<50cm) living on the continental shelf and moving to deeper waters (>500 m) as they reach maturity (~90 cm). They are associated with cold water and are found around the sub-Antarctic and South America, as far north as Ecuador in the cold Humboldt current. They are important predators, feeding primarily on fish, cephalopods and crustaceans; they also scavenge (CCAMLR 2023a).

Patagonian toothfish are continuously distributed on the northern part of the Kerguelen Plateau and populations are linked. Within this area, the populations are likely structured with juveniles settling in shallow waters around the islands and potential exchange between Kerguelen Islands and HIMI (Figure 13). As fish grow larger and older, they move to deeper waters, and major spawning grounds are located on the western and southern side of the plateau (Brand-Gardener *et al*. 2022).

Prior to the start of the Australian commercial fishery at HIMI, three random stratified trawl surveys (RSTS) were conducted in 1990, 1992, and 1993 to estimate the abundance and size structure of *D. eleginoides* and mackerel icefish (*C. gunnari*). Commercial fishing started in 1997, and trawl remained the dominant fishing gear for many years. Following the development of integrated weighted longline (IWL) to reduce the risk of seabird bycatch, longline gear was introduced in 2003. The catch taken by longline increased steadily over the years, and longline has become the dominant gear type since 2011. By 2013, almost the entire commercial catch was taken by longline (Table 2, Figure 14) (Brand-Gardener *et al*. 2022, CCAMLR 2023b).

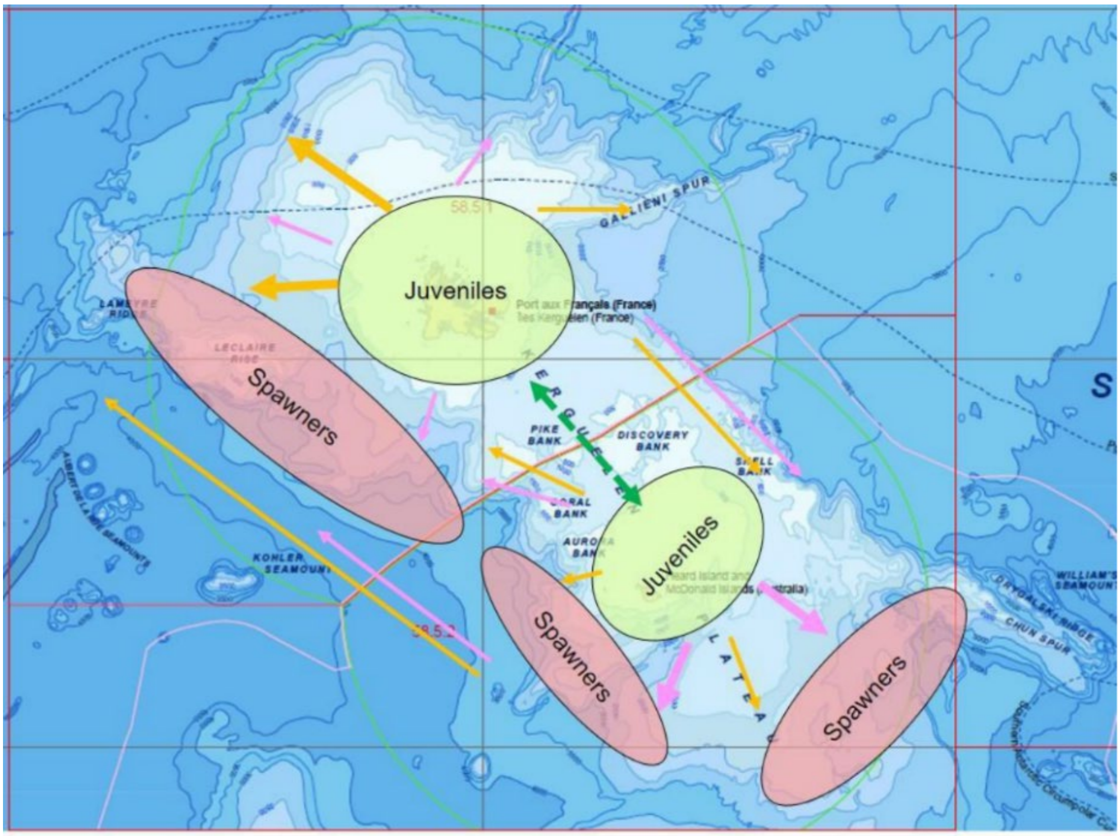


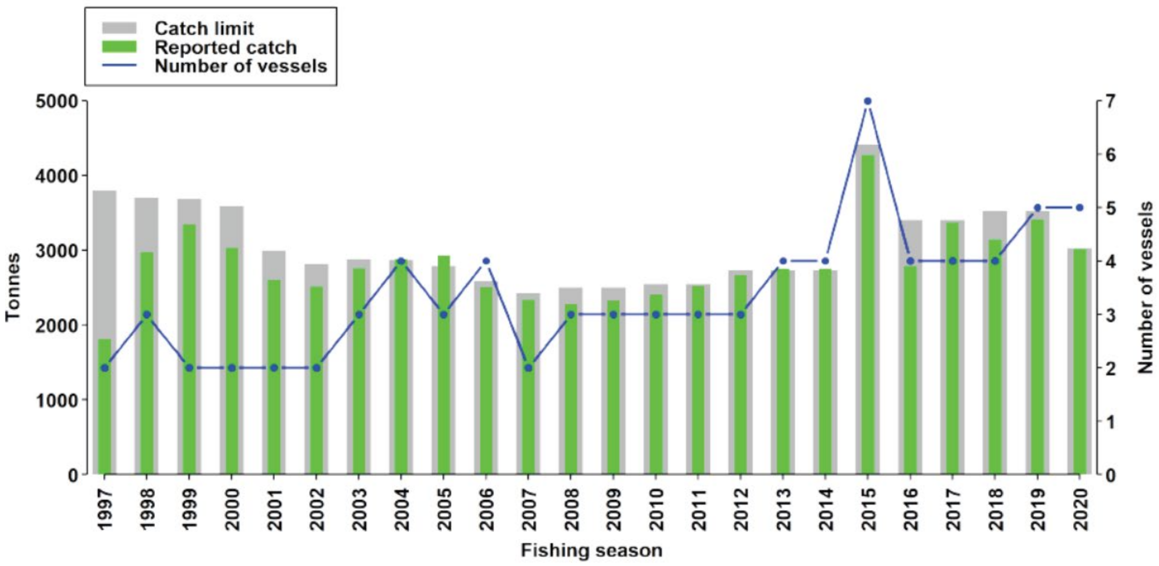
Figure 13: Schematic toothfish population structure on the northern part of the Kerguelen Plateau with Kerguelen Island to the north and Heard Island and McDonald Islands to the south. Juveniles settle in shallow waters on the plateau around the islands with potential exchange between areas (dark green arrows). Males (orange arrows) and females (pink arrows) then move into deeper waters as they grow larger and older, with major spawning grounds on the western and southern side of the plateau. Most adult fish move only short distances, but long-distance movement occur over the entire plateau, with some level of fish exchange between the Australian and French EEZ (green lines). CCAMLR Divisions are marked by red lines (from CCAMLR 2021b).

Illegal, unreported and unregulated (IUU) catches in CCAMLR Division 58.5.2 were potentially large in the late 1990s and early 2000s. IUU catches were estimated based on sightings of IUU vessels, their known fishing capacities, and catch and effort data from the licensed fishery. No IUU vessel has been sighted after 2005 and it is likely that no IUU catches have been taken since then.

The use of fish traps (also called pots) was also trialled in 2006 and between 2009-2013 to prevent depredation by whales, but catches were not sufficient to be commercially viable. Interest in using traps has recently increased (Brand-Gardener *et al.* 2022).

Table 2: Catch and effort history for *Dissostichus eleginoides* in the HIMI fishery (from CCAMLR 2023b).

Season	Longline catch (tonnes)	Trawl catch (tonnes)	Trap (pot) catch (tonnes)	Total catch (tonnes)	Number of vessels	Catch limit (tonnes)	IUU catch estimate (tonnes)
1997	-	1808	-	1808	1	3800	7117
1998	-	2966	-	2966	3	3700	4150
1999	-	3341	-	3341	2	3690	427
2000	-	3030	-	3030	2	3585	1154
2001	-	2599	-	2599	2	2995	2004
2002	-	2514	-	2514	2	2815	3489
2003	286	2468	-	2754	3	2879	1274
2004	552	2327	-	2879	3	2873	531
2005	665	2266	-	2931	3	2787	265
2006	656	1769	72	2497	3	2584	74
2007	624	1714	-	2338	2	2427	0
2008	835	1445	-	2280	3	2500	0
2009	1164	1155	13	2332	3	2500	0
2010	1237	1135	31	2404	3	2550	0
2011	1381	1104	32	2517	3	2550	0
2012	1369	1302	-	2671	3	2730	-
2013	2149	563	41	2753	4	2730	-
2014	2646	107	-	2754	4	2730	-
2015	4062	205	-	4267	7	4410	-
2016	2624	158	-	2783	4	3405	-
2017	3345	24	-	3369	4	3405	-
2018	3083	53	-	3136	4	3525	-
2019	3334	68	-	3402	5	3525	-
2020	2895	119	-	3014	5	3030	-
2021	2891	99	4	2995	5	3030	-
2022	2698	68	-	2766	4	3010	-
2023	2406	70	-	2476	3	3010	-



Catch and effort history at Heard Island (Division 58.5.2).

Figure 14: Catch and effort history for Patagonian toothfish from the HIMI fishery (from CCAMLR 2021b).

Mackerel icefish (C. gunnari)

Mackerel icefish (*C. gunnari*), belonging to the notothenioid family Channichthyidae, are endemic to the Southern Ocean and confined to the island shelves of the sub-Antarctic and the Antarctic Peninsula. They are most abundant at depths of less than 350m in the waters surrounding Heard Island, where they grow to a maximum length of around 45cm and a maximum age of 6 years. High abundances have also been observed in a non-contiguous area at Shell Bank to the northeast of the islands. The Heard Plateau and Shell Bank populations have different size structures and recruitment patterns. They can live for up to 15 years but in the HIMI area they grow to a maximum length of around 45cm and a maximum age of 6 years (CCAMLR 2023c).

Size at first maturity for females is 26.5cm and for males is 28.5cm total length. Mackerel icefish reach reproductive maturity at 3-4 years of age. Adults move inshore for spawning which takes place in shallow water, with eggs laid on the seafloor. Spawning occurs over 2-3 months in autumn and winter. Larvae are pelagic and may be caught in coastal shelf areas during late winter. They feed on small shrimp-like crustaceans such as krill and mysids. Icefish predators include Antarctic fur seals (*Arctocephalus gazella*) and gentoo penguins (*Pygoscelis papua*) (CCAMLR 2023c).

Mackerel icefish is considered a semi-pelagic species with young fish (0+ and 1+) found strictly in the pelagic zone, while adult fish move more towards the demersal zone. They are a schooling species usually found at depths of 30-250 metres but occur down to 700 metres. They migrate up and down the water column in a daily cycle. Individuals become increasingly sedentary with age and tend to stay in deeper waters (Brand-Gardener *et al*. 2022, CCAMLR 2023c).

Antarctic fish in general have a lower erythrocyte number and haemoglobin concentration than fish from temperate and tropical waters. Icefish are an extreme case and lack haemoglobin completely, lack myoglobin in five species, and have a vestigial number of erythrocytes or erythrocyte-like cells only. Mackerel icefish are endemic to the Southern Ocean and confined to the island shelves of the sub-Antarctic and the Antarctic Peninsula (CCAMLR 2023c).

An Australian licensed trawl fishery for *C. gunnari* began in 1997, while other nations had fished in these waters during the 1970s prior to the declaration of the AFZ in 1979. The fishing methods used in this fishery are midwater and bottom trawl. Trawl nets are limited to a minimum mesh size (90mm) to enable juvenile fish escape and which generally results in little or no bycatch (Sporcic *et al.* 2018, Brand-Gardener *et al*. 2022).

Reported catches of *C. gunnari* are presented in Table 3. In this fishery, the catch of *C. gunnari* reached a maximum of 2293 tonnes in 2003. In 2023, 336 tonnes of *C. gunnari* were caught (CCAMLR 2023d).

Table 3: Catch (tonnes) and effort history for *C. gunnari* in this fishery (after CCAMLR 2023d).

Season	Number of vessels	Catch limit (tonnes)	Catch (tonnes)
1997	1	311	207
1998	3	900	104
1999	1	1160	0
2000	2	916	87
2001	2	1150	1073
2002	2	885	966
2003	2	2980	2293
2004	2	292	84
2005	2	1864	1791
2006	2	1210	663
2007	1	42	1
2008	1	220	199
2009	1	102	99
2010	1	1658	365
2011	1	78	1
2012	1	0	4
2013	1	679	644
2014	1	1267	1123
2015	2	309	10
2016	1	482	469
2017	1	561	543
2018	1	526	515
2019	1	443	443
2020	1	527	507
2021	2	406	403
2022	3	1528	1024
2023	1	2616	336

Bycatch

The HIMI fishery bycatch limits are defined by CCAMLR Conservation Measure 33-02. For the 2023/24 season this included:

1. There shall be no directed fishing for any species other than *Dissostichus eleginoides* and *Champsocephalus gunnari* in Statistical Division 58.5.2 in the 2023/24 fishing season.
2. In directed fisheries in Statistical Division 58.5.2 in the 2023/24 season, the by-catch of unicorn icefish *Channichthys rhinoceratus* shall not exceed 1 663 tonnes, the by-catch of grey rockcod *Lepidonotothen squamifrons* shall not exceed 80 tonnes, the by-catch of grenadiers *Macrourus caml* and *M. whitsoni* combined shall not exceed 409 tonnes, the by-catch of *M. holotrachys* and *M. carinatus* combined shall not exceed 360 tonnes, and the by-catch of skates and rays shall not exceed 120 tonnes. For the purposes of this measure 'skates and rays' should be counted as a single species.
3. The by-catch of any fish species not mentioned in paragraph 2, and for which there is no other catch limit in force, shall not exceed 50 tonnes in Statistical Division 58.5.2.
4. If, in the course of a directed fishery, the by-catch in any one haul[2] is equal to, or greater than, 5 tonnes for *C. rhinoceratus*, 3 tonnes for all *Macrourus* spp. combined, or 2 tonnes for *L. squamifrons*, or 2 tonnes of *Somniosus* spp., or 2 tonnes of skates and rays, then the fishing vessel shall not fish using that method of fishing at any point within 5 nautical miles[3] of the location where the by-catch limit is exceeded for a period of at least five days[4]. The location where the by-catch limit is exceeded is defined as the path followed by the fishing vessel.
5. If, in the course of a directed fishery, the by-catch in any one haul of any other by-catch species for which by-catch limitations apply under this conservation measure is equal to, or greater than, 1 tonne, then the fishing vessel shall not fish using that method of fishing at any point within 5 nautical miles of the location where the by-catch exceeded 1 tonne for a period of at least five days. The location where the by-catch exceeded 1 tonne is defined as the path[5] followed by the fishing vessel.

Recent updates of the ecological risk assessments have lowered the risk of fishing to finfish bycatch species (see below). In the 2021–22 fishing season, retained catch other than Patagonian toothfish and mackerel icefish accounted for approximately 10% of the total (Patterson & Curtotti 2023).

The Heard Island and McDonald Islands Marine Reserve was declared in October 2002 and then expanded in March 2014 by proclamation after scientific assessment to an area of 71,200 km*2*. The *Heard Island and McDonald Islands Marine Reserve management plan 2014–2024* (Commonwealth of Australia 2014), made pursuant to the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), provides the management regime for the reserve.

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[2] For the purposes of this conservation measure, for a longline, each haul applies to a single longline regardless of how contiguous sections of gear are connected.

[3] This provision concerning the minimum distance separating fishing locations is adopted pending the adoption of a more appropriate definition of a fishing location by the Commission.

[4] The specified period is adopted in accordance with the reporting period specified in Conservation Measure 23-01, pending the adoption of a more appropriate period by the Commission.

[5] The specified period is adopted in accordance with the reporting period specified in Conservation Measure 23-01, pending the adoption of a more appropriate period by the Commission.

Ecological Risk Assessment for Effects of Fishing (ERAEF)

AFMA continues to update detailed ERAs for all major and minor Commonwealth managed fisheries as a key part of the move towards ecosystem-based fisheries management. The ERAEF method was developed jointly by CSIRO and the Australian Fisheries Management Authority. ERAEF provides a hierarchical framework for a comprehensive assessment of the ecological risks arising from fishing, with impacts assessed against five ecological components – target species; by-product and by-catch species; threatened, endangered and protected (TEP) species; habitats; and (ecological) communities (Hobday *et al*. 2007).

Demersal Longline

An assessment of the ecological impacts of the Heard Island and McDonald Islands Demersal Longline Fishery was completed in 2006 (Bulman *et al*. 2007a) using the Ecological Risk Assessment for the Effects of Fishing (ERAEF) method described by Hobday *et al*. (2007). A Level 1 analysis using the ERAEF method for the fishing seasons 2010/11-2014/15 was undertaken in 2016 (Bulman *et al*. 2018).

Results of the assessment were as follows (Bulman *et al.* 2018):

- The direct impact of fishing was not assessed because *D. eleginoides* has a biennial stock assessment, equivalent of a Level 3 assessment (quantitative stock assessment). Other hazards of this component were assessed but all were low risk
- Benthic habitats for the fishery were not assessed because a comprehensive habitat assessment was conducted by Welsford *et al*. (2014). Hazards impacting two pelagic habitats were assessed but were all low risk
- Risk scores ranged from 1-3 across all 32 hazards (fishing activities) considered for the five ecological components assessed. Most were eliminated at Level 1.
- Four of the five ecological components were eliminated at Level 1. The rate of byproduct/bycatch was low in the fishery and catches were generally 10-50% of the catch limit. For protected species, stringent seabird bycatch mitigation measures are employed when setting and hauling gear which has resulted in very low mortality rates of seabirds. The worst case was the capture of giant petrels and black-browed albatross. These species are listed as endangered, and the latter has the smallest population of all seabirds found within the HIMI region. No black-browed albatrosses were caught. Five giant petrels were caught but it was considered that this level of mortality would not affect the species. Southern elephant seals were considered because 13 were captured during the period. It is listed as vulnerable despite the population at Heard Island (>200,000) being considered as stable.
- Community was assessed as risk as a result of a lack of knowledge of the broader ecosystem consequences of the removal of toothfish. Ecosystem models are being developed to explore this impact, however CCAMLR decision rules that apply to the HIMI fishery take into account predator-prey relationships and associated trophic requirements.

In summary, compared to the 2006 assessment, the fishing effort in the longline fishery had increased and was now the major method of capture. Nevertheless, the assessment of the fishery remained similar or better than previously. More research and improved methodology has provided better stock assessments for key commercial species as well as the minor species, although high variability of the latter contributes to uncertainty. Ongoing stringent mitigation measures to reduce incidental catch of seabirds has resulted in maintaining low mortality rates. Elephant seal mortality would not impact populations. The rate of removal of non-target species is very low and unlikely to impact communities. The removal of toothfish from communities has been considered in the precautionary TAC setting. A reduction in bycatch of skates and rays to less than 25% of the previous assessment was significant, resulting in a downgrading of the consequence score for byproduct/bycatch species. However, continuation of an increase in effort in the fishery may impact skates in the future. The risk of translocation of species (via boat) was reduced from the previous assessment.

The threat of IUU fishing has been significantly reduced compared to the previous assessment with no reports of IUU activity in either the HIMI or adjacent French Division 58.5.1 during the assessment period.

Trawl

Demersal trawl and midwater trawl gear is used to target both *C. gunnari* and *D. eleginoides* in Division 58.5.2. The potential impacts of fishing gear on benthic communities are limited by the small area of commercial trawl grounds, a strategy of trawling gear lightly and the protection of large areas sensitive to the effects of bottom trawling within the Heard Island and McDonald Islands Marine Reserve, an IUCN Category 1a reserve, where fishing is prohibited (CCALMR 2023b,c).

Demersal (otter) trawl

Trawl nets are shaped like a cone or funnel with a wide opening and a narrow closed off cod-end (Figure 15). These nets are limited to a mesh size of not less than 120 mm in every part of the net for Patagonian toothfish and not less than 90 mm when targeting mackerel icefish to enable juvenile fish to escape. This gear uses otter boards/ trawl boards to keep the mouth of the net open and at the bottom. Trawl nets have bobbins or rollers on the ground to allow the net to move over the sea floor without snagging and to minimise bottom contact. These bobbins must be at least 520 mm in diameter and rockhopper rubber discs must be at least 400 mm in diameter.

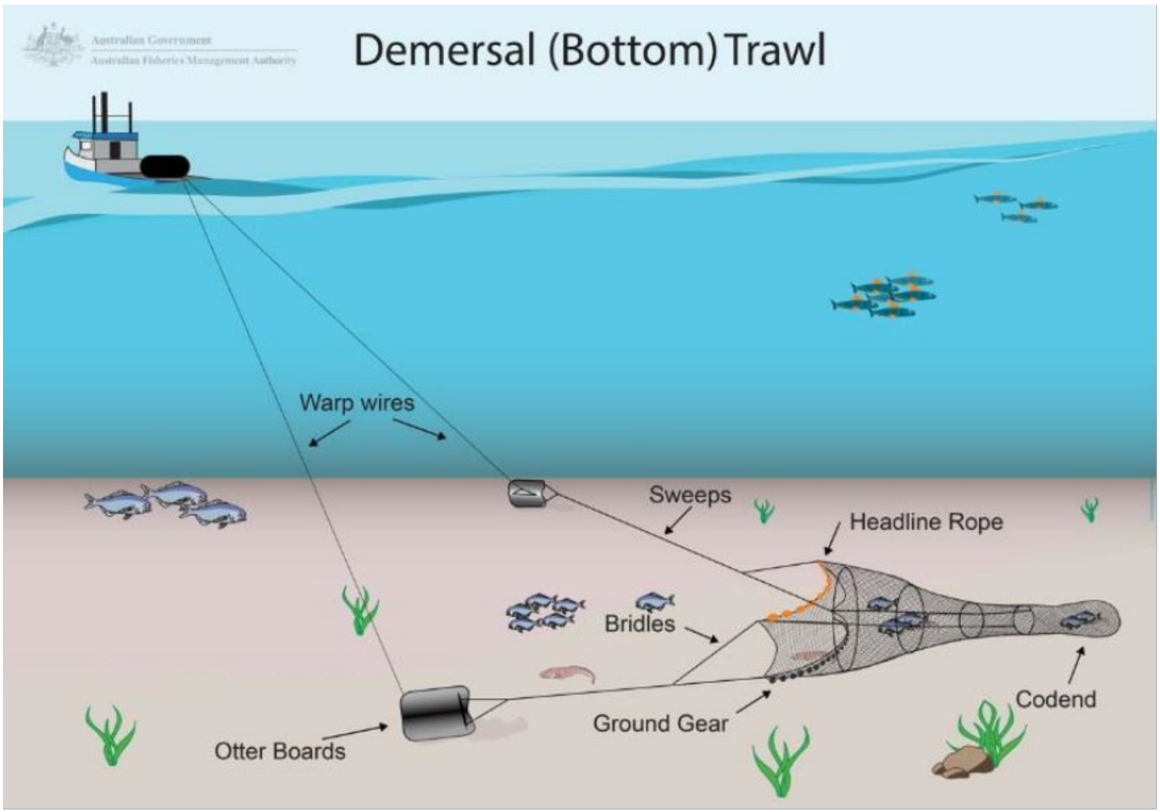

Figure 15: Demersal trawl configuration used in the HIMI fishery (Source: AFMA August 2024 https://www.afma.gov.au/methods-and-gear/trawling).

A Scale, Intensity, Consequence Analysis (SICA), found no ecological components to be examined at Level 2 since all risk scores were ≤2. Three ecological components (i.e., byproduct/bycatch, protected species and communities) were considered to have a minor external impact by other fisheries. By contrast, the key/secondary commercial species component was considered to have a moderate external impact by other fisheries (Sporcic *et al*. 2018a).

Benthic habitats were not assessed by Sporcic *et al.* (2018a) in the light of a previous assessment conducted by Welsford *et al.* (2014). However, a Level 1 analysis was conducted for activities identified as leading to some form of impact on pelagic habitats. The impact of all five activities identified (i.e. four internal; one external) on the "Heard/McDonald Islands pelagic provinces-Plateau" habitat were negligible.

Updated management arrangements implemented in the HIMI fishery since the initial ERAEF assessment (Daley *et al*. 2008) showed improvement all ecological components did not trigger a Level 2 analysis. *D. eleginoides* was chosen as the most vulnerable key commercial species for the direct impact of capture by fishing activity.

The grey rockcod (*Lepidonotothen squamifrons*) was identified as the most vulnerable bycatch species (minor risk) in contrast to skates and rays in the previous assessment, based on greater quantities removed from this sub-fishery. The minor risk score was for the activity "direct impact of capture by fishing", since the total removals were below accepted annual bycatch limit (80 t; long-term yield) (Sporcic *et al*. 2018a).

Three ecological communities were chosen as the most vulnerable component (risk score 2). The communities were scored 2, given that only a small area of each community was fished and two of these communities were also within the Marine Reserve. However, even though the removal of *D. eleginoides* from communities has been considered in the precautionary TAC setting process, there is still further work to do to understand the fishery dynamics at a community level. A variety of ecosystem models e.g. size-based models, SEAPODYM, EwE and Atlantis, for the Kerguelen Axis which includes the HIMI region, are developed and should enable exploration of the broader ecosystem effects of fishing (Sporcic *et al.* 2018a).

Compared to the 2006 assessment (Daley et al. 2008), the threat of impact from IUU fishing had been significantly reduced with no reports during this assessment period (2010/11-2014/15).

Assessment of the impacts of demersal gear on benthic habitats is limited by a general paucity of data, theory and procedure, particularly in remote locations such as HIMI. Much of the current understanding comes from the fishery itself, complimented by research fishing and occasional research cruises. In a significant study aimed at addressing this shortcoming, Welsford *et al*. (2014) showed that the great majority of vulnerable organisms live on the seafloor in depths less than 1200 m. This range overlaps with the depths targeted by the trawl fishery, and to a lesser extent by the longline fishery. However, due to the fact that the majority of trawling has focussed on a few relatively small fishing grounds, less than 1.5% of all the biomass in waters less than 1200 m are estimated to have been damaged or destroyed. Furthermore, the HIMI Marine Reserve, established in 2003, is estimated to contain over 40% of the biomass of the groups of benthic organisms considered as most vulnerable to bottom fishing at HIMI. Overall, an estimated 0.7% of the seafloor area within the EEZ at HIMI has had some level of interaction with bottom fishing gear between 1997 and 2013.

Midwater trawl

When midwater trawling, a net similar but typically larger than a demersal trawl is towed in the midwater column. The net is spread horizontally and vertically, but does not have the same ground gear as a demersal trawl as it is not designed to touch the seafloor (Figure 16). Midwater trawl nets are also equipped with electronic units to allow monitoring of the net in the water column, fishing takes place between 62-707 m and an average of 339 m.

Like demersal trawling, midwater trawling relies on the herding of fish inward toward the mouth of the net where they are ultimately trapped in the codend. The horizontal opening is maintained either by otter boards or by towing the net by two boats (pair trawling). Floats on the headline and weights on the groundline often maintain the vertical opening. Modern large midwater trawls, however, are rigged in such a way that floats are not required, relying on downward forces from weights to keep the vertical opening during fishing.

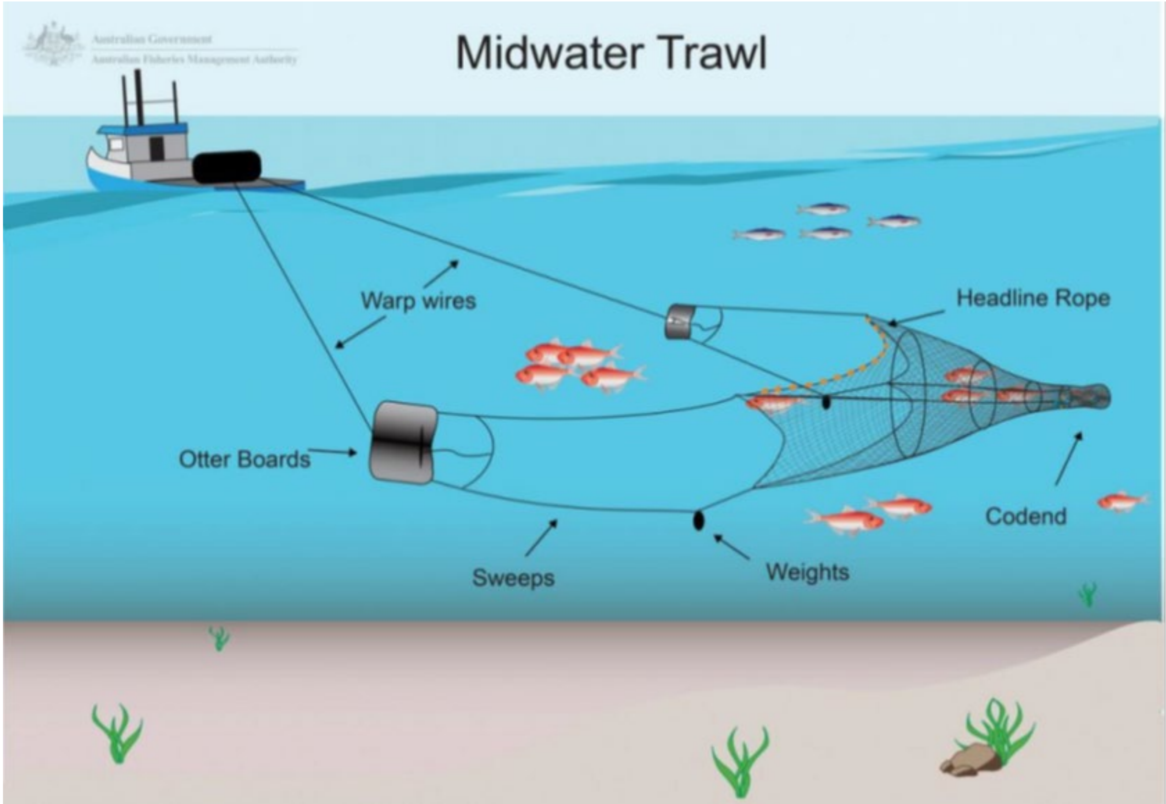

Figure 16: Midwater trawl configuration used in the HIMI fishery (Source: AFMA August 2024 https://www.afma.gov.au/methods-and-gear/trawling).

An assessment of the ecological impacts of the Heard and McDonald Islands Midwater Trawl Fishery was undertaken using the ERAEF method in 2006 (Bulman *et al*. 2007b) and 2016 (Sporcic *et al*. 2018b). All hazards (fishing activities) were eliminated at Level 1. While Bulman et al. (2007a) considered 106 species at level 2, a level 2 analysis was not trigged for any ecological component in the later assessment (Sporcic *et al*. 2018b). Three ecological communities were chosen as most vulnerable but given a moderate risk score because only a small area of each community was fished and two of these communities were also found within the Marine Reserve. The impacts on benthic habitats were not assessed due to a previous external assessment (Welsford *et al*. 2014). All activities impacting the pelagic habitat were negligible risk.

The target species, *C. gunnari*, which has a comprehensive management plan and annual stock assessments, represented only a medium risk. It has been accredited by MSC and presents no serious ecological concern (Brand-Gardener *et al.* 2022).

Fishery management arrangements

The Southern Ocean has experienced notable collapses of marine species following exploitation, including seals in the 19th century, the great whales in the middle of the 20th century, the marbled rockcod (*Notothenia rossii*) in the early 1970s and, more recently, some stocks of the Patagonian toothfish in locations other than HIMI (Constable *et al.* 2000). Regulation of harvesting activities has been attempted through several international conventions, most recently through CCAMLR which is part of the Antarctic Treaty System (see Constable *et al.* 2000 for a summary).

The catch limits for the key target species *D. eleginoides* and *C. gunnari* are determined by the AFMA Commission following review by the AFMA's Sub-Antarctic Resource Assessment Group and Sub-Antarctic Management Advisory Committee (SouthMAC), the CCAMLR Scientific Committee (SC-CAMLR) and the CAMLR Commission (Patterson & Curtotti 2023).

Catch limits are determined through scientific assessment of abundance data from an annual fishery-independent random-stratified trawl survey of groundfish on the HIMI Shelf (conducted since 1997), a mark-recapture program on Patagonian toothfish caught in the fishery, as well as data derived from the AFMA observer program which is consistent with the requirements of the CCAMLR Scheme of International Scientific Observation (Patterson & Curtotti 2023, Constable *et al.* 2024).

The fishery also has catch limits for bycatch species, such as deep-sea skates (Rajidae) and grey rockcod (*Lepidonotothen squamifrons*), based on assessments of long-term annual yield, and for unicorn icefish (*Channichthys rhinoceratus*) and grenadiers (*Macrourus* spp.) based on assessments undertaken by the AAD (Patterson & Curtotti 2023).

Ecosystem based CCAMLR objectives for sub-Antarctic fisheries are focused on ensuring stable recruitment for target species, maintenance of predator-prey relationships, recovery of depleted populations and minimising the risk of irreversible change to the environment via ecosystem effects of fishing (Constable *et al.* 2000). Due to uncertainties around natural variation in stock abundance, statistical error in stock assessments, uncertainty in model parameters, incomplete historical catch records and imprecise catch reporting, CCAMLR has adopted a precautionary approach to harvest. Harvest strategies developed for the target species set under the Commonwealth Fisheries Harvest Strategy Policy (DAWR 2018a) and Commonwealth Fisheries Bycatch Policy (DAWR 2018b) are considered to be consistent with the precautionary approach implemented by CCAMLR (Paterson & Curtotti 2024). The importance of the target species as prey in the subantarctic ecosystem is taken into account in the harvest strategy and catch limits must be sufficiently precautionary to ensure that the abundance of these species meets the ecological needs of dependent species (for example, seabirds, marine mammals).

For mackerel icefish, a short-lived species with highly variable recruitment, the target reference point for the spawning stock biomass (B_{targ}) is 75% of the level that would occur in the absence of fishing at the end of a 2-year model projection with the probability of the spawning biomass dropping below 20% of its pre-exploitation median level being less than 10% over the projection (Constable *et al.* 2000).

For Patagonian toothfish, the B_{targ} dictates that median escapement of the spawning biomass at the end of a 35-year projection period is 50% of the median pre-exploitation level and that the probability of the spawning biomass dropping below 20% of its pre-exploitation median level is less than 10% over the projection (Constable *et al*. 2000).

Effort in the HIMI fishery has been relatively stable since a total allowable catch (TAC) was first set in the mid-1190s with 2-5 vessels operating. Both the TAC and the catch of *D. eleganoides* have declined between the 2000-02 and 2013-14 fishing seasons from around 3,000t to 2,730t but increased in the 2014-15 season to 4,000t. Since then, the TAC has been more conservative (lower), and catches have been close to the TAC (Patterson & Curtotti 2023). Notwithstanding there has been a suggestion that is collapsing (Lin 2024), with calls for greater protection by increasing the size of the no-take reserve.

Considerable debate surrounds the use of marine protected areas as a fisheries management tool. While some advocate for their use (Roberts & Hawkins 2003, Russ & Acala 2011; Duarte *et al.* 2020) others caution against this as in general they do not reduce effort but rather move fishing pressure elsewhere (Halpern *et al*. 2004; Greenstreet *et al.* 2009; Kearney *et al.* 2012) and are only effective in situations where stocks are seriously overfished and/or where there is no effective fishery management system in place (Goni *et al*. 2010, Buxton *et al.* 2014; Kerwath *et al*. 2013, Fletcher et al., 2015). Hilborn (2018) argues that traditional fisheries management is more effective at regulating fisheries and that both biodiversity and food security will be better served by expanding fisheries management, not by establishing further no-take marine reserves. Under the Commonwealth harvest strategy policy, when a stock declines to below the limit levels, whether from fishing or another cause, AFMA must cease targeted fishing and develop a strategy to rebuild the stock to above its limit reference point (DAWR, 2018a). Clearly, if the entire fishery is closed, this is significantly more effective at rebuilding the stock level compared to closing an area, especially if the stock has a wider distribution than the area closure. This approach has been successfully followed for Orange Roughy in Australian waters under the Orange Roughy Rebuilding Strategy (AFMA, 2022).

Climate change makes management more difficult

This section addresses the effect of climate change on the redistribution of species and habitats and why this influences performance of a reserve network as well as complicating the management of fisheries.

Key findings:

- Climate change primarily affects fishery production through shifting distribution of species and range extension.
- Static MPAs may not provide the desired outcomes to mitigate threats against climate change
- Flexible management frameworks can provide effective protection in response to real time ecological shifts but require robust data collection systems and advancements in technology development.
- Cost effective fisheries dependent data collection systems may be impacted by large swaths of protected areas that prevent certain activities.

Climate change impacts for fishery production and shifting distributions

Climate change profoundly impacts fishery production, primarily through shifting species distributions and altering marine ecosystems (e.g. Cheung *et al.* 2010). As ocean temperatures rise, many fish species migrate towards cooler waters, often poleward or to greater depths (Pinsky *et al.* 2013; Sunday *et al.* 2015). This redistribution can lead to changes in the composition of fish communities, affecting both the availability of target species and the overall productivity of fisheries (Cheung *et al.* 2013). Warmer waters can also disrupt breeding and feeding patterns, impacting fish growth rates and survival. Species that cannot migrate or adapt quickly enough may experience population declines, leading to reduced catches. Furthermore, altered ocean currents and changing weather patterns can impact nutrient availability and primary productivity, further influencing fishery yields. Shifting distributions can create mismatches between fish populations and the locations of fishing industries, necessitating adjustments in fishing practices and potentially leading to conflicts over new fishing grounds or declines in fisheries profitability. Adapting to these changes requires robust, flexible management strategies, including dynamic fishery management plans that can respond to shifting stocks and promote sustainable fishing practices in the face of an uncertain climate future (Hobday 2011).

Suitability of static MPA frameworks vs flexible due to environmental dynamics

Marine Reserves may be a valuable tool for representing and protecting marine biodiversity, but their design must consider the dynamic nature of marine environments (Grantham *et al* .2011). Static reserve frameworks, which have fixed boundaries, offer simplicity in management and long-term protection of specific areas. They can effectively safeguard habitats, spawning grounds, and species that have predictable spatial patterns. However, static reserves may become less effective under changing environmental conditions, such as climate change (Hobday 2011), which can shift species distributions and alter habitat conditions (e.g. whales in North Atlantic, Meyer-Gutbrod *et al.* 2018).

In contrast, flexible reserve frameworks can adapt to environmental dynamics, making them potentially more effective in the face of such changes (Maxwell *et al.* 2015). These adaptive reserves can adjust their boundaries and management strategies in response to real-time data on ecological shifts, species movements, and environmental changes. This flexibility allows for the protection of mobile species and dynamic habitats, ensuring that conservation efforts remain relevant and effective. Such flexible approaches were used in eastern Australia over a period of 10 years to reduce unwanted bycatch of southern bluefin tuna (Hobday *et al.* 2010). Flexible management approaches have been used for pelagic species and regions, and not for benthic environments, however, this may become necessary as climate continues to change distributions of habitats.

Flexible protected areas pose additional challenges, including the need for continuous monitoring, and the potential for conflicts among stakeholders (Hobday *et al.* 2014). Implementing such frameworks requires advanced technology, substantial financial resources, and robust legal mechanisms to enforce changing boundaries (Hobday *et al.* 2014). Ultimately, the suitability of static versus flexible marine reserve frameworks depends on the specific conservation goals, the nature of the marine environment in question, and the capacity for adaptive management. Balancing the strengths and limitations of both approaches can lead to more resilient and effective marine conservation strategies.

Around areas with dynamic and changing ocean currents, such as the HIMI region, dynamic protection, with boundaries changing seasonally and over years, may provide advantages to protection of the desirable features and allow economic activities.

Impact of protection on research needed for management in a fast-changing world

Marine reserves clearly have a role in conserving biodiversity and ecosystems, but they can sometimes restrict the research or data collection needed for effective climate change management. Data can be collected by fishing activities, using gear types that is expensive or unavailable via scientific sampling. Such fishery-dependent data collection may be excluded from protected areas, depending on the regulations. Exclusion of legal fishing in a region may also make it easier for illegal fishing to occur undetected.

Obtaining permits to conduct scientific research in marine reserves can be a lengthy and complex process. This may delay or limit the scope of research, making it difficult to respond quickly to emerging climate-related issues. Marine reserves often have zones with varying levels of protection. Research activities may be allowed in some zones but not others, which can complicate the ability to conduct comprehensive studies across different habitats or ecological gradients within the reserve. Managers may prioritize resources for enforcement and habitat protection over research, leading to limited funding and support for scientific studies. This can restrict the availability of necessary infrastructure, personnel, or logistical support for conducting research and determining the benefits of protection. To balance the need for conservation with the need for research, adaptive management approaches within marine reserves can be implemented. These might include establishing research zones, streamlining permit processes, and encouraging collaboration between researchers and managers. Such measures can help ensure that marine reserves contribute effectively to both conservation and the scientific understanding needed for climate change adaptation.

Evaluating the HIMI marine reserve expansion

This section summarises the major findings of the review of the expansion of the HIMI Marine Reserve, posing several key questions and providing a range of considerations for future reviews of the NRSMPA.

Key findings:

- Analysis shows that with a few exceptions, most conservation values in the HIMI EEZ were well represented in terms of spatial coverage prior to the expansion of the reserve.
- While the inclusion of a more representative sample of some habitats such as those in deep water may have been justified, the significant expansion of the reserve is questionable.
- Marine reserves and fisheries are managed separately for complimentary but distinct purposes in Commonwealth waters. Accepting that the primary objective for the establishment of the NRSMPA is representation of habitat types, calls for an increase in the reserve in order to manage a perceived threat of overfishing is not justified.
- Threat mitigation is an objective of the management arrangements subsequent to the establishment of a reserve, but while the threats to the HIMI bioregion are understood there is little evidence to support the argument that the primary threat, climate change, would be mitigated by the expansion of reserve.
- Insufficient justification is provided for the declaration of a large part of the HIMI EEZ as a habitat protection zone encompassing the existing footprint of the HIMI fishery. This has the potential to impact the fishery and is at odds with the GBF principles that embrace sustainable human activities within conservation zones
- The extensive ESD based management systems that have been developed for the HIMI fishery already successfully meet the ecological guidelines of the EPBCA, the third-party certification requirements of the MSC, and the regional level, conservation values of CCAMLR.
- There is no objective basis using the Ecological Wellbeing components of ESD to justify a significant expansion in fishing closures, changes to zonation classification and associated gear restriction uncertainties.
- The reserve expansion is highly likely to generate significant negative impacts on the Human Wellbeing elements of ESD for the fishery and therefore the overall suite of community outcomes generated from the region.
- The planning processes undertaken to generate the reserve expansion were not consistent with applying the full set of ESD principles comparted to best practice EBM/MSP approaches as they did not include appropriate consideration of the human and governance elements of ESD which are essential to deliver the best overall outcomes for this region and the Australian Community.

Representation or threat mitigation – what drives the NRSMPA?

Australia's commitment to the CBD has been the development of the NRSMPA, the primary purpose which is to establish and manage a comprehensive, adequate and representative system of reserves. In this context, representation is to ensure that the reserve system reasonably reflects the biotic diversity of the marine ecosystems from which they derive. The NRSMPA guidelines (ANZECC 1998) aim to represent provincial-scale bioregions as identified by the IMCRA v4.0 (Commonwealth of Australia 2006).

A key concept used in IMCRA v4.0, and widely applied in conservation planning where direct observations of biodiversity distribution are rarely available, is surrogacy (Pressey 2004, Harris *et al.* 2008). Surrogates of distribution of biodiversity in the marine environment are usually physical attributes, such as seabed geomorphology or depth, that provide a reasonable proxy for the distribution of biodiversity (Beeton *et al.* 2015).

While Heard Island and McDonald Islands were not included in IMCRA v.4.0, they are considered to be located in a separate bioregion (DCCEEW 2024a). As such the ANZECC guidelines have underpinned the proposal for the establishment of the HIMI Reserve (Meyer et al. 2000, EA 2002), and subsequent expansion (Commonwealth of Australia 2014).

This approach to the implementation of protected areas in general has been questioned on the basis that establishment frequently may not correlate with identified conservation priorities (Chape *et al*. 2005, De Santo 2013, DeVilliers *et al*. 2014, Roberts *et al*. 2018, Cockerell *et al*. 2020). This argument centers around the observation that the system may often be dominated by areas that offer little protection against the impacts of extractive uses such as fishing and petroleum extraction.

However, Beeton *et al*. (2015) note that the NRSMPA was not established to mitigate threats to biodiversity, although threat mitigation within reserves is considered in decisions on reserve zoning and the activity matrices that determine what activities can be permitted within zones. They also note that biodiversity conservation objectives inform decisions about whether activities proposed to be undertaken within reserves are compatible with these objectives. In practice, this means that, in assessing activities and their potential impacts within reserves, greater weight is placed on their impacts on the reserve's conservation value than might otherwise be the case outside the reserve – that is, the 'environmental bar' is higher inside reserves.

A focus on poorly defined representation goals instead of threat reduction may diminish the conservation objectives of the NRSMPA (Cockerell *et al.* 2020). This may be particularly relevant in the case of HIMI where the major identified threat, climate change, is both poorly understood and may be largely ineffective in mitigating the threat.

While the effect of no-take reserves on exploited populations is well studied and understood (Lester 2009, Russ & Alcala 2011), their impact on fisheries dynamics is less well documented and benefits to fishers often questioned (Gell *et al*. 2003, Hilborn *et al*. 2004, 2018; Penn & Fletcher, 2010), especially in the context of well-managed fisheries (Buxton *et al*. 2014, Rassweiler *et al.* 2014, Fletcher *et al.* 2015).

Marine reserves and fisheries are managed separately and for complimentary but distinct purposes in Commonwealth waters (Beeton *et al.* 2015). The HIMI fisheries for Patagonian toothfish and mackerel icefish are managed by AFMA in accordance with the precautionary and ecosystem approaches of CCAMLR (Constable & Welsford 2011). Both fisheries are currently certified by the MSC and classified in the most recent Status of Australian Fish Stocks (2024) as sustainable. Indeed, the threat of IUU fishing has been mitigated by the presence of the HIMI fishery (Brooks *et al*. 2019). Despite this there have been calls for extending the reserve to protect toothfish spawning (Constable *et al*. 2024) and to counteract a collapse in the fishery (Lin 2024). The counter argument is that most effective way of managing fish stocks involves the use of robust conventional fisheries management (Kearney *et al.* 2012, Hilborn 2018).

Is the reserve expansion and proposed zonation justified?

The total area of the expanded HIMI Marine Reserve is 379,070 square kilometres. This increases the existing marine reserve by 308,117 square kilometres, a 400% increase over the current marine reserve (DCCEEW 2024c). Recent research has presented a case for more of the HIMI bioregion to be included in the reserve to comply with the CAR principles more fully (Welsford *et al*. 2024, Constable *et a*l. 2024). While this has merit, the proposed increase in the HIMI Marine Reserve goes well beyond Australia's commitment to the GBF, to protect 30% by 2030.

Welsford et al. (2024) provide an assessment of the representation various conservation values in the HIMI Marine Reserve as follows:

- *demersal fish assemblages* – of the seven regions of common profile (RCPs) identified by Hill et al. (2017), RCPs 3-7 have 31-54% of their area inside the current HIMI reserve, while RCPs 1 and 2 have 26% and 12% respectively in the reserve (Table 4).
- *benthic invertebrates* – all but one of the common habitat-forming taxa are represented in the current HIMI reserve by between 33-70% of their estimated biomass. Basket stars found on the deeper plateau and upper slope areas were less well represented at 16% of estimated biomass (Table 5).
- *seabirds and mammals* – Using a threshold of 75 percent or greater global importance, between 11 and 39% of globally important habitat for seals and seabirds is estimated to be represented in the current HIMI reserve (Table 6), with no globally important habitats for Antarctic fur seals and black-browed albatross identified in the HIMI EEZ.

This analysis shows that with a few exceptions, most conservation values in the HIMI EEZ are well represented in terms of spatial coverage consistent with the ANZECC guidelines. Therefore, while in the main the need for such a significant expansion of the reserve is questionable, based on more recent data there is justification for the inclusion of a representative sample of some habitats and associated conservation values of the deeper waters surrounding HIMI.

However, motivation to include areas based primarily on their importance as foraging areas for marine predators must be made in the context of potential threats to this function. It is insufficient to argue that the mere act of including an area in the reserve affords 'protection' if it is not clear what pressures or threats are being mitigated.

Notwithstanding the above, the impact of climate change is casting a shadow on both the CAR approach to representation of biodiversity in a reserve network, as well as the ability of reserves to mitigate significant threats to marine biodiversity. Shifts in species and habitat distributions will lead to a level of redundancy in the network and therefore will require different approaches to marine conservation.

Australia's approach to marine conservation, based on NRSMPA principles established more than a quarter of a century ago, is urgently in need of review. The pursuit of spatial targets (currently 30x30), while providing a representation of biodiversity within reserves, is doing little to protect this biodiversity against the key threats, the least of which is commercial fishing. Paramount amongst these threats is the pervasive impact of shifting distributions of populations from climate induced global warming. The expansion of the HIMI reserve, and marine reserves in general, will do little to mitigate this threat.

Table 4: Estimated representation of demersal fish assemblages inside the HIMI Marine Reserve, based on the analysis of areal extent of Regions of Common Profile (RCP) by Hill *et al*. (2017).

RCP	Areal Representation in the HIMI Marine Reserve (%)	Characteristics of RCP[6]
1	26.2	Deeper waters (more than 600 m), moderate mean SST (2–5 degrees Celsius), higher surface productivity (more than 1 $mg.m^{-3}$ Chl-a). Assemblage characterised by relatively high abundance of grenadiers (*Macrourus* spp.), blue antimora (*Antimora rostrata*), skates (*Bathyraja* spp.). Only RCP with blue-eyed lantern shark (*Etmopterus viator*).
2	12.2	Deeper waters (more than 600 m), colder mean SST (less than 1 °C), lower surface productivity (less than 1 $mg.m^{-3}$ Chl-a). Assemblage characterised by relatively high abundance of grenadiers and blue antimora.
3	46.1	Broad depth range (200–700 metres), warmer mean SST (more than 2 °C), higher primary productivity (more than 1 $mg.m^{-3}$ Chl-a). High probability of occurrence of the unicorn icefish (*Channichthys rhinoceratus*), Eaton's skate (*B. eatonii*) and grey rock cod (*Lepidonotothen squamifrons*).
4	31.5	Intermediate depth range (400–800 metres), moderate–low surface productivity (less than 1.5 $mg.m^{-3}$ Chl-a). Assemblage characterised by relatively high abundance of grenadiers, skates, Antarctic armless flounder (*Mancopsetta maculata*), and snake mackerel (*Paradiplospinus gracilis*).
5	52.0	Shallower depth range (200 metres), moderate mean temperatures SST (2–5 degrees Celsius) and lower surface productivity (less than 1 $mg.m^{-3}$ Chl-a). High probability of occurrence of unicorn icefish and mackerel icefish (*Champsocephalus gunnari*).
6	45.2	Broad depth range (200–700 metres), colder mean SST (less than 2 °C), lower primary productivity (less than 1 $mg.m^{-3}$ Chl-a). High probability of occurrence of the unicorn icefish (*Channichthys rhinoceratus*) and grey rock cod (*Lepidonotothen squamifrons*).
7	53.5	Shallower depth range (200 metres), moderate mean temperatures SST (2–5 degrees Celsius) and higher surface productivity (less than 1 $mg.m^{-3}$ Chl-a). High probability of occurrence of mackerel icefish.

[6] Note Patagonian toothfish (*Dissostichus eleginoides*) were in relatively high abundance across all assemblages.

Table 5: Estimated representation of common habitat-forming benthic invertebrates in the HIMI Marine Reserve (from Welsford *et al*. (2024).

Taxon (common name)	Representation of estimated biomass in the HIMI Marine Reserve (percent)
Alcyonaria (soft corals)	42
Actinaria (anemones)	40
Bryozoa	56
Cirripedia (stalked barnacles)	47
Scleractinia (stony corals)	33
Echinoidae (sea urchins)	50
Euryalidae (basket stars)	16
Gorgonacea (gorgonian corals)	50
Hydrozoa	55
Demospongia (sponges)	70
Pterobranchia	70
Ascideacea (sea squirts)	50
Serpulidae (tube worms)	51

Table 6: Estimated representation of globally important habitat for seabirds and seals in the HIMI Marine Reserve at more than 75 percent importance level. NA= no habitat of more than 75 percent global importance present in HIMI EEZ From Welsford *et al*. 2024).

Species	Representation of area of habitat importance
Antarctic fur seal	NA
Southern elephant Seal	39
King penguin	30
Macaroni penguin	25
Light-mantled albatross	11
Wandering albatross	25
Black-browed albatross	NA

Welsford *et al.* (2024) list the pressures on the HIMI marine ecosystem to include tourism, research, fishing, climate change, marine pollution, invasive species and species range extensions. The risk posed by each is summarised as follows:

- *Tourism* – occasional tourist visitation is strictly controlled and of a very low frequency, making the risk to conservation values very low.
- *Research* – scientific research is permitted under permit and includes an annual random stratified trawl survey to inform assessments of the ecological sustainability of the fishery. Given the limited survey effort and the strict regulation of activities, the risk of significant negative impacts to the conservation values described above from scientific research is low
- *Fishing* – Given the high spawning biomass, the precautionary TAC that satisfies the CCAMLR decision rules, the robust nature of the stock assessment and the extensive CCAMLR review process, the stock is classified as not overfished and not subject to overfishing (Patterson & Cortotti 2023). Recent ecosystem modelling indicates that the current scale of fisheries removals is unlikely to result in significant changes to the food web in the region (Subramaniam *et al*. 2022). Assessment of the impacts of bottom fishing methods on benthic habitats in the HIMI EEZ estimated that between 1997 and 2014, fishing had damaged or killed less than 2 percent of benthic organisms in areas of highest abundance less than 1200 meters deep, and that the HIMI Reserve and a transition to longlining on deeper slopes was likely to overall reduce the impact of fishing on benthic organisms and habitats, noting that longlining activities focus on the deeper slopes between 800 and 2000 meters depth where the larger toothfish occur (Welsford *et al*. 2024).
- *Marine pollution* – Given the remote location of the HIMI EEZ, the lack of transport routes and regulations on the fishing industry, the risk of marine pollution is considered to be low.
- *Invasive species and species range extensions* – this threat is considered to be low due to distance from and thermal intolerance of potential source populations.
- *Climate change* – The extent of climate change impacts on the region is uncertain due to a lack of sustained observations, however, sea surface temperature has warmed by 1°C since the late 19th century and is predicted to rise by 1-1.5°C by 2100 (Welsford et al. 2024). Marine heat waves and extreme weather events are also predicted to rise, and most taxa are predicted to decline in abundance (Fulton et al. 2021). Despite the lack of data, climate change is considered to be the major threat to the conservation values of the HIMI EEZ (Constable *et al*. 2024, DCCEEW 2024).

Clearly, in terms of the social and economic implications of the proposed expansion of the HIMI Marine Reserve, the fishing industry will be most directly affected. The perceived cost to commercial interests of government action may be seen as a 'sovereign risk' (McKenzie 2022) which includes;

- loss of access to existing fishing ground,
- loss of access to areas of fishing prospectivity, and
- zoning decisions that exclude or constrain fishing gear types.

Loss of access – Assessment of the economic impact by ABARES was done to inform the establishment of mainland Australian CMRs (Buxton & Cochrane 2015), but to our knowledge no such assessment is available for HIMI. For this reason, it is not clear how the proposed expansion of no-take area (IUCN II National Park) will affect the economic viability of the fishery.

Fishing prospectivity – The declaration of National Park Zones (IUCN category II) in largely unexplored offshore waters has been a feature of the declaration of marine reserves in Commonwealth waters. This has removed many areas of fishing prospectivity around mainland Australia (Buxton & Cochrane

2015) and has continued with the declarations around Macquarie Is., the Cocos and Keeling Is., and now with this proposal at HIMI. The impact of this is difficult to quantify given that the lack of or limited exploratory fishing and/or future gear innovations is unknown.

Zonation – A large portion of the HIMI EEZ is proposed as Habitat Protection Zone (IUCN category IV), to be managed to protect pelagic habitats or species in the waters surrounding HIMI. DCCEEW (2024c) states:
This Habitat Protection Zone is designated to protect the pelagic environment, which provides important foraging and migratory functions for seabirds, penguins and marine mammals. Protecting this area provides latitudinal and longitudinal connectivity corridors. These corridors will support more precautionary protections and monitoring that is targeted at understanding changes in the biotic and abiotic environment, including changes in species distribution as a function of depth and temperature.

The Habitat Protection Zone could allow demersal longline and other demersal fishing methods (e.g. trap, pot) in accordance with an authorisation and appropriate conditions, where they do not significantly impact on the pelagic habitat values. Demersal trawl would not be an allowed activity. These rules are consistent with the Habitat Protection Zone designated in the Macquarie Island Marine Park.

This motivation can be challenged on several grounds:

1. Protection is proposed without a clear statement as to what the pelagic zone is being protected from (e.g. midwater fishing, climate change or some other marine threat).
2. The proposal does not appear to address CAR principles as similar habitat is already represented in the existing HIMI reserve.
3. The argument for connectivity corridors is made without demonstrating the need for such corridors or that any process is impeding the movement of species within the HIMI EEZ (in response to a threat such as climate change).
4. Suggesting a precautionary approach to unknown changes in the biotic and abiotic environment (presumably driven by climate change) is not supported by any evidence as to how the zone will mitigate such a threat or risk.
5. The suggestion that the proposed design will enable the continuation of a well-regulated and sustainable fishery does not provide secure access to the fishery if as proposed HPZ *could* allow demersal longlining or other demersal fishing methods subject to conditions.
6. Despite the proposed HPZ being zoned to protect pelagic habitats and species, demersal trawling which does not impact pelagic habitats is not allowed.
7. Consistency with the HPZ at Macquarie Is. is not justified given the fishing industry's stated lack of support for this configuration (DCCEEW 2024d).
8. The demonstrable sustainability of the fishing method, as evidenced by MSC accreditation and compliance with CCAMLR conservation objectives and AFMA management policies.

On this basis, the declaration of a large portion of the EEZ as HPZ is questionable. Given the remote location of the area, the low level of impact of the fishery on the demersal habitat and the unimpeded access to the area as a foraging ground for seabirds and mammals, there appears to be little justification for this.

Greater resource access security for the existing well-regulated and demonstrably sustainable fisheries for toothfish and icefish could be achieved by following one of two alternatives:

1. If the existing fishing footprint was not declared as part of the marine reserve.
2. Declaration of the area as a multiple use or special purpose zone (IUCN category VI), the precedence for which exists in numerous CMRs around mainland Australia.

Is the reserve expansion consistent with ESD principles?

With respect to HIMI Marine Reserve expansion, at the fishery level, the extensive ESD based management systems that have been developed for the HIMI fishery already successfully meet the ecological guidelines of the EPBCA, the third-party certification requirements of the MSC, and the regional level, conservation values of CCAMLR. The independent assessment systems applied to the fishery have concluded that the risks generated by the HIMI fishery to the ecological components of ESD are all at very low or acceptable levels. The assessments found that only does the HIMI fishery pose very minimal threats to the ecological assets located within the HIMI region, but the areas currently closed to fishing within the existing marine reserve zones are already substantial.

Based on ESD principles, there is no objective basis from the Ecological Wellbeing components of ESD to justify a significant expansion in fishing closures, changes to zonation classification and associated gear restriction uncertainties. These aspects of the reserve expansion are highly likely to generate significant negative impacts on the Human Wellbeing elements of ESD for the fishery and therefore the overall suite of community outcomes generated from the region.

In addition, the planning processes undertaken to generate the reserve expansion were not consistent with applying the full set of ESD principles so that when they are compared against best practice EBM/MSP approaches, a number of deficiencies were identified including:

- There was no establishment of a governing body that included all relevant government, industry and community representatives associated with this region.
- There was not a clear recognition and establishment of the full set of ESD objectives (including social, economic and governance objectives) for use as the basis for decision making. While it is acknowledged that the initial proposal outlined there was “a preference to maintain the current fishing footprint”, this is not equivalent to a having clear objectives designed to ensure that the economic and social benefits generated from having a sustainable fishery in this region were explicitly considered at an equivalent level to the conservation objective.
- There was no clear specification of the formal threat and risk levels generated by the current set of activities operating in the region as part of the rationale and discussion for each of the ecological elements to justify the significant expansion in zones.
- Similarly, there was no description as to how the proposed zonation changes would address the unquantified ‘threats’ to each of the objectives. This is especially relevant to the fishery impacts most of which have all been rated as low to minor and it is also relevant to discussion about the uncertainty associated with mitigating the effects of marine reserves from climate change.
- There was no clear basis to measure performance of outcomes from the proposed change in zonation boundaries and classifications.
- Whilst the initial proposal stated that the intention was to maintain current fishing footprint, there was no assessment as to whether this intention would be sufficient to maintain the fishery into the future from the operational, economic and social perspectives. The approach of setting static zones for where activities can occur is not consistent with the recognition in the initial proposal that the distributions of species may shift in the near future.

- There was also no assessment of the potential impact from rezoning of the areas where the fishing currently operates as a habitat protection zone as a possible threat to the future marketing of product in international markets, or for maintaining certification by MSC. Moreover, as this type of zoning in other Marine Parks doesn't allow for the use of the main fishing method (longlining) there is no guarantee that the management plan will continue to allow this fishing method to continue, and especially when future reviews occur.
- An assessment of the cumulative threats to the HIMI fishery was not done despite it being plausible that it puts the longer-term fisheries existence at risk.
- Given this risk, there should also be an assessment of how the reserve expansion could potentially impact negatively on future governance outcomes. This should include what reductions there will be in the provision of scientific information from areas no longer allowed to be fished by certain methods.
- Furthermore, there is a high likelihood that if a significant reduction in fishing effort occurs in this region, this would increase the risks generated from increased IUU activities which would put the ecological assets at much greater risk than they currently face. Alternatively, to maintain a suitable 'on water presence' within the region, this would require a significant increased investment in regular Naval patrols, the cost of which would be borne by the Australian public from the need to increase Defence funding.

In summary, the processes undertaken to develop the HIMI Marine Reserve expansion did not include appropriate consideration of the human and governance elements of ESD which are essential components to deliver the best overall outcomes for this region and the Australian Community (see below).

Including Human Dimensions as part of the framework

In the 20 years since the establishment of the first Commonwealth Marine Reserves, it has become increasingly recognised that using a well-informed planning process that brings together all the competing ocean uses and representatives of all major social values for the area and treats them all fairly, should result in an outcome that has greatest potential for real benefits to the community. To be effective, Marine Spatial Planning (MSP) should involve a broader process than just addressing marine park planning objectives, as it requires appropriately and transparently balancing all the potential benefits and risks to social and economic outcomes in addition to addressing the ecological attributes (Rice *et al*. 2014).

A further contextual element that has been identified for effective resource management planning is that humans need to be explicitly considered as part of the ecosystem (McCloud *et al.,* 2005, Charles 2014). This requires effective stakeholder engagement at the beginning of any planning process as this is needed to identify all of the objectives, goals, problems and solutions to ensure the success of MSP necessary for effective marine ecosystem-based management (EBM) approaches (Fogarty & McCarthy 2014). Finally, all planning and decision-making should be inclusive for all relevant stakeholders and taken in the broad context of the livelihoods of dependent communities, not the narrow context of just one dimension of sustainable development (Rice *et al*. 2014). In summary, establishing Marine Reserves should be seen as only one component in the development of an effective and holistic regional-level EBM system (Fogarty & McCarthy 2014).

Consistent with the increased recognition of including human wellbeing elements in marine planning, at the global level, marine reserve objectives have recently shifted from a primary focus on maintaining ecosystems through prohibiting extractive activities, to more equitable approaches that also address the needs of both people and nature (e.g. Charles *et al.* 2017). In this respect, encompassing partially protected areas and multiple use (IUCN IV and IUCN VI) can offer effective and equitable pathways for biodiversity conservation when tailored to local context (Andradi-Brown *et al.* 2024).

Do marine reserves afford the protection necessary to the area given risks of climate change? What are they protecting?

Marine reserves that are managed and enforced can protect marine ecosystems by restricting human activities, thereby conserving biodiversity, preserving habitats, and enhancing fish stocks (Edgar *et al.* 2014). An assumption is that protected areas enhance ecological resilience to climate variability by supporting intact trophic webs and larger individuals, which has been supported by empirical analysis (Soler *et al.* 2015). Protection may also alter community responses to long-term climate change by offering higher quality habitat which may be then occupied by range-shifting species.

However, in the face of climate change, their ability to provide necessary protection is uncertain. There is evidence of benefits from temperate waters, where climate is changing rapidly. Research in eastern Tasmania, a global warming hotspot (Hobday & Pecl 2014), showed that reserve sites were distinguished from fished sites with resistance to colonization by subtropical vagrants and less pronounced changes in the community composition. Protection from fishing thus provided resistance to the initial stages of tropicalization in this region (Bates *et al.* 2013). It is well established that marine reserves can protect species that are less mobile, providing refuges that **may** serve as sources of larvae (Harrison *et al.* 2012) and juveniles to replenish surrounding areas. Demonstration of larval export to support increased abundance outside protected areas is highly context-dependent, and evidence for generalisation is absent. In locations where this export and recruitment occurs in well managed fisheries (i.e stocks are not overfished), while contributing to the overall sustainability of these fish populations this export will not increase the net level of recruitment or support increased fisheries production beyond the reserve boundaries

However, the static nature of traditional marine reserves may limit their effectiveness under dynamic climate conditions. Adaptive management strategies, including the potential for dynamic boundaries and integrated network approaches, are necessary to address the shifting distributions of species and changing environmental conditions. By incorporating flexibility and ongoing monitoring, marine reserves can continue to offer protection in the face of climate change. In a redesign of the HIMI zones, a dynamic management approach should be considered if spatial protection is to be effective to climate variability and change.

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