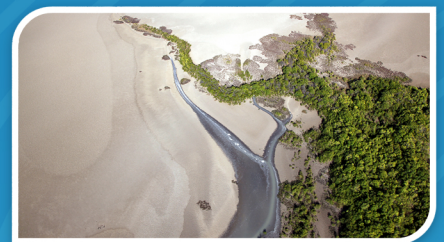


Northern Territory Marine Science



End-user Knowledge Needs Analysis





Northern Territory Marine Science

End User Knowledge Needs Analysis

January 2018

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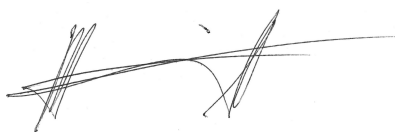
Foreword

The Northern Territory's inhabitants are fortunate to enjoy life in one of the few remaining relatively intact tropical marine ecosystems in the world. In Australia, the Northern Territory marine environment is unique, in both its character and use. It has significant biological, ecological and cultural values, and hosts much of the industry in the Territory. However, this exceptional environment is facing increasing pressure from a broad range of human activities and demands, including climate change, resource use and development.

In the face of these pressures, government, regulators and industry are called upon to make policy, regulatory, strategic and operational decisions regarding human use of, and impacts on, the Northern Territory marine environment. In many instances, these decisions are not adequately informed by marine science knowledge and a poor decision can limit the prosperity and quality of life of the Northern Territory's people. As researchers and educators who work and live in the north, it is incumbent on organisations like ours to provide the knowledge that is needed to maintain marine ecosystems in a healthy state, so that all users can reap the benefits of the valuable resources without compromising their long-term sustainability. By assisting the decision-making processes of government, industry, community leaders and administrators with relevant marine science, our work can have a lasting impact on the future of the Northern Territory's precious ecosystems.

The Australian Institute of Marine Science (AIMS) and Charles Darwin University (CDU) are pleased to partner in the Northern Territory Marine Science End User Needs Analysis (NTMSEUNA). The NTMSEUNA provides us with a much stronger foundation from which to plan the marine research needed to protect the ecosystems of the Northern Territory and ensure the social and cultural values associated with the environment flourish. The NTMSEUNA identifies the marine science imperatives of all key stakeholders in the Northern Territory marine environment and includes a very comprehensive engagement with Indigenous communities regarding their aspirations and concerns for the marine environment. The NTMSEUNA brings to light the sheer volume and range of marine science that is necessary to ensure the environments are adequately preserved so that economic, social and cultural interactions can continue.

We thank Australian Venture Consultants and the North Australian Indigenous Land and Sea Management Alliance for their work in producing this comprehensive and important analysis and look forward to its implementation. We want to ensure that marine science research in the Northern Territory is applied and robust and focused on answering the important questions around marine ecosystem management and use, so that all stakeholders and end users enjoy the benefits for generations to come.



Dr Paul Hardisty



Professor Simon Maddocks

Traditional Aboriginal owners of land and sea *country* around Australia have never relinquished rights to our lands and waters. Our sense of belonging, identity and languages, our health, economy and futures are indelibly connected to our lands and seas.

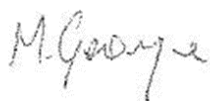
Today, many seek access to our *country* for many purposes; mining, tourism, the military, agriculture, conservation, Government agencies, research institutions and others. The pressures of this interest and development in north Australia more broadly, impact the health of our *country*, as they do us. We, as Traditional Owners, have a responsibility to care for our *country* and equally to grow up the next generations of kin to carry on this responsibility. It is not about 'protection' of environmental and cultural assets, but about active management and enhancement of these, about improved well-being and meaningful participation in wider economic activity.

Aboriginal people bring many valuable assets to the table: our *country*; local, historical and traditional knowledge; innovative thinking; permanently resident work force; and in the Northern Territory, strong land tenure and representation through statutory Land Councils. Our people have long participated in land and sea -based economic activity . . . from trade with Macassans, semi-industrial fishing during the Mission era, through to carbon farming and other ecosystem services, mining, arts and tourism and community based research. Our aspirations, experience and capabilities however, are relatively unrecognised in the development agenda.

Traditional Owners, like Governments and others, need to plan for development; make decisions about threats and opportunities; anticipate and monitor change; and manage and respond to impacts. For this we need good quality research and information, not just about environmental assets and issues relevant to development, but about proponents themselves, their outlook and interests. It's in our interests to drive and participate in research and development on our *country*: and it's in the quality of relationships amongst us and interested stakeholders that effective participation in a healthy and diverse northern economy can grow.

The NT Marine Science End User Needs Analysis (NTMSEUNA) has responded to this need for quality information by canvassing a broad range of stakeholders about their knowledge needs and research interests. This considerable effort and enormous compendium of information provides a unique and indispensable platform for better directed and better quality research, and importantly a positive step in engagement with the needs, interests and capabilities of Indigenous owners of land and sea *country*.

We look forward to building on respectful and productive relationships with the research community, and contributing to the application of wider and deeper knowledge to the many management challenges that face all of us in achieving prosperous and sustainable futures.



Melissa George
Chief Executive Officer



Peter Yu
Chair

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Summary of Findings

What is the Northern Territory Marine Science End User Needs Analysis?

The Northern Territory Marine Science End User Needs Analysis (NTMSEUNA) identifies the marine science imperatives of all key stakeholders in the Northern Territory marine environment.

Addressing these marine science imperatives will ensure that the important marine ecosystem services that the Northern Territory marine environment provides are optimally protected, the social and cultural values associated with that environment flourish and the industries operating within or intersecting with the Northern Territory marine environment achieves optimal levels of productivity and can operate with certainty.

The development of the NTMSEUNA has been funded by the Australian Institute of Marine Science and Charles Darwin University. The project has been overseen at arms-length by an independent Steering Group comprised of representatives of Northern Territory and Commonwealth Government policy makers and regulators, Aboriginal, industry and community interests in the Northern Territory marine environment, as well as marine science expertise. The analysis, consultation and drafting that has resulted in this report has been undertaken both separately and collaboratively by Australian Venture Consultants and the North Australian Indigenous Land and Sea Management Alliance Ltd.

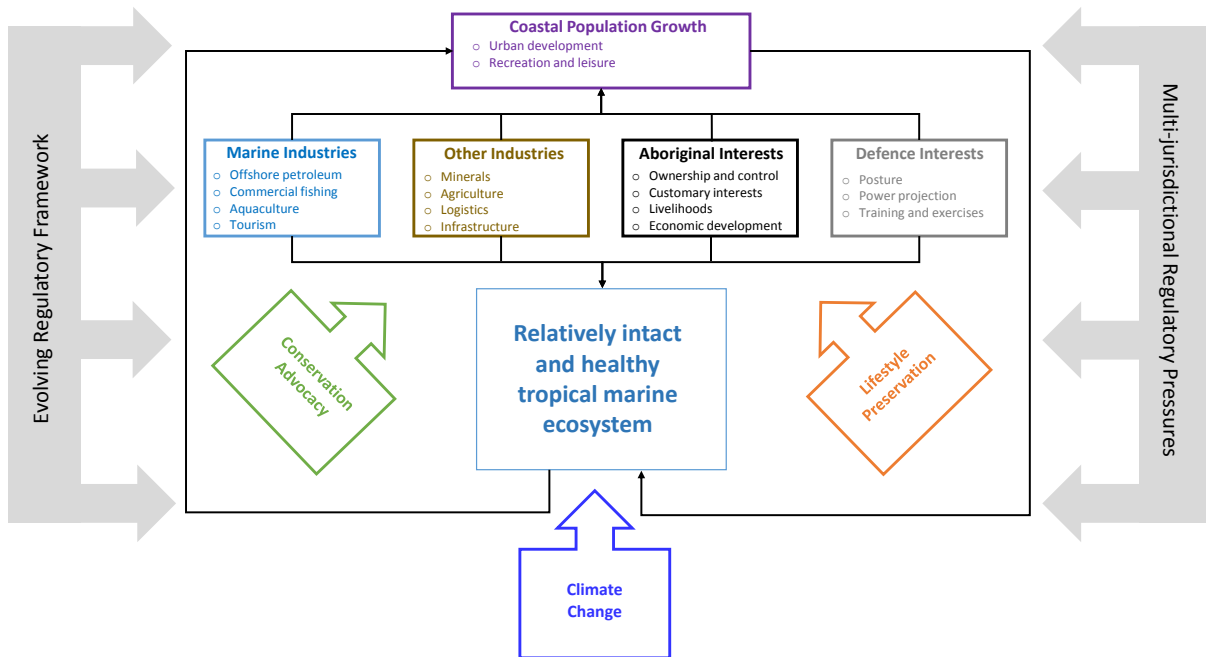
Why is the Northern Territory Marine Science End User Needs Analysis Necessary?

The Northern Territory marine environment is one of the few relatively intact tropical marine ecosystems in the world, particularly with respect to its coastal, littoral and shallow water zones. Extensive estuarine systems and the degree to which their source waters are almost unmodified by damming or diversion is globally unique. Extensive mangrove communities, seagrass meadows, reefs, shoals, islands, large bays and ria systems that are characteristic of the Northern Territory marine environment host globally significant marine ecosystems and biodiversity and provide both refugia and large areas of important habitat for several globally endangered species. The physical ocean environment provides important ecosystem connectivity and is a major determinant of regional climate.

Every day government, industry and community leaders and administrators make policy, regulatory, strategic and operational decisions pertaining to human interaction with the Northern Territory marine environment. In many instances, these decisions are not adequately informed by marine science knowledge. Ultimately, this results in decisions that reside on a continuum between those that knowingly place important marine ecosystem services at risk with the expectation of a significant public benefit and crude application of the precautionary principle, which can result in unnecessary loss of productivity and/or opportunity, or inadequate protection of key ecosystem services.

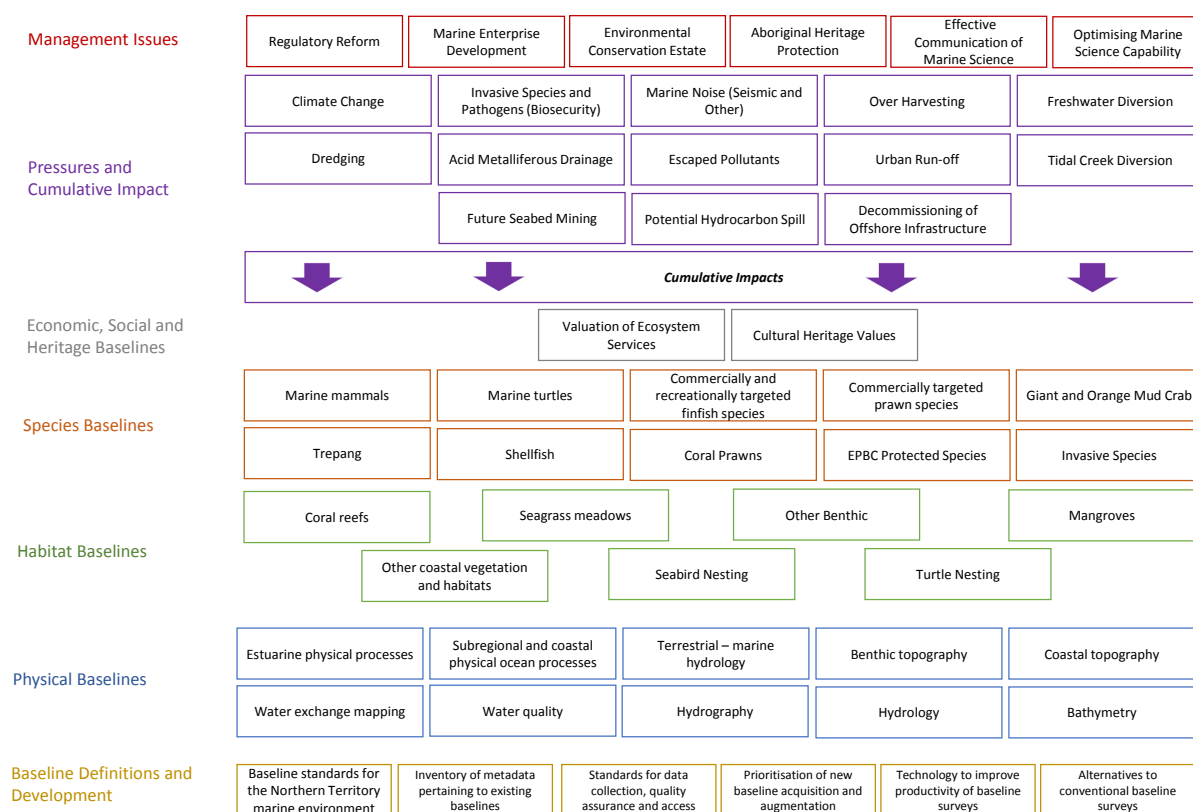
The Northern Territory is mainly a primary industry and tourism-based economy. While its growth will be subject to commodity price cycles, the longer-term trend toward increased economic development and coastal population growth are likely to continue. As this anthropogenic activity occurs, several socio-economic forces, together with global climate change are likely to shape the nature of the marine science knowledge needs that are required to facilitate

optimal decision making with respect to the Northern Territory marine environment. This is illustrated in the following figure and discussed in detail in Section 2 of this report.



What are the Key Outcomes from the Northern Territory Marine Science End User Needs Analysis?

Interviews and workshops have sought input from Northern Territory and Commonwealth policy makers and regulators of the marine environment; Aboriginal interests in the Northern Territory Marine environment; the Australian Defence Force (ADF); the marine logistics, offshore oil and gas, commercial fishing, aquaculture, pearling, crocodile, minerals, irrigated agriculture and forestry industries; coastal communities; recreational fishing sector; marine conservation sector and scientific profession. This consultation has identified a total of 153 key issues requiring 246 specific marine science knowledge needs to be addressed. Collectively, these can be summarised based on the themes shown in the following diagram.



Aboriginal Interests in the Northern Territory Marine Environment and their Marine Science Knowledge Needs

A unique aspect of the Northern Territory marine environment is the extent of Aboriginal interests from both a geographical and breadth of rights perspective. In accordance with Commonwealth and Northern Territory legislation and case law, Aboriginal people are owners, managers, holders of resource rights and have wider stakeholder interests in the Northern Territory marine environment, including controlling access to approximately 85 percent of the intertidal zone along the Northern Territory coastline. There are also significant marine oriented Aboriginal cultural rights that are protected by law.

Historically, these rights have been mainly recognised as rights to occupy land and sea country at the exclusion of others, to use those resources to support livelihoods and to undertake customary practice. However, more recently, the legal and customary rights and interests held by Aboriginal people are being recognised by courts as encompassing certain commercial rights and interests. With a recognised need to address significant socio-economic disadvantage, this is serving as a catalyst for increased economic participation from coastal Aboriginal communities, with regions of interest to this study hosting an increasing number of community livelihood-oriented enterprises, as well as some of Australia's most successful Aboriginal owned and operated businesses.

Aboriginal people comprise a large portion of the population of the Greater Darwin Palmerston Area and the vast majority of the population in other Northern Territory coastal settlements.

Through Aboriginal Ranger Groups, Aboriginal communities along the Northern Territory coastline perform a range of marine conservation and resource management and

enforcement activities, including fee-for-service activities for government and industry, with demand for these services increasing.

There is a need to understand the role that conventional marine science plays in decisions made by Aboriginal people and to fully involve Aboriginal people in the process that generates marine science knowledge.

With respect to Aboriginal interests in the Northern Territory marine environment, this study has identified 34 key issues requiring 60 specific marine science knowledge needs to be addressed that revolve around the following key themes:

- Causes of coastal vegetation dieback;
- Knowledge to support sustainable harvests;
- Population baselines, pressures on key species and management frameworks;
- Habitat status, pressures and management frameworks;
- Biosecurity threats;
- Impacts of large anthropogenic disturbance;
- Adequacy of the marine conservation estate;
- Communication and governance of Aboriginal interests in the marine estate;
- Employment opportunities and enterprise development in coastal settlements; and
- Knowledge required to support the growth of the Aboriginal environmental services sector.

Aboriginal interests in the Northern Territory marine environment and their marine science knowledge needs are discussed in Section 3.

Northern Territory Marine Conservation Estate

The Northern Territory marine conservation estate includes a limited area of Northern Territory marine parks, coastal reserves and Indigenous Protected Areas (IPAs), and a relatively extensive network of Commonwealth Marine Parks. Different levels of access and activity are allowed on different areas of this marine conservation estate. The conservation estate portfolio is designed to protect specific threatened species and ecosystems, as well as important Aboriginal cultural values, and ensure the preservation of a connected network of ecosystems that are representative of those that are characteristic of the Northern Territory.

By protecting a range of representative ecosystems and bioregions representing breeding and feeding habitats for a variety of species, the North Network of Commonwealth Marine Parks aims to increase the resilience of the overall marine environment, reducing susceptibility to natural and anthropogenic pressures such as cyclones, climate change and potential hydrocarbon spills. The majority of these reserves are currently classed as 'multiple use zones', or Category VI under the International Union for Conservation of Nature (IUCN) protection schemes. This zoning is known as 'protected area with sustainable use of natural resources' and applies to ecosystems and habitats that are associated with cultural (usually traditional) values and usage, together with natural resources management systems that allow sustainable non-industrial use of resources. Priorities in management are the balancing of ecological, social and economic dimensions, with a focus on inter-generational security of livelihood for local communities.

The Northern Territory marine conservation estate also includes a few marine parks and coastal reserves managed under the jurisdiction of the Northern Territory Government, most of which also include a terrestrial component.

The final component of the Northern Territory marine conservation estate is comprised of IPAs. IPAs are areas of land and/or sea country voluntarily dedicated by Traditional Owners as non-legislated protected areas, recognised by all Australian governments as part of the National Reserve System of Protected Areas. IPAs are managed by Indigenous Rangers and partner organisations according to protected area guidelines of the IUCN.

The reserves that comprise the Northern Territory marine conservation estate are listed in the following table and discussed in Section 4, with the marine science knowledge needs of the managers of that estate discussed in Section 5.

Commonwealth Marine Parks in Northern Territory Marine Environment	Northern Territory Marine Parks and Coastal Reserves	Indigenous Protected Areas
<ul style="list-style-type: none"> ▪ Oceanic Shoals ▪ Joseph Bonaparte Gulf ▪ Arafura ▪ Arnhem ▪ Wessel ▪ Limmen 	<ul style="list-style-type: none"> ▪ Limmen Bight Marine Park ▪ Garig Gunag Barlu/Coburg Peninsula National Park ▪ Casuarina Coastal Reserve ▪ Channel Point Coastal Reserve ▪ Shoal Bay Coastal Reserve ▪ Indian Island Conservation Area ▪ Charles Darwin National Park ▪ Tree Point Conservation Area ▪ Vernon Islands Conservation Area ▪ Melacca Swamp Conservation Area ▪ Djukbinj National Park ▪ Mary River National Park ▪ Kakadu National Park ▪ Barranyi National Park ▪ Finucane Island National Park 	<ul style="list-style-type: none"> ▪ Marri-Jabin (Thamurrurr) Stage 1 ▪ Djelk ▪ Dhimurru ▪ Laynhapuy ▪ Anindilyakwa ▪ Yanyuwa (Barni-Wardimantha Awara) ▪ Marthakal Stage 1 ▪ South East Arnhem Land

Regulators of the Northern Territory Marine Environment and their Marine Science Knowledge Needs

Adopted as a Territory from the State of South Australia in 1910, the Northern Territory was granted self-government in 1978 by the *Northern Territory (Self Government) Act 1978* (Cth). This Act functions in a similar manner to a State Constitution, but reserves some powers of government for the Commonwealth, including acquisition of land from the Territory and Indigenous land rights. In any event, the Northern Territory marine environment consists of waters that fall under the jurisdiction of both the Northern Territory and Commonwealth Governments.

The key Northern Territory and Commonwealth Government regulators of aspects of the Northern Territory marine environment are listed in the following table.

Fisheries Regulators	Marine Safety and Biosecurity Regulators	Environmental Regulators and Managers of the Marine Conservation and Heritage Estate
Northern Territory Government Agencies		
<ul style="list-style-type: none"> ▪ Department of Primary Industries and Resources (Fisheries NT and Primary Industry Group) 	<ul style="list-style-type: none"> ▪ Director of Marine Safety and Regional Harbour Master – Department of Infrastructure, Planning and Logistics 	<ul style="list-style-type: none"> ▪ Environmental Protection Authority ▪ Department of Environment and Natural Resources ▪ Parks and Wildlife Commission ▪ Power and Water Corporation ▪ Aboriginal Areas Protection Authority
Commonwealth Government Agencies		
<ul style="list-style-type: none"> ▪ Australian Fisheries Management Authority 	<ul style="list-style-type: none"> ▪ Australian Marine Safety Authority ▪ National Offshore Petroleum Safety and Environmental Management Authority ▪ Department of Agriculture and Water Resources 	<ul style="list-style-type: none"> ▪ Department of the Environment and Energy ▪ National Offshore Petroleum Safety and Environmental Management Authority

With respect to regulators of the Northern Territory marine environment, this study has identified 23 key issues that require 66 specific marine science knowledge needs to be addressed that revolve around the following themes:

- Species and habitat baselines, pressures and management frameworks;
- Immediate environmental pressures and management priorities;
- Knowledge to inform an evolving regulatory framework;
- Knowledge to inform commercial fisheries development; and
- Knowledge to inform safety and environmental impact of vessels and offshore infrastructure.

Regulators of the Northern Territory marine environment and their marine science knowledge needs are discussed in Section 5.

Australian Defence Force and its Marine Science Knowledge Needs

Australia's key strategic defence interests are now clearly oriented toward the north of the Nation. Areas of most immediate importance to Australia are its borders and offshore territories, its strategic intersection with the interests of Indonesia, Timor-Leste, Papua New Guinea and various Pacific Island countries, as well as its maritime interests in South East Asia more generally. The economic importance of northern Australia and its offshore resources plays a significant role in current and future defence planning. This is a major aspect of ADF doctrine that has been further promoted in the most recent Defence White Paper that articulates ADF doctrine out to 2035.

In this contemporary defence landscape, the Northern Territory is playing an increasingly important role supporting the operations of the ADF from a posture and power projection, as well as training and exercise perspective. ADF presence and investment in Northern Australia will gradually increase over the next decade to support the needs of the more capable, high technology future force that the ADF will bring into service, as well as a more active defence posture. This will be supported by the existing ADF bases in the Northern Territory, namely HMAS Coonawarra, and other operations of Larrakeyah Barracks, Robertson Barracks, RAAF Tindal and RAAF Darwin.

Of relevance to this study is HMAS Coonawarra. HMAS Coonawarra is a critically important northern installation for the Royal Australian Navy (RAN). It is the base that supports border integrity operations and major international exercises in Australia's northern waters, with approximately 100 RAN and foreign naval vessels visiting the base and Darwin Harbour more generally each year. The 2016 Defence White Paper sets out a schedule of new asset acquisitions for the RAN. Prior to these assets being deployed, RAN bases across the north of Australia, including HMAS Coonawarra, will require significant upgrades.

The Northern Territory and the ADF installations play a key role in several domestic and international defence exercises. The main exercises are Talisman Sabre, Kakadu and Pitch Black, each of which interact with the Northern Territory marine environment to varying degrees.

The Department of Defence also has obligations under international conventions and Australian law to undertake and maintain hydrographic and oceanographic surveys of Australian waters. Significant areas of the Northern Territory marine environment are inadequately surveyed and, under a recently announced programme, the Department of Defence will endeavour to partner with industry and academia to cost-effectively address identified deficiencies in the Australian hydrographic and oceanographic survey data.

With respect to the needs of the ADF, this study has identified three key issues requiring three specific marine science knowledge needs to be addressed that revolve around the following themes:

- Marine science evidence that demonstrates the RAN's high standards of marine stewardship; and
- Development of survey data under the HydroScheme Industry Partnership.

The ADF's operation in the Northern Territory marine environment and its marine science knowledge needs are discussed in detail in Section 6.

Darwin Port and its Marine Science Knowledge Needs

As a place of trade, the general area around Darwin Port pre-dates European settlement, with the Larrakia people having conducted trade with South East Asia, particularly with Makassan Trepanng fisherman from the southwest corner of Sulawesi, for thousands of years. Today, commodity ore exports, livestock exports, petroleum imports and bulk liquids, containerised import and export cargoes and specialised cargo is all handled through the multi-modal facility at East Arm Wharf, with the City Wharf area dedicated to cruise ship and limited defence needs. In 2015, the Northern Territory Government provided the People's Republic of China (PRC)'s domiciled company, Landbridge Holdings, with a 99-year lease to operate Darwin Port, retaining a 20 percent interest.

In 2015–16, the Northern Territory had merchandise exports of approximately \$5.1 billion, equivalent to 22 percent of the Gross State Product (GSP). A significant portion of these exports were transported through Darwin Port including \$444 million of live animal and \$317 million of crude petroleum product. Darwin Port plays a critical role in the Northern Territory's export-oriented economy and will play an increasingly important role in supporting the economy of northern Australia more generally, particularly central and western northern Australia. Darwin Port is the only true multi-modal port in northern Australia, with direct rail connectivity through central Australia, to the southern, eastern and west regions of the Nation. Apart from the mineral and petroleum bulk commodity ports in Western Australia and Queensland, Darwin is

the busiest commercial port in northern Australia and has only been operating at this scale for the past five years.

Darwin Port's strategic location with respect to key Asian markets for Australian exports, proximity to northern Australian primary production areas, multi-modal connectivity to the wider Nation and expansion potentially renders it one of the most important pieces of economic infrastructure in northern Australia. This is particularly true with respect to its proximity to the current southeast Asian 'terminus' of the PRC's 'One-Belt-One-Road' international logistics infrastructure investment programme.

The current operational footprint of Darwin Port includes:

- East Arm Wharf and Logistics Precinct that incorporates a bulk liquids facility, container and common-user supply-base facility, bulk handling facility, multi-user barge ramp and common user area, several recreational boat ramps and the Darwin Business Park and Berrimah Freight Terminal;
- Hudson Creek Barge Facility that supports several coastal barge operations that service communities and industries along the northern Australian coastline;
- Darwin Wharf Precinct that incorporates the Stokes Hill and City Wharfs and is primarily a restaurant and tourism precinct supporting cruise ships and limited visiting naval vessel operations;
- Fisherman's Wharf that is the home port for local fishing and pearling operations, as well as additional coastal barge operations;
- Recreational marina facilities including Cullen Bay, Bayview and Tipperary Marinas
- HMAS Coonawarra;
- Darwin LNG, located on Wickham Point;
- Ichthys LNG, located on Bladin Point; and
- Channel Island Power Station.

Plans for the East Arm Wharf include:

- Expanding the refrigerated container park and strategic hardstand area;
- Harbour support vessel facility expansion;
- Quay-line container park expansion;
- Increased bulk commodity handling capacity; and
- Expansion of the marine supply-base.

Middle Arm has been identified as the site for a new industrial precinct that will focus on downstream gas processing and gas related industries, and other expansion plans in the Port area generally include a marine industry park, defence industry hub, transport industry precinct, cruiseliner facility and new fishing fleet marina.

From Darwin Port's perspective, this study has identified 11 key issues requiring 19 specific marine science knowledge needs to be addressed that revolve around the themes of:

- Water quality;
- Dredging; and
- Various other issues including predicting usage conflicts, managing biosecurity and the port-residential interface.

Darwin Port and its marine science knowledge needs are discussed in Section 7.

Commercial Fishing Industry and its Marine Science Knowledge Needs

The Northern Territory commercial fishing industry is comprised of fisheries that are managed either exclusively by the Northern Territory or exclusively by the Commonwealth, as well as those that are managed jointly by these jurisdictions, depending on whether a fishery operates exclusively in Northern Territory or Commonwealth waters or transects both.

Collectively, these fisheries produce a Gross Value of Product (GVP) of at least \$55 million and up to \$90 million, depending on the extent to which the catch of the Northern Prawn Fishery (which extends across northern Australia) is attributed to the Northern Territory. The commercial fishing industry is also a significant contributor to employment and a major component of the small-to-medium enterprise sector in the Northern Territory.

The following table summarises the commercial fisheries operating in the Northern Territory marine environment.

Northern Territory Managed Fisheries	Jointly Managed Fisheries	Commonwealth Managed Fisheries
<ul style="list-style-type: none"> ▪ Barramundi ▪ Mud Crab ▪ Coastal Line ▪ Trepang ▪ Coastal Net and Other ▪ Aboriginal Coastal Licences 	<ul style="list-style-type: none"> ▪ Demersal ▪ Offshore Net and Line ▪ Spanish Mackerel ▪ Timor Reef ▪ Aquarium ▪ Squid Jigging 	<ul style="list-style-type: none"> ▪ Northern Prawn Fishery ▪ Western Tuna and Bill Fishery

Collectively, these fisheries target:

- A range of finfish species including Barramundi, King Threadfin, Threadfin, Blue Salmon, Red Snapper, Gold Band Snapper, Sweetlip Snapper, Emperor species, Cod species, Black Jewfish, Spanish Mackerel, Grey Mackerel, Trevally, Mullet, Baitfish, and various shark species including Black-tip Sharks, and Spot-tailed Sharks;
- Mud Crab;
- Trepang;
- Aquarium fish, coral, other invertebrates and 'live-rock'; and
- Banana, Tiger and Endeavour Prawns.

With respect to the commercial fishing industry, this study has identified 19 key issues requiring 33 specific marine science knowledge needs to be addressed across the following themes:

- Continued access to the fishery;
- Equitable allocation of the fishery resource;
- Productivity of the fishery; and
- Fishery development.

These marine science knowledge needs are consistent with the Fisheries Research and Development Corporation's National Fishing and Aquaculture Research, Development and Extension Strategy and are discussed in Section 8.

Pearling, Aquaculture and Crocodile Industries and their Marine Science Knowledge Needs

Marine oriented 'farming' industries in the Northern Territory produce an estimated GVP of approximately \$48 million per annum. Aquaculture and pearling produce a GVP of approximately \$25 million, of which pearling operations account for 70 percent and the crocodile industry accounts for an estimated additional \$23 million.

The pearling industry revolves around the production of the *Pinctada maxima* (or South Sea Pearl), which is highly valued in international jewellery markets. Production facilities are located on the Coburg Peninsula and in Bynoe Harbour.

Currently, a single Barramundi operation accounts for almost all the Northern Territory's aquaculture GVP. However, a planned large-scale Prawn farm producing Banana and Black Tiger Prawns may soon add significantly to the sector's GVP, with other smaller industries also in development including Trepanng, Giant Clams and Tropical Black Lip Oysters.

The Northern Territory crocodile industry has been operating in the Northern Territory since the late 1970s and is currently comprised of eight farms located primary around the Darwin area. These operations produce a range of products from the native *Crocodylus porosus* (or Salt Water Crocodile) including skins, meat, teeth, feet, heads, skeletons and live animals. The Northern Territory crocodile industry accounts for approximately two-thirds of Australian crocodile skin exports.

With respect to the pearling, aquaculture and crocodile industries, this study has identified 11 key issues requiring 22 specific marine science knowledge needs to be addressed across the following themes:

- Ensuring biosecurity;
- Managing other external threats; and
- Improving industry productivity.

The needs of this sector are discussed in Section 9.

Offshore Petroleum Industry and its Marine Science Knowledge Needs

The offshore petroleum industry is a major driver of the Northern Territory economy. The Northern Territory offshore petroleum industry is currently comprised of:

- Two onshore LNG processing and export facilities located in Darwin Harbour and sourcing natural gas and condensate from production facilities in the Joint Petroleum Development Area in the Timor Sea and the Browse Basin in offshore Western Australia;
- Domestic gas supply from a production facility in the Joseph Bonaparte Basin;
- Exploration and development activity in the Timor and Arafura Seas; and
- A significant offshore oil and gas services sector based out of Darwin Port.

The ConocoPhillips operated Bayu Undan Field and associated Darwin LNG facility has been operating since 2006. With the Bayu Undan Field now approaching its end of life, the operator is assessing back-fill options to extend the operating life of the LNG facility.

The recent construction of the Inpex Ichthys LNG project has been a major stimulus for the Northern Territory economy. It is estimated that at peak production, the Ichthys project will add \$4.5 billion to Northern Territory petroleum exports.

The offshore services industry based out of Darwin Port services the offshore infrastructure and operations of ConocoPhillips and other operators in offshore Northern Territory. It also is the main support base for Inpex's operations and Shell's Prelude project operating in the Browse Basin and Eni's Blacktip production facility operating off the Joseph Bonaparte Basin off the Kimberley coast of Western Australia.

With respect to the offshore petroleum industry, this study has identified 11 key issues requiring 31 specific marine science knowledge needs to be addressed across the following themes:

- Environmental baseline data;
- Infrastructure planning;
- Hydrocarbon spill response;
- Managing seismic noise; and
- Decommissioning of infrastructure.

These needs are discussed in Section 10.

Marine Tourism Industry

There are an estimated 1.7 million visitors to the Northern Territory each year, with approximately half of those visitors being holiday makers. Darwin is the focus of visitors with approximately three quarters of visitors to the Northern Territory only leaving Darwin for a day trip. Furthermore, the most popular tourism attractions in the Northern Territory are terrestrial experiences. Nevertheless, the Northern Territory's pristine tropical marine environment, marine-oriented Aboriginal culture and significant recreational fishing stocks render it a popular marine tourism destination.

The main aspects of tourism that intersect with the marine environment are cruise ships and fishing charters. Cruise ship visits contribute an estimated \$54 million to the Northern Territory economy each year. The impact of cruise ship visitors on the Northern Territory marine environment is understood to be minimal and primarily confined to waterfront dining, cruises on the Adelaide River and water activities oriented around Cullen Bay.

The fishing charter sector is the most visible component of marine tourism in the Northern Territory with over 60 operators accounting for approximately 300,000 fishing days in total. Furthermore, this activity is more widely dispersed along the Northern Territory coastline, with an estimated 70 percent of the total fishing effort that occurs in regional areas derived from fishing charters.

This study has not ascertained key issues or marine science knowledge needs for the Northern Territory marine tourism industry. However, it is assumed that the fishing charter sector would have many common issues and marine science knowledge needs with the commercial and recreational sectors. This sector is discussed Section 11.

Minerals Industry and its Marine Science Knowledge Needs

The Northern Territory minerals industry is a major component of the Northern Territory economy, currently producing a GVP of approximately \$3.0 billion and directly employing almost 6,000 people. While the industry produces at least a dozen mineral commodities, manganese, gold, zinc-lead, uranium and bauxite are the major drivers of production value.

Minerals operations intersect with the Northern Territory marine environment either through export operations or mine generated heavy metals and pollutants entering the marine environment either directly or through connectivity with river catchments. The main projects that have a significant intersection with the Northern Territory marine environment are:

- McArthur River Mine that is operated by Glencore and is the world's second largest zinc-lead mine. It is located near Borroloola, 900 kilometres southeast of Darwin and serviced by an export facility at Bing Bong;

- Gove Bauxite Mine that is operated by a wholly-owned subsidiary of Rio Tinto and located in northeast Arnhem Land, exporting bauxite ore; and
- Groote Eylandt Mining Company (GEMCO) that is a wholly-owned subsidiary of Latitude 32 mining and exporting manganese from an operation on Groote Eylandt.

The future prospect of subsea mining in the Northern Territory will obviously have a significant intersection with the Northern Territory marine environment.

With respect to the minerals industry, this study has identified 11 key issues that require 22 specific science knowledge needs to be addressed across the following themes:

- Wider-scale cumulative impacts of direct interactions with the marine environment;
- Impacts of acid and metalliferous drainage and escaped pollutants on the marine environment; and
- Efficient regulation of the mining industry's interface with the marine environment.

The needs of this sector are discussed in Section 12.

Irrigated Agriculture and Forestry Industry and its Marine Science Knowledge Needs

Agriculture more widely is a significant component of the Northern Territory economy producing a GVP of approximately \$500 million. The beef cattle sector typically accounts for approximately two-thirds to three quarters of Northern Territory agricultural GVP each year.

The horticulture sector produces various fruit, vegetables and nursery and cut flower products, and the mixed farming sector produces various field crops from groundwater fed irrigation systems. Estimates of the value of irrigated agriculture production in the Northern Territory range from \$133 million to \$245 million. Horticulture operations are concentrated in the Litchfield, Katherine/Mataranka, Central Australia and Douglas-Daly River Regions.

In addition, there is approximately 50,000 hectares of irrigated and un-irrigated forestry production in the Northern Territory, rendering it the second largest production land user after beef cattle. This is comprised of Black Wattle plantations on the Tiwi Islands, African Mahogany plantations in the Douglas-Daly River Region and Sandalwood plantations in the Douglas-Daly River and Katherine Regions.

There are plans to expand the Ord River Irrigation Area into parts of the Northern Territory and several areas of the Northern Territory have been identified as suitable for supporting irrigated agriculture, particularly around the Roper and Wildman River areas. This could include forestry, horticulture, field crop and/or stand-and-graze cattle production.

All current irrigation operations source from groundwater resources. However, for the industry to grow there will likely need to be some off-stream harvesting of peak-flows upstream from floodplains where topography is suitable for storage.

With respect to the irrigated agriculture and forestry industries, the main theme is understanding the resilience of potentially affected marine ecosystems to changes in timing and volume of freshwater ingress to identify optimally sustainable levels of freshwater harvest for the industries. This study has identified five key issues pertaining to this theme, requiring six specific marine science knowledge needs to be addressed. These are discussed in Section 13.

Coastal Communities and their Marine Science Knowledge Needs

The vast majority of Northern Territorians live in cities, towns or settlements that are on or near the coast, with almost 60 percent of the population residing in the Greater Darwin Area and an additional 18 percent residing in Local Government Areas (LGAs) with a coastline.

The Darwin City CBD and built waterfront occupies a large portion of the Darwin peninsula. The majority of usage of the marine estate stems from the retail, restaurant, high density residential and tourism precinct in the Darwin Wharf Area, as well as Cullen Bay, Kitchener Bay, Tipperary Waters and Bayview Marinas. The current Darwin Master Plan contains numerous proposals to develop and increase utilisation of the coastal estate, including waterfront parks, releasing waterfront land for residential and commercial development and rerouting and upgrading road and public transport links. In particular, the plan calls for significant reclamation activities involving landfill, seawalls and other related stabilisation works to reclaim a significant portion of the northwest shoreline of East Arm, opposite the Charles Darwin National Park.

Most of the coastal population that resides outside of the Greater Darwin Area is Aboriginal and is concentrated in the coastal settlements along the Northern Territory coastline and on its islands. There are at least 20 such settlements that range in population from 200 to 4,000, with many of these settlements supporting additional communities and outstations. Because there are numerous island settlements and many of the coastal mainland settlements are inaccessible by land during the wet season, they are heavily reliant on coastal barge operations for regular supply and servicing.

With respect to coastal communities, this study has identified 17 key issues requiring 31 specific marine science knowledge needs to be addressed across the following themes:

- Stormwater run-off from the Darwin CBD;
- Predicting and managing coastal inundation;
- Destruction and diversion of tidal creeks; and
- Stormwater and public health.

Section 14 discusses the needs of this sector.

Recreational Fishing Sector and its Marine Science Knowledge Needs

Recreational fishing is a major pastime in the Northern Territory, incorporating many social and cultural values. The sector is estimated to have a significant multiplier effect on the local economy through fishing retail (bait and tackle), recreational vessel hire and purchase, fuel, and ancillary services such as hospitality and accommodation associated with extended fishing trips, with an estimate of total impact of up to \$100 million per annum.

The recreational fishing effort in the Northern Territory is coastally oriented. While an estimated 22 percent of the non-Indigenous population of the Northern Territory participate in recreational fishing once a year, around 20 percent of those account for 60 percent of the total recreational fishing effort. The vast majority of the recreational fishing effort is boat and line based and occurs between April and November. Approximately 50 percent of the recreational fishing effort is concentrated in the wider Darwin Harbour Area, with less than 9 percent focused on the Arnhem and Gulf of Carpentaria coastlines.

The main species that are targeted by recreational fishers in the Northern Territory are Barramundi and Snapper, with a large portion of fish caught on a 'catch-and-release' basis. Mud Crabs are also an important recreational species.

With respect to the recreational fishing sector, this study has identified 8 key issues requiring 12 specific marine science knowledge needs to be addressed across the following themes:

- Understanding the current and future impact of the sector on the fishery resource;
- Accurately defining the sector's contribution to the economy and social fabric of the Northern Territory; and
- Maintaining the sector's social licence to operate.

These are discussed in Section 15.

Northern Territory Marine Science Capacity

This study also identifies and discusses the various Commonwealth, Northern Territory and other scientific organisations operating in the Northern Territory that have marine science capability and capacity. The capacity is discussed based on the organisations, collaborations and specific industry sector scientific capabilities listed in the following table.

Commonwealth Organisations	Northern Territory Organisations	Collaborations	Industry Sectors with Marine Research Capability
<ul style="list-style-type: none"> ▪ Australian Institute of Marine Science ▪ Commonwealth Scientific and Industrial Research Organisation (CSIRO) Oceans and Atmosphere Business Unit ▪ Integrated Marine Observing System ▪ Department of Environment and Energy ▪ Bureau of Meteorology 	<ul style="list-style-type: none"> ▪ Department of Primary Industry and Resources (NT Fisheries) ▪ Department of Environment and Natural Resources ▪ Charles Darwin University ▪ North Australian Indigenous Land and Sea Management Alliance Ltd 	<ul style="list-style-type: none"> ▪ Northern Australia Environmental Resources Hub ▪ Northern Australia Cooperative Research Centre ▪ Aboriginal Research Practitioners Network ▪ Northern Australia Marine Research Alliance 	<ul style="list-style-type: none"> ▪ Offshore petroleum ▪ Commercial fishing ▪ Aquaculture and pearling

Compared to capacity that resides elsewhere in Australia, the individual Northern Territory marine science capacity and capability of many of the organisations listed in the above table is relatively limited. However, this capacity can be significantly enhanced through greater collaboration around strategic marine science knowledge needs and by better harnessing the national resources of some of the larger research organisations and industry.

Given limited and often contracting resources in research organisations, it is important to access local and Indigenous knowledge of marine systems and their dynamics, as well as the scientific capacity of Aboriginal communities. To achieve this, the research sector will need to continue to develop its ability to effectively engage with Aboriginal communities in the design, development and delivery of marine science research outputs.

Common Marine Science Knowledge Needs

A key output of this study is the identification of marine science knowledge needs pertaining to the Northern Territory marine environment that are common to multiple stakeholders and interests in the Northern Territory marine environment. This serves as the basis for greater collaboration and co-investment in the acquisition of priority marine science knowledge.

These common interests are summarised in the following figures.

Common Interests in Baseline Definition and Development

	Aboriginal Interests	Regulators	Australian Defence Force	Darwin Port	Commercial Fishing	Pearling, Aquaculture & Crocodiles	Offshore Petroleum	Minerals	Irrigated Agriculture & Forestry	Coastal Communities & Urban Development	Recreational Fishing
Baseline standards for the Northern Territory marine environment											
Inventory of metadata pertaining to existing baselines											
Standards for data collection, quality assurance and access											
Prioritisation of new baseline acquisition and augmentation											
Technology to improve productivity of baseline surveys											
Alternatives to conventional baseline surveys											

Common Interests in Physical Marine Baselines

	Aboriginal Interests	Regulators	Australian Defence Force	Darwin Port	Commercial Fishing	Pearling, Aquaculture & Crocodiles	Offshore Petroleum	Minerals	Irrigated Agriculture & Forestry	Coastal Communities & Urban Development	Recreational Fishing
Estuarine physical processes											
Subregional and coastal physical ocean processes											
Terrestrial – marine hydrology											
Water exchange mapping											
Benthic topography											
Coastal topography											
Hydrography											
Water quality											
Hydrology											
Bathymetry											

Common Interests in Marine Habitat Baselines

	Aboriginal Interests	Regulators	Australian Defence Force	Darwin Port	Commercial Fishing	Pearling, Aquaculture & Crocodiles	Offshore Petroleum	Minerals	Irrigated Agriculture & Forestry	Coastal Communities & Urban Development	Recreational Fishing
Coral reefs	Green	Green			Green		Green	Green			
Seagrass meadows	Green	Green			Green		Green	Green			
Benthic	Green	Green			Green		Green	Green			
Mangroves	Green	Green			Green		Green	Green			
Other coastal vegetation and habitats	Green	Green			Green		Green	Green			
Seabird Nesting	Green	Green			Green		Green	Green			
Turtle Nesting	Green	Green			Green		Green	Green			

Common Interests in Species Baselines

	Aboriginal Interests	Regulators	Australian Defence Force	Darwin Port	Commercial Fishing	Pearling, Aquaculture & Crocodiles	Offshore Petroleum	Minerals	Irrigated Agriculture & Forestry	Coastal Communities & Urban Development	Recreational Fishing
Marine mammals	Brown	Brown			Brown		Brown	Brown			
Marine turtles	Brown	Brown			Brown		Brown	Brown			
Commercially and recreationally targeted finfish species	Brown	Brown			Brown		Brown	Brown			Brown
Commercially targeted prawn species					Brown		Brown	Brown			
Giant and Orange Mud Crab	Brown	Brown			Brown						
Trepang		Brown			Brown						
Shellfish	Brown	Brown									
Seahorse	Brown	Brown									
Coral Prawns							Brown				
Invasive Species		Brown		Brown	Brown	Brown	Brown	Brown			Brown

Common Interests in Economic and Heritage Baselines

	Aboriginal Interests	Regulators	Australian Defence Force	Darwin Port	Commercial Fishing	Pearling, Aquaculture & Crocodiles	Offshore Petroleum	Minerals	Irrigated Agriculture & Forestry	Coastal Communities & Urban Development	Recreational Fishing
Valuation of Ecosystem Services	Grey	Grey		Grey	Grey						
Cultural Heritage Values	Grey	Grey	Grey	Grey	Grey	Grey	Grey	Grey	Grey	Grey	Grey

Common Interests in Cumulative Pressures

	Aboriginal Interests	Regulators	Australian Defence Force	Darwin Port	Commercial Fishing	Pearling, Aquaculture & Crocodiles	Offshore Petroleum	Minerals	Irrigated Agriculture & Forestry	Coastal Communities & Urban Development	Recreational Fishing
Climate Change											
Invasive Species and Pathogens (Biosecurity)											
Marine Noise (Seismic and Other)											
Over Harvesting											
Freshwater Diversion											
Dredging											
Acid Metalliferous Drainage											
Escaped Pollutants											
Urban Run-off											
Tidal Creek Diversion											
Future Seabed Mining											
Potential Hydrocarbon Spill											
Decommissioning of Offshore Infrastructure											

Common Interests in Management Issues

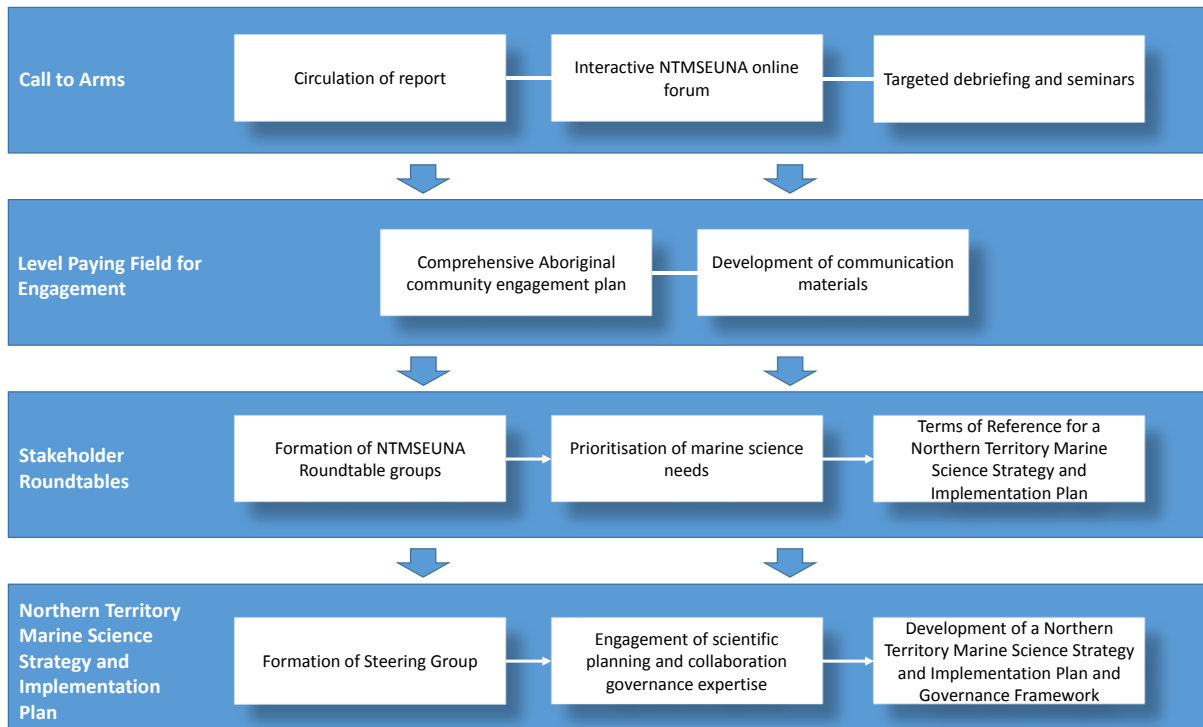
	Aboriginal Interests	Regulators	Australian Defence Force	Darwin Port	Commercial Fishing	Pearling, Aquaculture & Crocodiles	Offshore Petroleum	Minerals	Irrigated Agriculture & Forestry	Coastal Communities & Urban Development	Recreational Fishing
Regulatory Reform											
Marine Enterprise Development											
Environmental Conservation Estate											
Aboriginal Heritage Protection											
Effective Communication of Marine Science											
Optimising Marine Science Capability											

Toward a Comprehensive Northern Territory Marine Science Strategy

This report stops short of developing and presenting a comprehensive, end user driven marine science strategy and implementation plan for the Northern Territory. There are certain limitations with respect to comprehensive coverage of stakeholders, particularly with respect to the diverse Aboriginal interest in the Northern Territory marine environment, specific prioritisation (including only a limited basis for geographical prioritisation) and detailed local marine science capability assessment that restrict this report's ability to achieve this.

However, the report does set out a clear and achievable pathway to develop what is a critically necessary collaborative strategy to ensure that the many marine science knowledge needs that are required to better inform policy, regulatory, strategy and operational decisions

pertaining to the Northern Territory marine environment are better informed by marine science are acquired effectively and efficiently. This process is summarised in the following diagram.



1. Introduction and Background

1.1. What is the End User Needs Analysis and why is it Necessary?

1.1.1. What is the Northern Territory Marine Science End User Needs Analysis?

The Northern Territory Marine Science End User Needs Analysis (NTMSEUNA) identifies the marine science imperatives of all key stakeholders in the Northern Territory marine environment. Investment in addressing these marine science knowledge needs will ensure that the Northern Territory marine environment is optimally protected, that social and cultural values associated with the Northern Territory marine environment flourish and that industry that intersects with the Northern Territory marine environment achieves optimal levels of productivity and may operate with certainty.

1.1.2. What is the Northern Territory Marine Environment?

For the purposes of the NTMSEUNA, the Northern Territory marine environment is defined as:

- Estuarine, coastal and oceanic marine environments within Northern Territory and Commonwealth waters, as well as waters out to the boundary of Australia's Exclusive Economic Zone (EEZ), between the Northern Territory-Western Australian border and Northern Territory-Queensland border;
- The Joint Petroleum Development and Perth Treaty Areas in the Timor and Arafura Seas; and
- Regional ocean and catchment processes that affect that body of water.

The marine environment supported by these waters is one of the world's few relatively intact tropical marine ecosystems. This is particularly the case for the coastal, littoral and shallow water zones, which represent Australia's third longest and only entirely tropical coastline. Extensive estuarine systems and the degree to which their source waters are almost unmodified by damming or diversion is globally unique. Extensive mangrove communities, seagrass meadows, reefs, shoals, islands, large bays and ria systems that are characteristics of the Northern Territory marine environment host globally significant marine ecosystems and biodiversity and provide both refugia and large areas of important habitat for several globally endangered species.

The Northern Territory marine environment is the source of critically important marine ecosystem services. For example, the Northern Territory marine environment:

- Underpins or facilitates the majority of industry in the Northern Territory, which in turn provides employment to the growing Northern Territory community;
- Is a source of key social, cultural and leisure values that define both Aboriginal and non-Aboriginal culture in the Northern Territory;
- Is a critical contributor to the customary economy for many Aboriginal communities;
- Provides food for humans and animals;
- Performs biological regulation, nutrient cycling and climate regulation functions;
- Is a vector for potential invasive species and pathogens, yet also acts as a barrier to entry for exotic human, animal and plant disease; and
- Provides storm and erosion protection to coastal communities and industry.

1.1.3. What is Marine Science?

For the purposes of this study, marine science refers to scientific knowledge and the development of scientific knowledge pertaining to the physical, chemical, biological and ecological aspects of the marine environment, as well as issues related to the management of marine resource. It seeks to understand how human activity best interacts with the marine environment and to inform management of that activity. In this regard, the scope of the definition extends to aspects of social science that help stakeholders understand and manage sustainable human interaction with the marine environment.

A strong, science-based understanding of the marine environment plays an essential role in building stakeholder confidence. For example, a deeper understanding of relevant aspects of marine science:

- De-risks industry investment and operational decisions;
- Provides governments with confidence that policy and regulation designed to protect important marine environmental values and regulate human interaction with the marine environment will be effective with respect to protecting important ecosystems and environmental values, without placing unnecessary restrictions on human activity;
- Provides custodians of the marine estate greater surety that their interests in that estate are not being compromised by co-existence of the interests of others; and
- Ensures that the community is optimally informed when endorsing trade-offs that might be associated with some human usage of marine resources.

Greater knowledge attained through investment in targeted marine science is essential for industry's licence to operate and for governments to garner the confidence of the community that regulation adequately protects important marine environmental values without imposing unnecessary productivity, social or cultural penalties on users of the marine resource.

1.1.4. Why Do We Need the NTMSEUNA?

Every day government, industry and community leaders and administrators make policy, regulatory, strategic and operational decisions pertaining to human interactions with the Northern Territory marine environment. In many cases, these decisions are made in a decision-making environment that is not adequately informed from a marine science perspective.

The consequences of this reside on a continuum between two poles. Decisions are made that knowingly place the ecosystem services provided by the Northern Territory marine environment at risk in the interest of significant public benefit or the precautionary principle is crudely applied. Over reliance on the precautionary principle is undesirable from the following two perspectives:

- In a decision-making environment that is deficient in marine science knowledge, there is no way of knowing whether the decision has been adequately precautionary and, therefore, whether important ecosystem services are at risk or not; and
- Crude application of the precautionary principle in the absence of adequate relevant marine science knowledge may unnecessarily sterilise parts of the Northern Territory marine environment from social, cultural or economic activity, or impose unnecessary costs on that activity, resulting in lost opportunity and/or significant productivity penalties.

Neither of these outcomes are desirable. So long as these circumstances remain, so will limits to the future prosperity and quality of life of the people of the Northern Territory. However, because from a formal scientific perspective, so little is known about the Northern Territory marine environment (and much of the global marine environment for that matter), the

investment required to provide a comprehensive localised marine science knowledge base is insurmountable. Additionally, because so little is known, there is much that is of interest, particularly to the marine scientific profession.

Further, as outlined above, the Northern Territory marine environment is in many respects unique in Australia in both character and usage. These factors are discussed in more detail in later sections, but the marine environment underpins or intersects with a majority of industry in the Northern Territory and is critical to the viability and cultural survival of many remote and Aboriginal communities. This key nexus has been identified and built upon in many development and research plans for the Northern Territory, including the recent White Paper on Developing Northern Australia and the Northern Australia Food Futures initiative. However, the ability to progress many of these plans is constrained by the need to undertake extensive environmental research at often prohibitive cost before many concrete investments can be made. Sub-optimal cross-sectorial collaboration in the marine research effort can result in inefficiencies, duplication and siloing of knowledge.

If the decision-making environment is to be improved, public and private investment in the acquisition of marine science knowledge pertaining to the Northern Territory marine environment must be prioritised according to the needs of those making the decisions in government, industry and communities and the research effort optimally coordinated. The purpose of the NTMSEUNA is to provide a basis for a more focused and coordinated investment in marine science pertaining to the Northern Territory marine environment.

1.2. Project Structure

The NTMSEUNA has been jointly commissioned and funded by the following organisations:

- **Charles Darwin University (CDU)**, the Northern Territory's premier institution of higher education (www.cdu.edu.au); and
- **Australian Institute of Marine Science (AIMS)**, Australia's leading tropical marine research agency (www.aims.gov.au).

The project was overseen and governed at 'arms-length' from these organisations by a Steering Group comprised of the experts listed in Table 1.

Steering Group Member	Steering Group Role
Dr Ian Poiner	Co-Chair
Mr Luke Bowen, General Manager, Northern Australia Development Office	Co-Chair
Mr Joe Morrison, Chief Executive Officer, Northern Land Council	Member
Ms Diane Brody, Policy, Research, Communications and Social Justice, Northern Land Council	Alternate for Joe Morrison
Ms Leslie Tangatulum, Tiwi Land Council	Member
Mr Denis Tipakalippa, Tiwi Land Council	Alternate for Leslie Tangatulum
Mr Paul Vogel, Chair, Northern Territory Environmental Protection Authority	Member
Mr Alister Trier, Chief Executive Officer, Northern Territory Department of Primary Industry	Member
Mr Ian Curnow, Executive Director–Fisheries, Northern Territory Department of Primary Industry	Alternate for Alister Trier
Mr Mark Coffey, Head of the Commonwealth Office of Northern Australia	Member
Mr Terry O'Connor, Chief Executive Officer, Darwin Port	Member
Ms Katherine Winchester, Chief Executive Officer, Northern Territory Seafood Council	Member
Mr David Ciaravolo, Executive Officer, Amateur Fishermen's Association of the Northern Territory	Member
Ms Sandy Griffin, Environmental Manager, Inpex Corporation	Member
Mr David Parry, Environmental Advisor, Rio Tinto	Member
Dr Paul Hardisty, Chief Executive Officer, AIMS Science	Observer
Dr Lawrence Cram, Pro Vice Chancellor, CDU	Observer

TABLE 1 – MEMBERS OF THE MARINE SCIENCE END USER NEEDS ANALYSIS STEERING GROUP¹

The research, consultation and analysis that has underpinned the development of the NTMSEUNA has been undertaken by:

¹ Other members of the Steering Group over the life of the project were Tristian Sloan, former Executive Officer of the Amateur Fishing Association of the Northern Territory; John Gunn, former CEO of the Australian Institute of Marine Science (AIMS, Observer); Greg Oliver, former Environmental Manager, Inpex Corporation and Bill Freeland, former Chair of the Northern Territory Environmental Protection Authority. Furthermore, other experts have participated in Steering Group meetings including Brendan Douglas, Director of Research, Charles Darwin University (CDU); Karen Gibb, Director–Research Institute for the Environment and Livelihoods, CDU; Richard Brinkman, Research Program Leader, Sustainable Coastal Ecosystems and Industries in Tropical Australia, AIMS; Edward Butler, NT Science Leader, AIMS; Belinda Carlson, Australian Government Office of Northern Australia; Sally Clarke, Australian Government Office of Northern Australia AND Richard Campbell, Program Coordinator, Northern Land Council.

- **Australian Venture Consultants (AVC)**, a strategic analytical firm with expertise in developing end user driven, mission oriented scientific plans (www.ventureconsultants.com.au); and
- **North Australian Indigenous Land and Sea Management Alliance Ltd (NAILSMA)**, an organisation that delivers large-scale and complex projects, combining science and research, Indigenous knowledge and practical delivery, producing cultural, environmental and economic benefits for Indigenous people on land and sea country (www.nailsma.org.au).

AVC has been the principle author of this report, with NAILSMA undertaking a separate study under the project governance structure that has substantially informed this report and which is contained in Appendix 9.

1.3. Methodology

The NTMSEUNA has been undertaken via a review of existing literature pertaining to the Northern Territory marine environment and human interaction with the Northern Territory marine environment, an extensive series of semi-structured interviews with key decision makers in government, industry and community organisations with interests in the Northern Territory marine environment and an extensive process of review by the Steering Group and interviewees that have contributed to the study. This process is summarised in Figure 1.

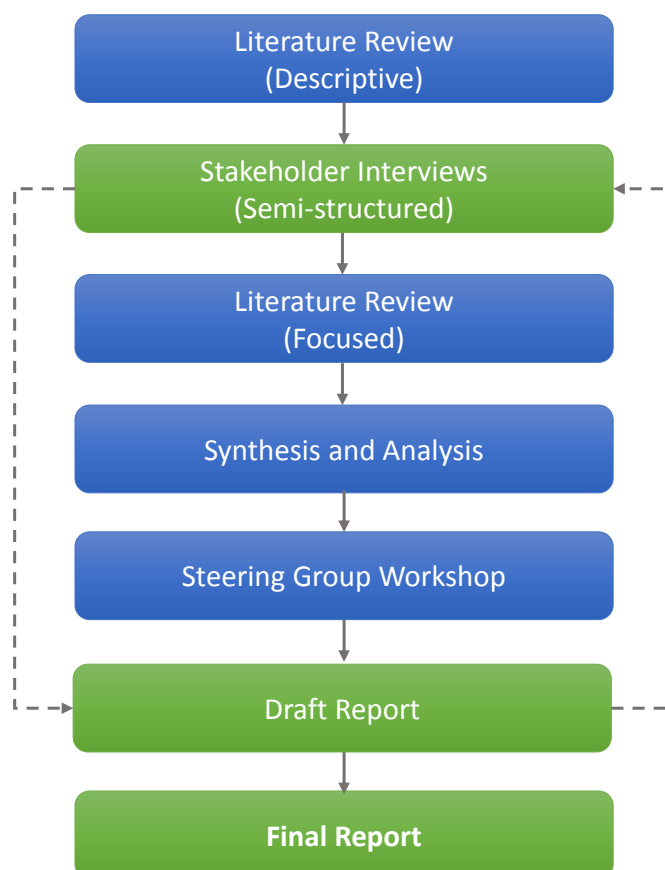


FIGURE 1 – METHODOLOGY USED TO DEVELOP THE NORTHERN TERRITORY MARINE SCIENCE END USER NEEDS ANALYSIS

The basic structure of the project is illustrated in Figure 2.

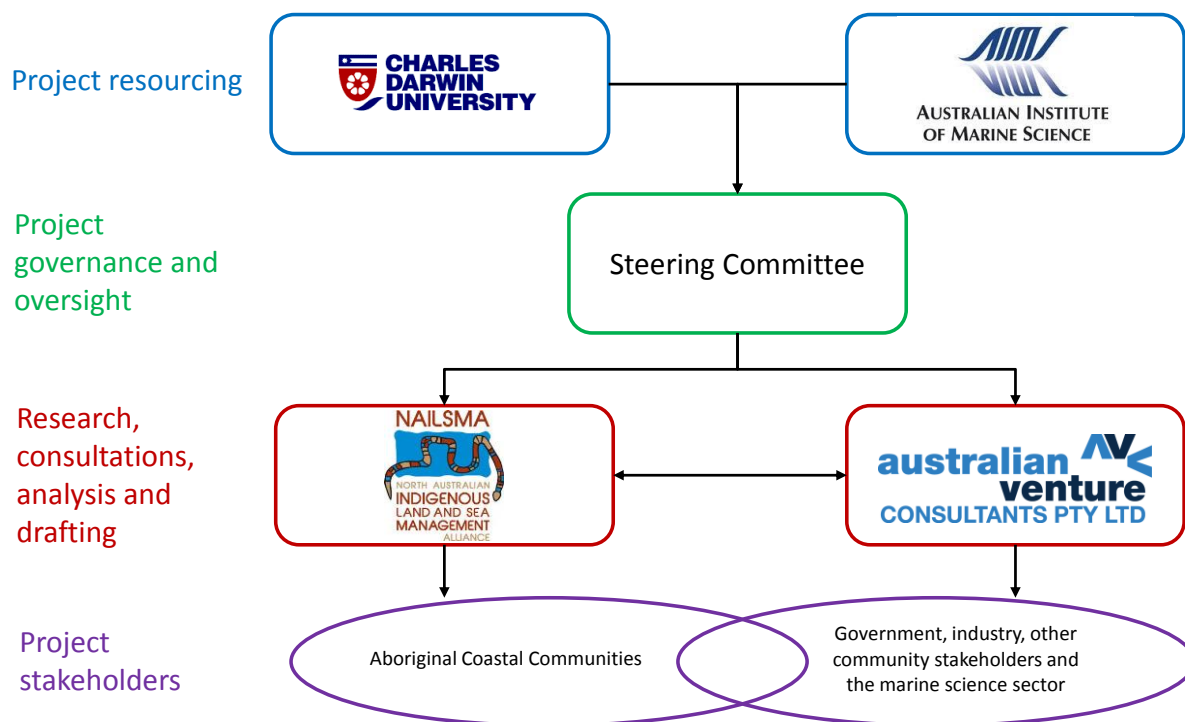


FIGURE 2 – NORTHERN TERRITORY MARINE SCIENCE END USER NEEDS ANALYSIS PROJECT STRUCTURE

1.3.1. Literature Review

AVC has reviewed a wide range of scientific publications, economic analysis and plans pertaining to the Northern Territory marine environment. NAILSMA has undertaken a review of Indigenous sea country plans and other published materials pertaining to Aboriginal interests in parts of the Northern Territory marine environment. These materials are referenced throughout this document.

1.3.2. Consultations and Interviews

AVC has conducted a total of 55 semi-structured interviews with key decision makers in government, industry and community organisations with interests in the Northern Territory marine environment. Interviewees are listed in Appendix 1 and sector representation across the interview base is summarised in Figure 3 below.

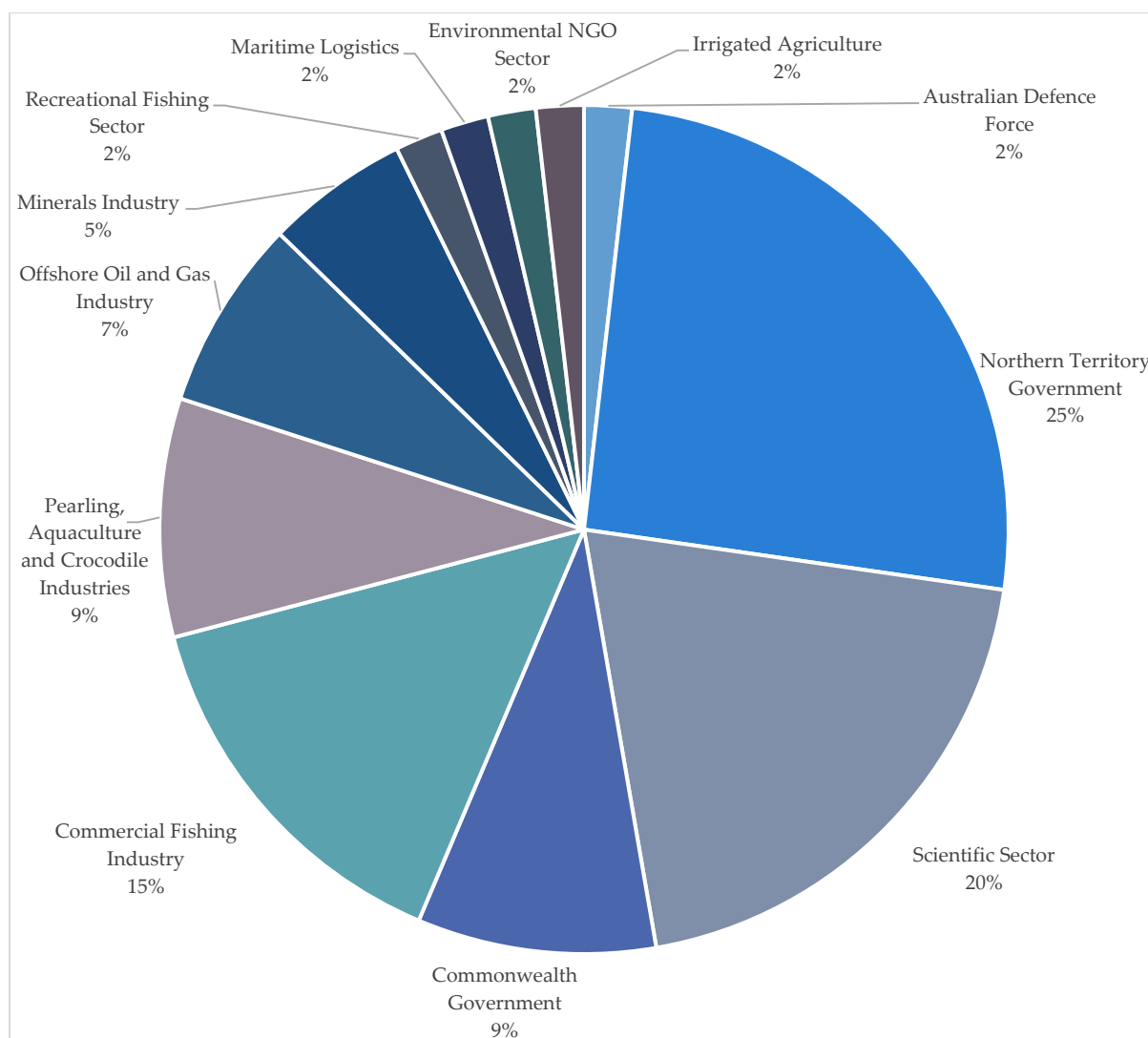


FIGURE 3 – STAKEHOLDER REPRESENTATION OF INTERVIEWEES

Given the potential breadth and depth of issues, achieving genuine engagement of specific Aboriginal interests would require a comprehensive set of consultations involving many dozens of coastal communities. Given resource constraints, a more targeted approach was taken consisting of:

- Deep engagement by NAILSMA with the Maningrida, Boroloola, Galiwin'ku and Darwin Area communities. These communities were selected as the focus of engagement because they are each currently engaged with contemporary marine resource management issues; and
- Committee-level discussions with the Tiwi Coastal Waters Consultative Committee facilitated by AVC, as well as with the Anindilyakwa Land Council, facilitated by a former AIMS staff member. These committee-level discussions did not seek to identify specific needs, but rather higher-level themes.

As such, this analysis is only based on a sample of the larger Aboriginal interests across the Northern Territory coastline and does not purport to represent the breadth of Aboriginal interests or the breadth of interests within the communities themselves. Furthermore, while key overarching themes and interests have been identified and explored, identified themes have not been prioritised.

1.4. Structure of this Report

Table 2 sets out the structure of this report.

Industry	Section
Description of the purpose, process and governance of the NTMSEUNA	1
Discussion on the key forces that will shape the nature of marine science knowledge needs pertaining to the Northern Territory marine environment into the future	2
Aboriginal interest in and custodianship of the Northern Territory marine environment and marine science knowledge needs	3
Description of the Northern Territory marine conservation estate	4
Regulators of the Northern Territory marine environment and their marine science knowledge needs	5
Current and anticipated activities of the Australian Defence Force (ADF) in the Northern Territory marine environment and its marine science knowledge needs	6
Status and development plans for Darwin Port (maritime logistics) and its marine science knowledge needs	7
Commercial fishing industry and its marine science knowledge needs	8
Pearling, aquaculture and crocodile industries and their marine science knowledge needs	9
Offshore petroleum industry and its marine science knowledge needs	10
Marine tourism industry and its marine science knowledge needs	11
Minerals industry and its marine science knowledge needs	12
Irrigated agriculture and forestry industry and its marine science knowledge needs	13
Coastal communities, coastal urban development and their marine science knowledge needs	14
Recreational fishing sector and its marine science knowledge needs	15
Northern Territory marine science capability	16
Marine science knowledge needs common to multiple interests	17
Toward a comprehensive Northern Territory marine science strategy and implementation plan	18

TABLE 2 – STRUCTURE OF THIS REPORT

2. Key Forces that will Shape Northern Territory Marine Science Knowledge Needs into the Future

The Northern Territory marine environment hosts very significant biological, ecological and cultural values. Because the Northern Territory is sparsely populated with much of the coastline remote and inaccessible from the mainland during the wet season, and because until the early 1990s, economic development utilising the Northern Territory marine environment has been limited, much of the Northern Territory marine environment remains relatively intact.

The Northern Territory economy is mainly primary industries based and this is likely to remain the case for the foreseeable future, the greater impact of tourism in recent years notwithstanding. As such, it will likely experience periods of contraction and expansion in response to commodity cycles. Nevertheless, longer-term trends toward increased economic development and coastal population growth are likely to continue. As this occurs, several interrelated economic, demographic, social and environmental dynamics will be at play, which in turn will shape the nature of marine science knowledge that is required to inform policy, regulatory, strategic and operational decisions that affect the Northern Territory marine environment. These are as follows:

- Industry, mainly in the form of primary industries, tourism and the infrastructure that supports these sectors that is either dependent on marine resources or interacts with the marine estate will, subject to commodity cycles, continue to expand;
- Increased Aboriginal economic participation across northern Australia will see Aboriginal custodians adopting diverse positions as to how and to what ends they and others utilise their sea country and Aboriginal landowners, custodians and managers will become increasingly influential decision makers with respect to the use and management of the Northern Territory marine environment;
- The ADF will be a larger user of the Northern Territory marine environment from a defence posture and power projection perspective, as well as for training and exercise purposes;
- Collectively, these forces will drive growth in a population that will remain skewed toward coastal settlements and the Northern Territory marine environment will continue to be an important focus of recreation and leisure activities for that population;
- There will be sustained pressure from Aboriginal and non-Aboriginal Northern Territorians whose lifestyle and cultural interests are largely dependent on the health of the Northern Territory marine environment, to protect those interests;
- As development opportunities are better recognised and encouraged by government policy designed to promote the development of northern Australia, intensity of advocacy from various sectors to secure the most favourable terms for access to the most productive aspects of the Northern Territory marine resource will increase, leading to increased attention from national and global conservation advocacy movements and the various marine oriented environmental non-government organisations (NGOs) that comprise that movement;
- The regulatory framework that currently applies to the Northern Territory marine environment will be forced to evolve and modernise to ensure that marine ecosystem services are not excessively compromised and that sustainable development is not unduly constrained; and

- This regulatory environment and activities in the Northern Territory marine environment will evolve in a relatively complex national and international, multi-jurisdictional environment.

These inter-related dynamics that will shape the nature of marine science knowledge needs in the Northern Territory into the future are illustrated conceptually in Figure 4 and summarised in the following subsections.

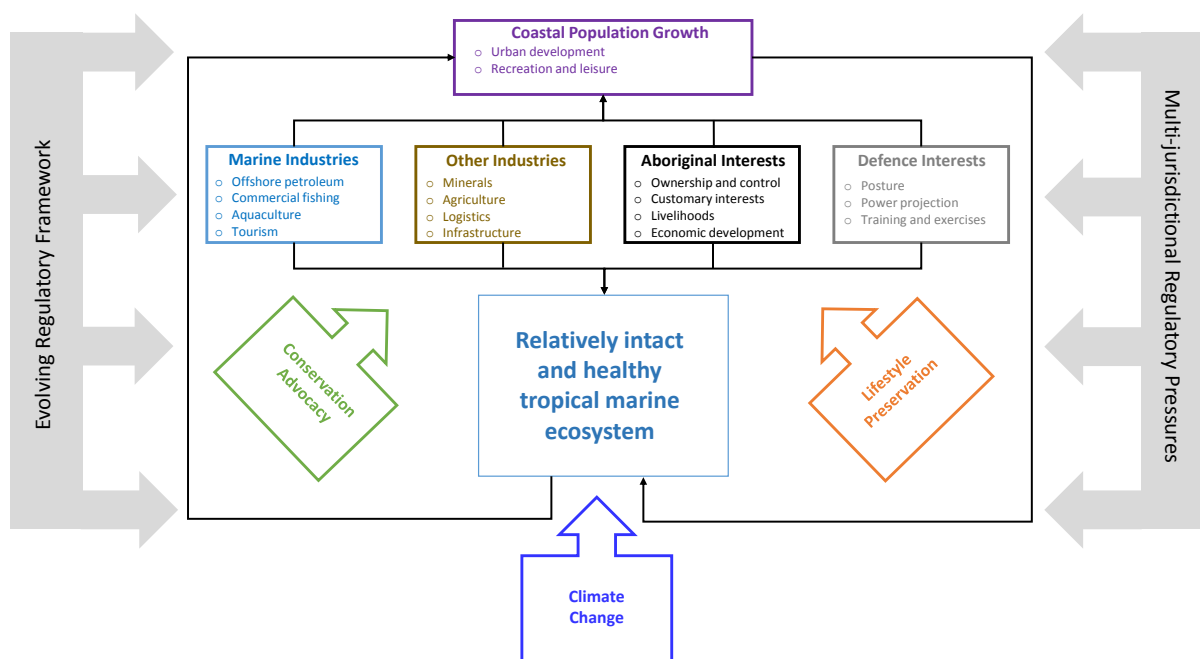


FIGURE 4 – FORCES THAT WILL CONTINUE TO SHAPE MARINE SCIENCE KNOWLEDGE NEEDS IN THE NORTHERN TERRITORY

2.1. Relatively Intact and Healthy Tropical Marine Ecosystem

While it is true that formal academic understanding of much of the Northern Territory marine environment is limited, Aboriginal people have observed the Northern Territory marine environment for many thousands of years. Increasingly referred to as Indigenous ecological knowledge (IEK), this unique resource is for the most part not taken into account in contemporary assessments of the health of the Northern Territory marine environment. If more holistic assessments of the Northern Territory marine environment are to be given effect, mechanisms for recognising and responding to Aboriginal perspectives on the marine environment will be necessary.

The Northern Territory marine environment is near the Indo-Malay epicentre of global marine biodiversity and is connected to this epicentre by major global currents. As such, it hosts significant marine biodiversity and is on an important migratory pathway for many species, including species of marine megafauna. The Northern Territory marine environment itself hosts a diversity of habitat including mangroves, seagrass meadows, coral reefs, underwater pinnacles and soft benthic environments. These habitats provide feeding, breeding and

nursery areas for many species of dugong, turtle, dolphin, sawfish, sea snakes, seahorse, shark, ray and demersal and pelagic finfish.^{2,3,4}

While difficult to quantify, primarily because of the very lack of marine science knowledge identified in this report, the Northern Territory marine environment is regularly assessed as being one of the least impacted regions in the world. This is particularly so when compared to surrounding ecosystems, nearly 66 percent of which have shown heavy increases in impact in recent years. The relatively intact nature of the Northern Territory marine environment compared to other regional marine environments is clearly illustrated in Figure 5⁵ in which scores measure the cumulative impact of 19 identified anthropogenic stressors on marine environments around the globe.

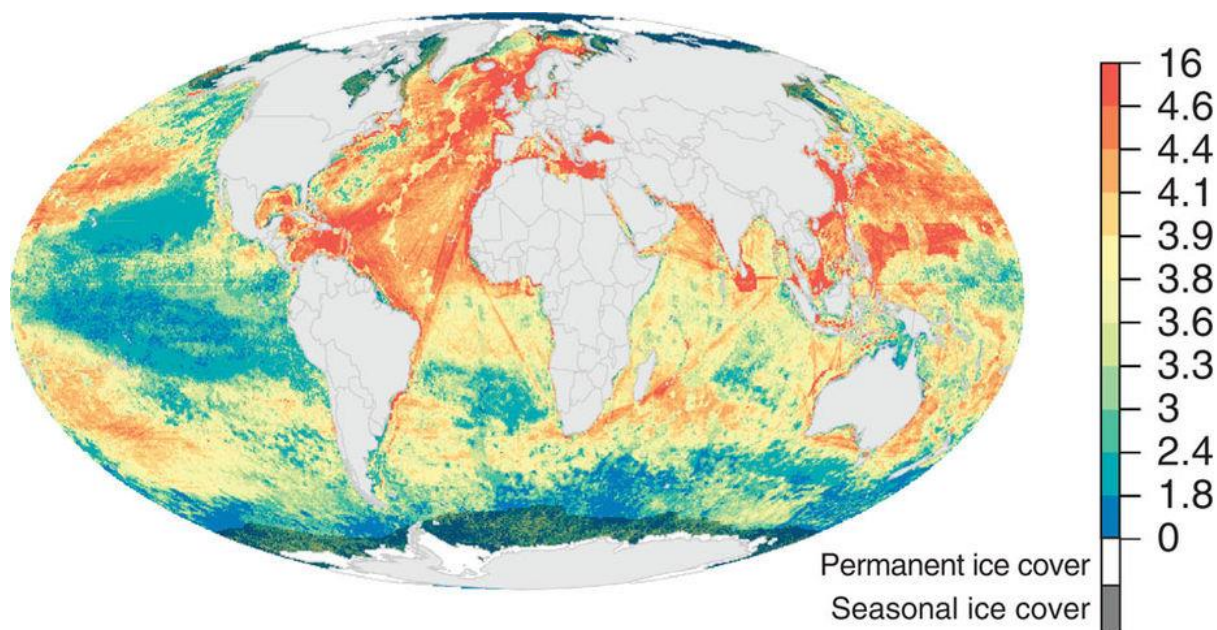


FIGURE 5 – CUMULATIVE HUMAN IMPACT TO GLOBAL MARINE ECOSYSTEMS AS OF 2013

Impact scores are based on all 19 anthropogenic stressors. Colours are assigned to 10-quantiles in the data, except the highest scores which are the top 5% of scores. Areas of permanent sea ice are shaded white and the area within maximum sea ice extent is masked to indicate where scores are less certain because change in sea ice extent could not be included.

Human impact assessments for the Arnhem Coast bioregion (which encompasses a majority of the Territory coastal environment) show that anthropogenic pressures fell or remained at steady near-zero levels across all assessed metrics except for direct impacts (gross presence of boats or infrastructure), nutrient inputs and surface temperature impacts of climate change. This contrasts with the rest of Australia, particularly the east and west coasts.⁶

² Edyvane, K., *Beyond the Horizon: Marine Biodiversity Research Directions and Priorities of the Northern Territory Government...*, Marine Biodiversity Group, Department of Natural Resources, Environment and the Arts, Northern Territory Government, Darwin

³ Wilson, D. (2005), *Biological Survey of the Arafura Sea*, National Oceans Office, Australian Museum and CSIRO, Sydney

⁴ Zann, L. and Sutton, D. (ed)(1996), *The State of the Marine Environment Report for Australia Technical Annex 3: State and Territory Issues*, Department of the Environment, Sport and Territories, Australian Government, Canberra

⁵ Halpern, B.S. et al. (2015), 'Spatial and temporal changes in cumulative human impacts on the world's oceans', *Nature Communications*, 6:7615

⁶ Ibid

Key aspects of the Northern Territory marine environment are discussed in the following subsections. The current status of the Northern Territory marine conservation estate is discussed in Section 4 and the regulation of the Northern Territory marine environment in Section 5.

2.1.1. Physical Oceanography

The Northern Territory coastline abuts the Arafura Sea and the eastern extremes of the Timor Sea. These contiguous, semi-enclosed, fully tropical seas are bordered to the north by the Indonesian, Timor-Leste and Papua New Guinea archipelago. Because of the dominance of the Sahul Shelf, the Arafura Sea in particular is mostly relatively shallow, with the main exceptions being the Timor Trough and Arafura Channel.⁷ The sediments of the Arafura Sea are calcium carbonate rich and exhibit substantial but varying fractions of carbonate sand and subsoil shell fragments.

The shelf west of the Cape York Peninsula, which contains waters that are shared with Queensland, features shallow, tropical waters of less than 70 metres depth, with multiple tidal regimes from numerous inflows and high cyclonic activity. A clockwise gyre in the Gulf of Carpentaria occurs during the monsoon, mostly because of complex tidal activity, with speed and strength exacerbated by tropical cyclone activity.⁸ On account of the Carpentaria Gyre, the sea-floor basin in the centre of the Gulf receives low levels of sediment relative to sea-floor areas closer to shore and is less biologically diverse than unaffected coastal areas.⁹

Further west, the Van Diemen Rise and Arafura Shelf benthic environment is highly crenelated and disturbed, with valleys, canyons, shoals and trenches. Oceanic currents are driven by strong winds and tides, and the transfer of water from the Pacific Ocean to the Indian Ocean by means of the Indonesian Throughflow (ITF) and the South Equatorial Current further to the north. This seasonal circulation pattern, the Holloway Current, follows the contours of the Australian coastline and is a major influence across the Top End.¹⁰ The marine region is also one of the sources of the Leeuwin Current, which flows along the west coast of Australia.

The dominant current in the region is the ITF, a warm water current that transports water westward from the Pacific Ocean to the Indian Ocean. The ITF has substantial influence on the climate in the entire region as it transports heat and moisture to the Indian Ocean and adjacent land masses. Figure 6¹¹ illustrates the major currents that influence the Northern Territory marine environment.

⁷ Wagey, T. (2006), *Arafura and Timor Seas Expert Forum*, Charles Darwin University

⁸ Forbes AMG, Church JA (1983), *Circulation in the Gulf of Carpentaria. II. Residual currents and mean sea level*, Australian Journal of Marine and Freshwater Research, 34:11–22

⁹ Long, B. G et al. (1995), *Distribution, biomass and community structure of megabenthos of the Gulf of Carpentaria*, Australia, Marine Ecology Progress Series, 127–139.

¹⁰ Schiller, A (2011), *Ocean circulation on the North Australian Shelf*, Continental Shelf Research, 31:1087–1095

¹¹ Cook, K. IN: OceanWatch Australia, 'Carpentaria ghost nets program: saltwater people working together'

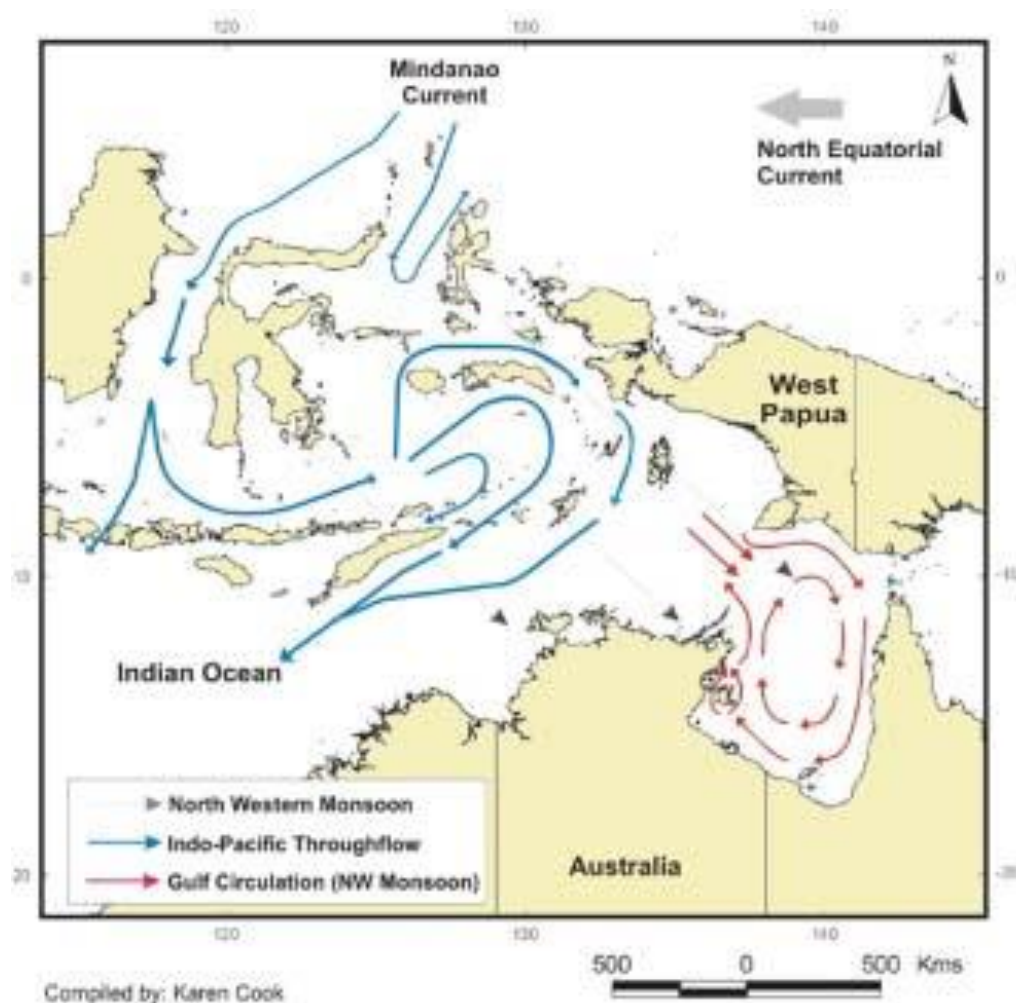


FIGURE 6 – MAJOR CURRENTS IN THE NORTHERN TERRITORY MARINE ENVIRONMENT

A combination of the ITF and high tidal ranges provide strong flows across the seafloor, resulting in significant ongoing sedimentary transport,¹² particularly in the Gulf of Carpentaria where the Carpentaria Gyre contributes further to sediment transport.

From a metocean perspective, the Australian Monsoon has a major impact on the Northern Territory marine environment as it is the principal determinant of freshwater and nutrient inflows to the Northern Territory marine environment. Heating of the vast northern Australia landmass during summer results in a high gradient between land and sea, leading to tropical downpours from November to March/April and a dry period between May and October. The Australian Monsoon is characterised by periodic tropical cyclones and storms, with a tropical cyclone being present somewhere in the Northern Territory for an average of 7.7 days per season, with the Gulf of Carpentaria averaging two tropical cyclones per season and the Arafura and Timor Seas one tropical cyclone per season.¹³

The extent of precipitation associated with the Australian Monsoon and therefore the volume of freshwater and nutrient ingress to the Northern Territory marine environment is determined by the Indian Ocean Dipole and the *El Nino* Southern Oscillation. A negative difference in

¹² Wilson, D. (2005), *Biological Survey of the Arafura Sea*, National Oceans Office, Australian Museum and CSIRO, Sydney

¹³ Australian Bureau of Meteorology

temperature between the western and eastern Indian Ocean results in higher sea-surface temperatures, leading to greater precipitation, whereas a positive difference results in lower sea-surface temperatures leading to less precipitation. Warming of the sea-surface in the central and eastern Pacific Ocean associated with *El Nino* leads to later onset and shorter duration of the Australian Monsoon, resulting in less rain and fewer cyclones, whereas cooling of sea-surface temperatures in the central and eastern Pacific Ocean associated with *La Nina* leads to earlier onset and longer duration of the Australian Monsoon, resulting in more precipitation and cyclones.

2.1.2. The Coastal and Estuarine Environment

At 10,953 kilometres (5,437 kilometres of mainland coastline and 5,516 kilometres of island coastline), the Northern Territory coastline is the third longest in Australia, behind Western Australia and Queensland.¹⁴ It is a highly irregular and indented coastline, characterised by numerous near-shore islands and is a classic example of a ria coast, being a coastline characterised by coastal inlets that have been formed by the partial submergence of dendritic river valleys. Where exposed to ocean current, wave action and other erosive processes, bays have also formed.

Much of the Northern Territory coast is isolated and remote, with large stretches of the mainland coastline inaccessible by land during the wet season. High rainfall associated with the Australian Monsoon results in many small seasonal rivers and creeks, as well as permanent watercourses, draining into these rias and bays. These periodically deliver large volumes of freshwater and nutrients into these sheltered areas of the marine estate, resulting in a wide variety of coastal and estuarine ecosystems.

The Northern Territory hinterland is typically characterised by monsoonal lowlands, enormous river deltas and broad seasonal floodplains. Tidal range varies from approximately 8 metres along the more exposed western coastline near the Western Australian border, to less than one metre in the sheltered waters of the Gulf of Carpentaria. This combination of moderate to large tidal ranges and extremely flat terrain results in tidal influences extending up to 100 kilometres upstream in some cases, creating a range of brackish to freshwater estuarine ecosystems.

The presence of large numbers of islands, reefs, shoals and other features mean that for the most part wave action is minimal, resulting in mostly muddy shorelines and large mangrove forests, with occasional sandy beaches and headlands. However, coastal topography can also be characterised by coastal dunes, coastal cliffs and tidal mud and salt flats. In addition to mangroves, coastal vegetation can include salt marshes, brackish and freshwater swamps, seasonally inundated grasslands, sedgeland, paperbark swamp, low woodlands, rainforest, vine thickets and eucalypt woodlands.

These ecosystems host:

- Significant populations of waterbirds, shorebirds and migratory birds;
- Marine fauna biodiversity, including a number of endangered sawfish and shark species, marine turtles and marine megafauna; and
- Marine and coastal flora biodiversity.

¹⁴ Anon, *Coastline lengths*, Geoscience Australia, available www.ga.gov.au

Appendix 2 lists the main bays and rias along the Northern Territory coastline, together with some of their notable environmental values.

2.1.3. Islands

Often associated near the ria systems and bays that are characteristic of the Northern Territory coastline are numerous islands. There are 12 major island groups along the Northern Territory coastline ranging from large islands such as the Tiwi (Melville and Bathurst) Islands and Groote Eylandt to much smaller islands and promontories. Similar to the bays and rias, these islands provide important habitat for a large variety of shorebirds, waterbirds and migratory birds, as well as important marine fauna and flora.

Appendix 3 lists the main island groups along the Northern Territory coastline, together with some of their notable environmental values.

2.1.4. Mangroves

Primarily because of the large range of intertidal coastal environments in northern Australia, Australia demonstrates the fourth highest mangrove species diversity in the world. A key aspect of the Northern Territory biosphere are its coastal and estuarine mangrove forests, which account for approximately 40 percent of Australia's total mangrove forests and 32 of the 41 species of mangrove found in Australia.¹⁵ Because mangrove communities tend to occur in highest concentrations in relatively low energy coastal environments, they can be found along most of the Northern Territory coastline.

Speciation of mangroves in the Northern Territory is typically zonal whereby:

- The seaward zone that is most proximate to wave action is usually characterised by *Rhizophora*, *Avicennia* and *Sonneratia*;
- The middle zone that is above the intertidal zone and therefore is less frequently fully submerged usually features *Ceriops*, *Bruguiera* and *Excoecaria*; and
- The landward zone where direct tidal action is rarely experienced but concentrations remain extremely high is most often characterised by *Lumnitzera*, *Hibiscus* and *Ceriops*.

Mangrove forests perform very important functions in the Northern Territory marine environment, namely:

- **Coastal Stabilisation**
The large amount of woody biomass and complex root systems provide shoreline stabilisation.
- **Water Quality Regulation**
The woody biomass and roots of mangrove forests also trap large amounts of alluvial silt washed downstream, as well as particulate matter picked up by wave action. This serves to filter and clarify coastal waters, reducing turbidity and, in turn, reducing algal and micro-floral loads, leading to improved water quality and higher levels of dissolved oxygen.¹⁶

¹⁵ Department of Agriculture, Fisheries and Forestry (2008), *Australian Forest Profiles: Mangroves*, Northern Territory Government

¹⁶ Mastaller, M. (1997), *Mangroves: The Forgotten Forest Between Land and Sea*, Tropical Press, Malaysia

- **Fisheries Productivity**

The life-cycle of 75 percent of Australia's commercial fishery and 90 percent of species targeted by the recreational fishing sector are dependent upon estuarine and near-shore ecosystems.¹⁷ Estimates of the commercial value attributable to mangrove ecosystems range from \$1,000 to \$20,000 per hectare per annum depending on the degree of exploitation and intensity of fishing effort.¹⁸ In northern Australia, the condition and extent of mangrove ecosystems account for approximately 70 percent of the annual catch per unit of effort for species that are classed as being highly mangrove dependent, including Barramundi, Mud Crabs and Banana Prawns.¹⁹ The increased abundance of juveniles of these species has a flow-on effect to the entire marine ecosystem, with mangrove habitat in pristine or near-pristine condition having a multiplier effect on abundance of between four and ten times across fish and crustaceans.²⁰

- **Carbon Sequestration**

Coastal marine ecosystems represent approximately 40 percent of Australia's total carbon sequestration and have the highest potential for carbon storage of any ecosystem.²¹ Mangrove forests store carbon in the form of ligneous tissue and capture carbon-rich silt and mud. This is discussed further in Section 2.6.

Paradoxically, it is some of these mangrove communities that are among the most at threat from increasing temperatures and rising sea levels associated with global climate change. The extent to which the important ecosystem services provided by mangrove forests are at threat is highlighted by the recent mass dieback event in the Gulf of Carpentaria, whereby approximately 10,000 hectares of mangrove communities along nearly 700 kilometres of the southern coastline of the Gulf of Carpentaria were affected, including some cases of near total mortality. While the precise cause of this event is unknown, it is generally believed to be the result of a combination of recent poor rainfall, coupled with high sea-surface temperatures associated with global climate change. This is discussed further in Section 2.6.

2.1.5. Seagrasses

Seagrass refers to various species of marine flowering plants that have adapted to silty near-shore environments. Seagrasses are widespread throughout the Northern Territory marine environment, with an estimated 70,000 hectares found in the Van Diemen Gulf and Gulf of Carpentaria regions alone.²² Distribution of species is variable, with *Thalassia*, *Enhalus* and *Thalassodendron* species dominating deeper waters trending to *Halophila* and *Halodule*

¹⁷ Creighton, C. et al. (2013), *Revitalising Australia's Estuaries*, Fisheries Research and Development Corporation

¹⁸ Ronnback, P. (1999), 'The ecological basis for economic value of seafood production supported by mangrove ecosystems', *Ecological Economics*, 29(2):235–252

¹⁹ Manson, F. et al. (2005), 'A broad-scale analysis of links between coastal fisheries production and mangrove extent: a case study for north eastern Australia', *Fisheries Research*, 74(1-3): 69–85

²⁰ Robertson, A. and Duke, N. (1987), 'Mangroves as nursery sites: comparisons of the abundance and species composition of fish and crustaceans in mangroves and other nearshore habitats in tropical Australia', *Marine Biology*, 96(2): 193–205

²¹ Creighton, C. et al. (2013), *Revitalising Australia's Estuaries*, Fisheries Research and Development Corporation

²² *A survey of intertidal seagrass from Van Diemen Gulf to Castlereagh Bay, Northern Territory, and from Gove to Horn Island, Queensland* (2005), Roelofs, A et al., for National Oceans Office, published Commonwealth Department of Environment and Energy (DoEE), available www.environment.gov.au

species closer to shore.²³ Seagrass forms vast meadows, often fringing estuaries and bays, and is critical to maintaining the quality of many marine ecosystems through stabilising sediment and filtering nutrients. Precise mapping of these meadows is difficult due to the remoteness of location and the variable nature of seagrass, with species mixes changing over time in response to local water conditions and seasonal trends, dying back and re-sprouting from buried rhizomes.

Seagrass meadows also support a diverse array of marine life, providing critical habitat for many commercially important species of fish and invertebrates (particularly Tiger Prawns). Per hectare, seagrass meadows are the third most valuable ecosystem globally in ecosystem services and productivity, behind only estuaries and floodplains. In addition to the impact on commercial species of note, seagrass meadows are vitally important for several threatened, endangered and protected species, particularly dugongs, however, little is known of the distribution and abundance of marine flora and fauna found in these meadows, with most information dating from anecdotal studies in the 1970s, fixed-wing aerial surveys in the 1980s and some recent Commonwealth Scientific and Industrial Research Organisation (CSIRO) helicopter surveys.²⁴

2.1.6. Coral Reefs and Shoals

The Northern Territory marine environment is also characterised by many coral reefs and shoals that provide habitat for a wide range of marine flora and fauna including the Howland and Bank Shoals, Bynoe Harbour, Darwin Harbour, Vernon Islands, Knight, Cape Hotham, Ruby Island and Drayton Reefs.

Several shipwrecks, primarily in Darwin Harbour, are the subject of marine heritage and serve as artificial reefs. These include the wrecks of Marchant III, Antares Steel Barge, Darwin Sub Aquaclub Barge, Parmelia/D9, John Holland Barge, DK06/Ham Luong, Song Saigon, Bellbird, NR Diemen, Mandorah Queen, USS Peary, USS Meigs, SS Mauna Loa, SS Zealandia and Hulk Kelat.

2.1.7. Marine Biodiversity

As a whole, the Northern Territory marine environment features a rich and biologically diverse range of marine life, with many different tropical species.

Food webs throughout the region are mainly reliant on zooplankton and large diatoms, typical of shallow, warm tropical waters, with the predominant phytoplankton seen on the continental shelf and coastal waters distinctly different from the oceanic dinoflagellate flora of the Coral Sea on the eastern side of Cape York. Copepod animals (zooplankton) common to the area include a range of small crustaceans. Coral, invertebrates, fish and other marine animals are relatively diverse, with the common apex predator fish including snapper, grouper and emperor species.²⁵

²³ Taranto, T.J et al (1997) *Maps of percentage cover of algae and percentage cover of seagrasses*, published CSIRO Marine Research, available www.cmar.csiro.au/datacentre

²⁴ *Northern Territory*, published Seagrass Watch, available www.seagrasswatch.org/northernterritory.html; *A survey of intertidal seagrass, op cit*

²⁵ *Commonwealth Report Card – North Marine Bioregion (2012)*, published Cth Department of the Environment, available www.environment.gov.au

Many threatened, endangered and protected species (TEPS) are found in the region, although as a whole endemism (species occurring only in the area) is low, probably as a result of a lack of physical barriers to species dispersal.²⁶ For some species (particularly those associated with commercial-scale fishing, such as trevally, Barramundi, emperor, snapper, salmon, jewfish and grouper), significant population and dispersion data are available.²⁷ For others, less is known, particularly coastal fish, which are likely to be ecologically significant as the most abundant near-shore predatory species.

Long-term monitoring of populations in the marine environment, however, is severely lacking, and sound data on abundance, distribution, condition and other important management data is sparse. Drawing conclusions on populations specific to the Northern Territory is therefore difficult and, in the absence of actual data, reliance is often placed on similarities to other marine habitats or communities, assuming populations are in good condition due to the relatively lower use of the marine environment and extreme remoteness of much of the Northern Territory.²⁸ In particular, little is known of benthic seabed habitats outside the west of the Gulf of Carpentaria, Darwin Harbour and surrounds, and the Van Diemen Rise to the northeast of the Tiwi Islands. Recent species surveys in the Oceanic Shoals Marine Park (Marine Reserves are discussed further in Appendix 4) highlight the potential downside of relying on assumptions and representative data, with these surveys identifying a previously unknown hotspot of biological diversity in the region, with 57 species not previously known in the region identified, including 7 not previously known in Australia and species identified by the International Union for Conservation of Nature (IUCN) as threatened, near threatened or endangered.²⁹

2.2. Industrialisation and Population Growth

2.2.1. Recent Expansion

Over the past 25 years, the population of the Northern Territory has grown at a compound annual growth rate of 1.6 percent. Over the same period, the Northern Territory economy has grown at 3.6 percent, including at a rate of 4.1 percent over the past decade. The trend in population and economic growth in the Northern Territory over the past 15 years is illustrated in Figure 7.^{30,31}

²⁶ *State of the Marine Environment* (2016), published Cth Department of Environment, available <https://soe.environment.gov.au>

²⁷ Ibid

²⁸ Ibid

²⁹ National Environmental Research Program – Marine Biodiversity Hub, *Exploring the Oceanic Shoals Commonwealth Marine Reserve*, published 2015, available www.nespmarine.edu.au

³⁰ Australian Bureau of Statistics (2016), *Australian Demographic Statistics: Estimated Resident Population, States and Territories*, Australian Government, Canberra

³¹ Australian Bureau of Statistics (2016), *Australian National Accounts: State Accounts, Gross State Product Chain Volume Measures and Current Prices*, Australian Government Canberra

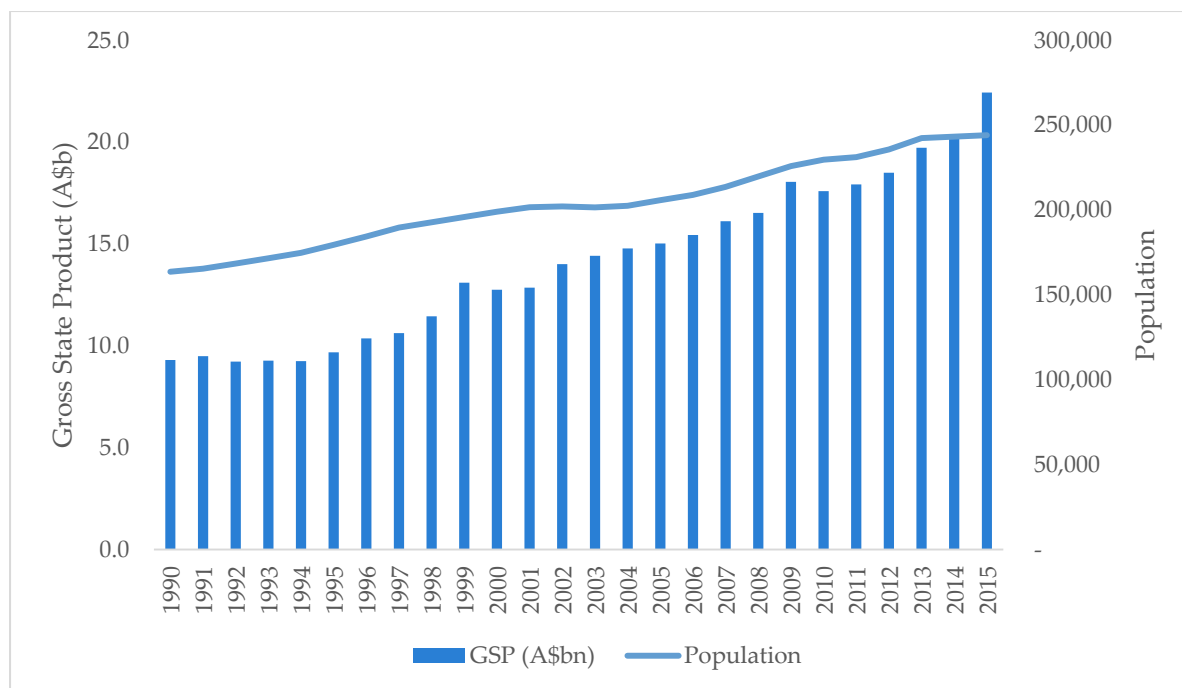


FIGURE 7 – NORTHERN TERRITORY POPULATION AND GROSS STATE PRODUCT (1990 TO 2015)

Compared to 1990, there are currently 1.5 times as many people living in the Northern Territory and the Northern Territory economy, in terms of Gross State Product (GSP), is 2.5 times larger. As illustrated in Figure 8³², most of this growth has been in coastal areas, particularly the greater Darwin Harbour Area. Indeed, this part of the Northern Territory recorded an increase in residential population of 28.6 percent over the period 2006 to 2016, the highest population increase of any capital city in Australia.

³² Australian Bureau of Statistics (2017), *Regional Population Growth, Australia, 2016*

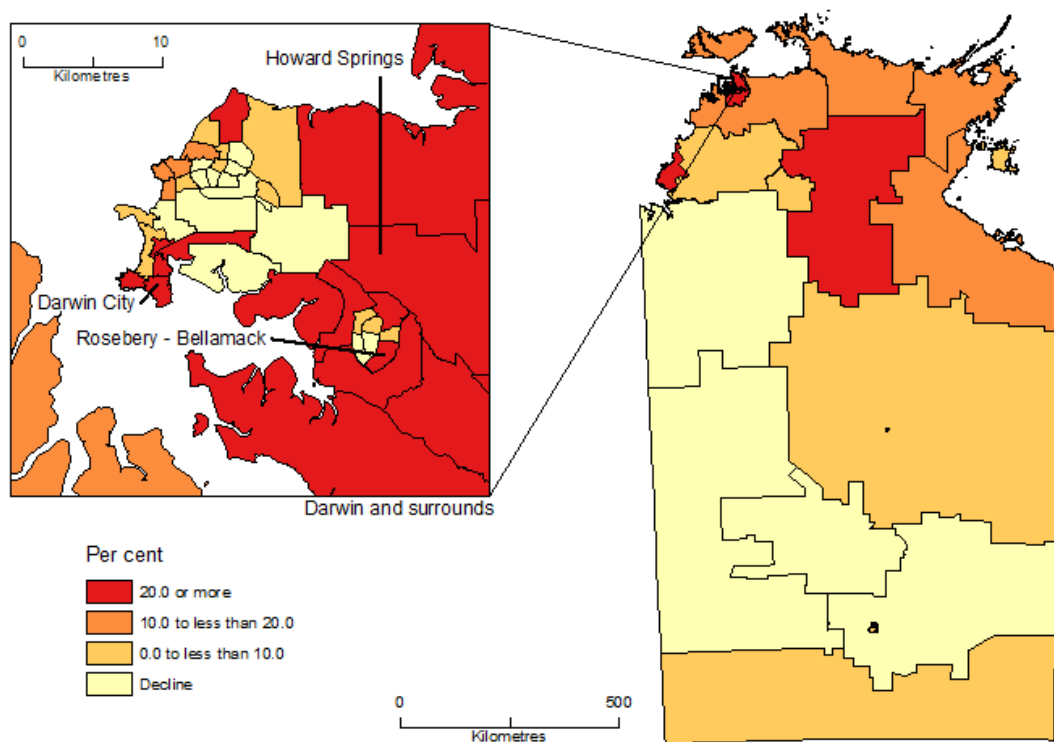


FIGURE 8 - POPULATION CHANGE BY STATISTICAL AREAS LEVEL 2, NORTHERN TERRITORY, 2006–2016

With primary industries and construction accounting for around 40 percent of GSP, the Northern Territory economy is driven primarily by the petroleum, minerals, agriculture, forestry and fisheries sectors, the infrastructure that supports those sectors and the needs of its workforce. Over the course of the past decade, the growth of these primary industries has seen the Northern Territory maintain a GSP per capita equivalent to the Nation's largest primary industry-based economy, Western Australia, despite having an economy smaller than that of Tasmania's, where primary industries and construction account for approximately 20 percent of GSP. This is illustrated in Figure 9^{33,34,35} below.

³³ Australian Bureau of Statistics (2017), *National Accounts*, Australian Government, Canberra

³⁴ Australian Bureau of Statistics (2016), *Regional Population Data*, Australian Government, Canberra

³⁵ Northern Territory Government, 2015-16 Budget and Western Australian Department of State Development

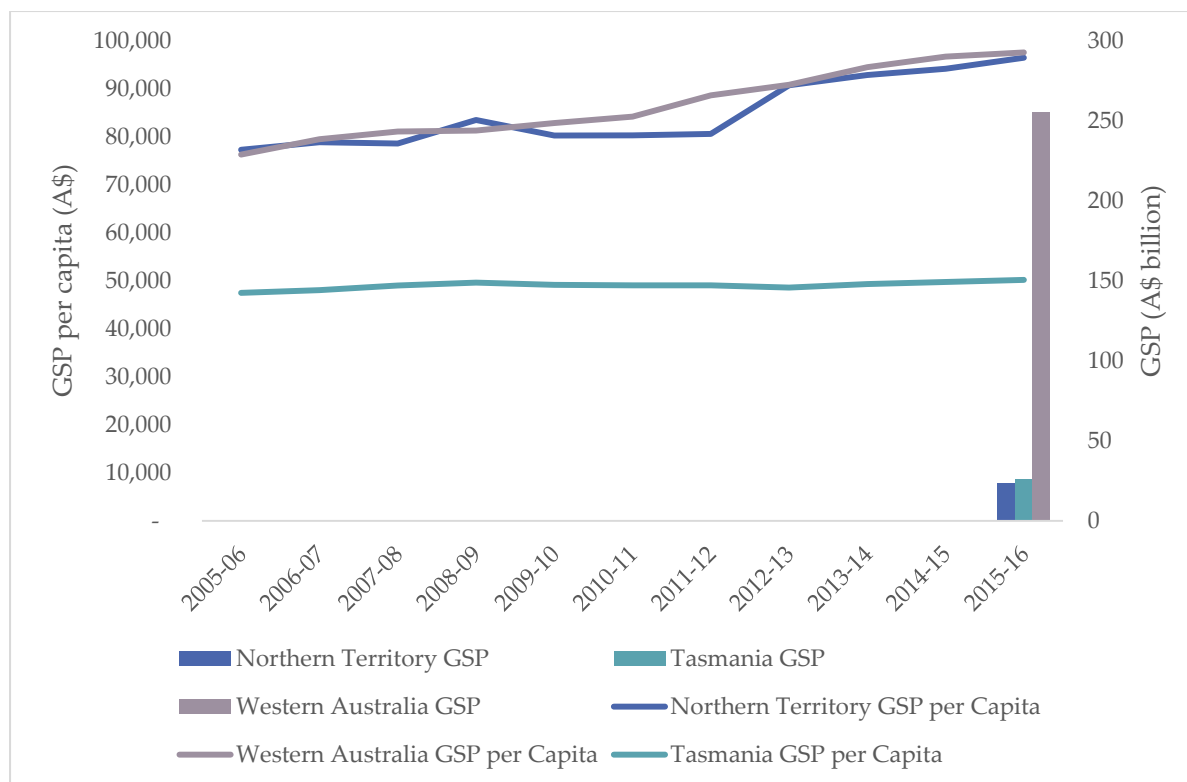


FIGURE 9 – COMPARISON OF NORTHERN TERRITORY, TASMANIA AND WESTERN AUSTRALIA GSP AND GSP PER CAPITA

Similar to other resources industry exposed states, the Northern Territory has experienced a dramatic decline in population growth over the past year. Indeed, at 0.1 percent, the Northern Territory experienced the Nation's slowest rate of population growth for the year ending March 2017.³⁶

The status, trajectory, key issues and marine science knowledge needs of the key sectors that intersect with the Northern Territory marine environment and that will continue to drive economic development in the Northern Territory are discussed in detail in Sections 7, 8, 9, 10, 11, 12 and 13,

As illustrated in Figure 10³⁷, the population of the Northern Territory is primarily coastal oriented, with around 75 percent of the population of the Northern Territory living in a Local Government Area (LGA) that has a coast.

³⁶ Australian Bureau of Statistics (2017), *Australian Demographic Statistics, Mar 2017*

³⁷ Australian Bureau of Statistics (2017), *Regional Population Growth: Estimated Resident Population Local Government Areas*

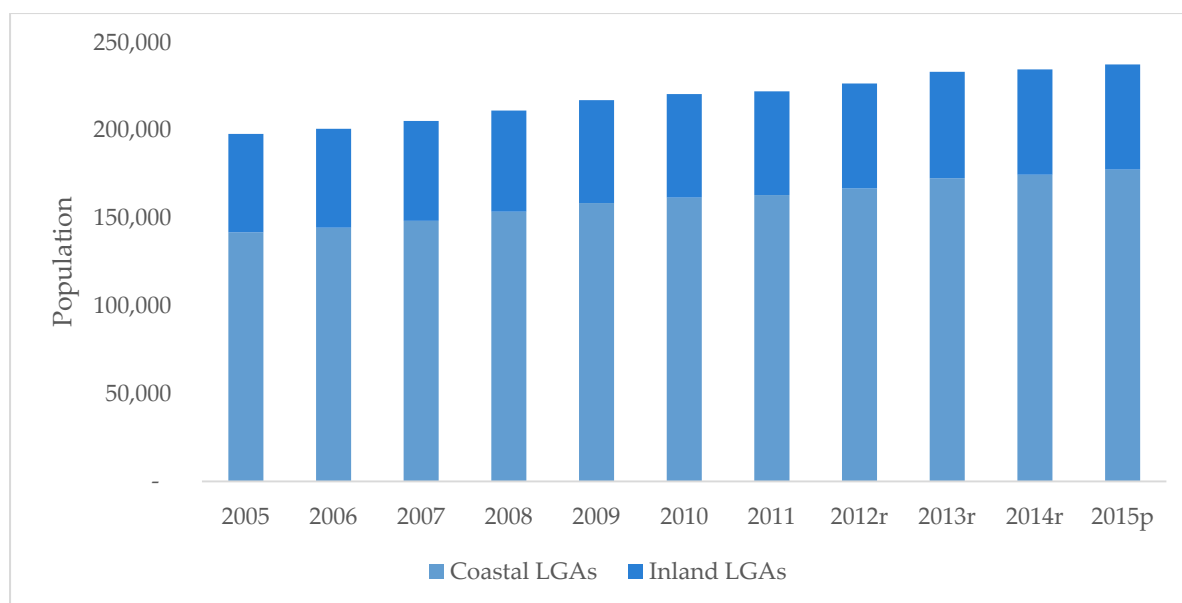


FIGURE 10 – NORTHERN TERRITORY POPULATION BY COASTAL AND INLAND LOCAL GOVERNMENT AREAS

Furthermore, the majority of growth in the Northern Territory population has occurred in coastal LGAs, which have collectively grown at a Compound Annual Growth Rate of 2.3 percent per annum over the past decade, as opposed to a growth rate of 0.7 percent for inland LGAs. Approximately 65 percent of the inland population live in the larger inland towns of Alice Springs and Katherine.

Importantly, approximately 60 percent of the total population of the Northern Territory reside in the greater Darwin Harbour Area and this population has grown at an average of 2.6 percent per annum over the past decade. This is summarised in Table 3³⁸ below.

Local Government Area	2015–16 Population (% of Total Population)	10 Year Population Growth (CAGR)
Wagait	427 (0.17%)	3.0%
Belyuen	208 (0.08%)	0.5%
Darwin	83,465 (34.04%)	1.8%
Litchfield	23,879 (9.74%)	4.2%
Palmerston	35,173 (14.35%)	3.8%
Total Darwin Harbour Area	143,152 (58.38%)	2.6%

TABLE 3 – POPULATION DYNAMICS OF THE GREATER DARWIN HARBOUR AREA

³⁸ Australian Bureau of Statistics (2017), *Regional Population Growth: Estimated Resident Population Local Government Areas*

The population trends of other coastal LGAs in the Northern Territory are summarised in Table 4³⁹.

Local Government Area – coastal outside Darwin Harbour area	2015–16 Population (% of Total Population)	10 Year Population Growth (CAGR)
East Arnhem	9,275 (4.36%)	1.6%
West Arnhem	7,436 (3.03%)	1.6%
Roper Gulf	7,409 (3.02%)	1.6%
West Daly	3,773 (1.54%)	2.6%
Victoria Daly	3,274 (1.34%)	-0.6%
Tiwi Islands	3,093 (1.26%)	2.7%
TOTAL	35,678 (14.55%)	1.6%

TABLE 4 – POPULATION DYNAMICS FOR COASTAL LOCAL GOVERNMENT AREAS OUTSIDE OF THE GREATER DARWIN HARBOUR AREA

The current status, trajectory, issues and marine science priorities of a growing urban coastal population are discussed in Section 14.

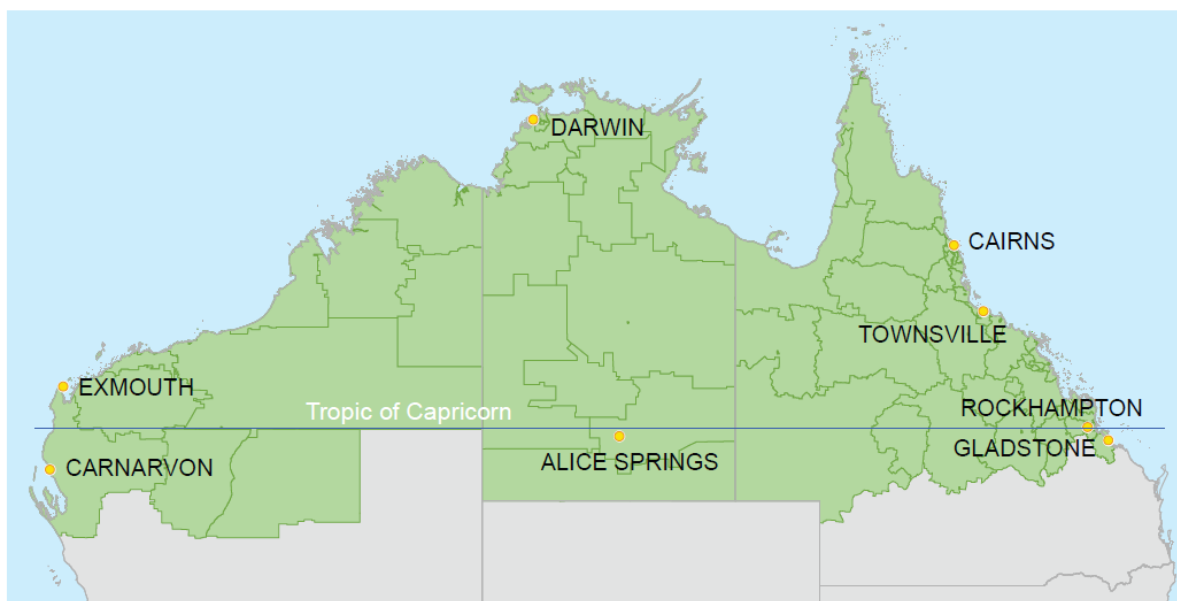
2.2.2. Developing Northern Australian Policy Initiative

The past two years has seen renewed bipartisan Commonwealth support for accelerating the development of northern Australia. Commencing in 2015 with the release of the White Paper on Developing Northern Australia,⁴⁰ the Commonwealth Government, through a dedicated Office of Northern Australia, has put in place several initiatives designed to promote the development of the areas of Western Australia and Queensland above the Tropic of Capricorn and the entire Northern Territory. The area of focus of this policy is illustrated in Figure 11⁴¹ below.

³⁹ Australian Bureau of Statistics (2017), *Regional Population Growth: Estimated Resident Population Local Government Areas*

⁴⁰ Australian Government (2015), *Our North, Our Future: White Paper on Developing Northern Australia*

⁴¹ Northern Australia Infrastructure Facility (2016), *Area Defined as Northern Australia for the purposes of the Northern Australian Infrastructure Facility*, Australian Government, Canberra



Northern Australia as defined in the NAIF Act 2016

FIGURE 11 – AREA OF FOCUS OF THE AUSTRALIAN GOVERNMENT’S DEVELOPING NORTHERN AUSTRALIA POLICY PLATFORM

The key focus of the developing northern Australia policy platform is on land tenure reform, water resource development, logistics gateways, other economic infrastructure development and overall governance of regional development across the northern half of the Nation. Supporting the policy platform is the recently established Northern Australia Cooperative Research Centre (CRC). The key Commonwealth funding vehicle for specific capital projects under the policy is the Northern Australia Infrastructure Facility, a \$5 billion concessional loan facility that is designed to stimulate investment from other levels of government and/or private enterprise in economic infrastructure in the north.

While not focused exclusively on northern Australia, complementing the Commonwealth’s developing northern Australia policy platform and relevant to this study is the National Water Infrastructure Loan Facility, a \$2 billion concessional loan facility designed to provide State and Territory Government’s with co-funding for the construction of water infrastructure across the Nation.

2.3. Northern Territory Aboriginal Economic and Social Participation

There are currently approximately 75,000 Aboriginal people living in the Northern Territory, comprising approximately 30 percent of the total population. In most remote and regional areas, a majority of the population are Aboriginal. Many of these Aboriginal Northern Territorians continue customary practice and observe customary law, whilst also engaging with the mainstream economy.

It is estimated that the Aboriginal population in Northern Territory LGAs with a coastline is approximately 40,000 with over 25,000 Aboriginal people living in coastal areas outside of the greater Darwin Harbour Area. The portion of the population of the greater Darwin Harbour Area that is Aboriginal is approximately 25 percent, whereas in coastal areas outside of the greater Darwin Harbour Area an average of 85 percent of the population is Aboriginal,

approaching 100 percent in some areas. In all instances, the Aboriginal population is a relatively young population. This is summarised in Table 5⁴² below.

Costal LGA	2015–16 Population	% Indigenous	Indigenous Population	Median Age
East Arnhem	9,275	93.5%	8,439	25
West Arnhem	7,436	77.4%	4,792	28
Roper Gulf	7,409	79.7%	5,186	26
West Daly	3,773	90.8%	2,874	24
Victoria Daly	3,274	64.8%	1,820	27
Tiwi Islands	3,093	89.2%	2,187	30
Wagait	427	8.9%	41	51
Belyuen	208	95.7%	157	30
Darwin	83,465	7.4%	5,828	34
Litchfield	23,879	9.7%	2,309	37
Palmerston	35,173	11.3%	3,809	30
Total Darwin Harbour region	143,152	8.5%	12,144	N/A
Total coastal other regions	35,678	70.9%	25,298	N/A
Northern Territory Total	177,197	25.5%	58,248	N/A

TABLE 5 – ESTIMATED ABORIGINAL POPULATION IN NORTHERN TERRITORY COASTAL LOCAL GOVERNMENT AREAS

Aboriginal people have major land holdings across the coastal areas of the Northern Territory and control access to over 85 percent of the intertidal areas relevant to the *Aboriginal Land Rights (Northern Territory) Act 1976* (ALRA). Aboriginal people have significant other vested interests in the Northern Territory marine environment, including determinations under the *Native Title Act 1993* (Cth), sacred sites (both registered and unregistered), Indigenous Protected Areas (IPAs) in sea country, joint management of marine conservation areas and pioneering marine research.

Aboriginal people also have extensive cultural, social, commercial and livelihood interests in the wider Northern Territory marine environment. Those interests are often considered subordinate to the interests of other users of the marine estate. However, increasing demands from Aboriginal people for full participation in decision making on issues that affect their interests in the marine estate is a trend that will continue, particularly in the face of the increasing policy and industry focus on the accelerated development of northern Australia (see Section 2.2).

For the Northern Territory to reach its full development potential, the conventional, somewhat transactional approach used by project proponents when seeking to access lands in which Aboriginal people have interests, whereby the goal of the proponent is often extinguishment of Aboriginal interests, will need to give way to the pursuit of more equitable arrangements for access. Aboriginal landowners have demonstrated an eagerness to reach more equitable agreement with respect to developments that are proposed on their lands, taking some of the impact risk provided core values are respected.

Much of the uncertainty that exists in this context is the result of limited or absent land-use planning outside of major regional centres, as well as limited participation by Aboriginal

⁴² Australian Bureau of Statistics (2017), 2016 Census

people in those land-use planning processes. This applies to the marine estate as much as it does the terrestrial estate.

Aboriginal interest in the Northern Territory marine environment and the marine science knowledge needs and contributions of Aboriginal people are discussed in greater detail in Section 3.

2.4. Defence and Strategic Interests

Historically, Australia's strategic defence interests have been oriented primarily on the eastern seaboard. In more recent times, the Indian Ocean and its access through the Southeast Asian archipelago has emerged as one of the most important contemporary strategic theatres. Underpinning this is the fact that:

- Approximately 40 percent of the world's population live in Indian Ocean littoral nations;
- Those nations host approximately two-thirds of the world's oil resources, 35 percent of the world's natural gas resources and 60 percent of the world's uranium resources; and
- Approximately 30 percent of world trade, including 50 percent of container traffic and 64 percent of oil transport, passes through Indian Ocean sea lanes.⁴³

In this progressively important theatre, Australia's strategic interests in the region are increasingly intersecting with those of other Indian Ocean littoral nations, as well as the regional powers of the United States, People's Republic of China (PRC) and India. New strategic alliances are being formed and defence power projection and posture in the region is evolving, including in and around northern Australia. This dynamic is illustrated conceptually in Figure 12⁴⁴ below.

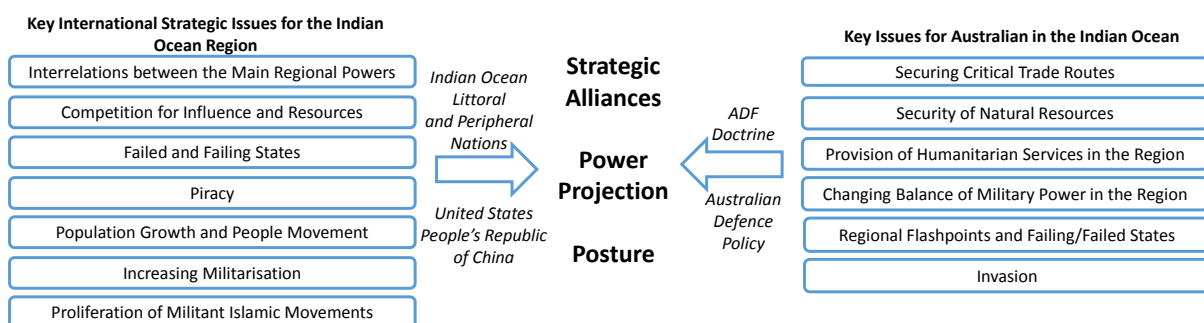


FIGURE 12 – STRATEGIC INTERESTS IN THE INDIAN OCEAN REGION

The Northern Territory is playing an increasing role in this important strategic dynamic. While the main basing requirements of the ADF will, for sustainment reasons, remain located near major urban and industrial centres, forward operational basing of air, naval and land force capability will see the ADF become an increasingly important stakeholder in the Northern Territory marine environment. Indeed, approximately one-third of new Defence spending in Australia over the coming decade is expected to be in the Northern Territory.⁴⁵ Furthermore, it is likely that the Northern Territory will perform an increasingly important role in ensuring

⁴³ Future Directions International (2012), *Indian Ocean: A Sea of Uncertainty*, Future Directions International, Perth

⁴⁴ ADAPTED FROM: Future Directions International (2012), *Indian Ocean: A Sea of Uncertainty* AND Copley, G. and Pickford, A. (2009), *Such a Full Sea: Australia's Options in a Changing Indian Ocean Region*, Future Directions International, Sid Harta Publishers, Victoria

⁴⁵ Department of Defence (2016), *Defence White Paper*, Australian Government, Canberra

interoperability between Australia and its allies such as the United States, primarily through its role in facilitating joint military exercises.

The specific nature of defence interests in the Northern Territory marine environment and the marine science knowledge needs that are required to support defence decisions pertaining to the Northern Territory marine environment are discussed in Section 6.

2.5. Conservation Advocacy

As anthropogenic pressures on the Northern Territory marine environment increase, so will the attention of the national and global conservation advocacy movement and the various marine oriented environmental NGOs that comprise that movement.

Globally, the environmental conservation movement and the loose coalition of many NGOs that are part of and work within it have become a sophisticated and well-resourced advocacy force. The movement has had much success in influencing policy and regulation through consistent engagement with policy makers and is able to activate very effective campaigns in response to specific issues. Most importantly, it is underpinned by a political force that is garnering increasing support from mainstream Australia.

The Northern Territory was a major focus of anti-uranium mining campaigns during the 1970s and, more recently, it has been the subject of a well-organised and influential anti-fracking campaign. This campaign resulted in a moratorium and independent review of fracking in the Northern Territory being taken to the 2016 Northern Territory general election by the then Labor opposition, a policy which it implemented shortly after being elected. Nevertheless, conservation advocacy in the Northern Territory to date has primarily revolved around terrestrial impacts and resource usage, with the Northern Territory yet to experience a sustained modern conservation campaign targeting use and management of the marine resource at a local policy level. As development and urbanisation increasingly impacts on the Northern Territory marine environment, it is highly likely that this activity will draw increasing attention from the environmental conservation movement.

2.6. Climate Change

As illustrated in Figure 13⁴⁶ below, and similar to the rest of Australia, the Northern Territory marine environment has been and will continue to be impacted by climate change. This will contribute to minor changes in the marine environment and availability of the marine resources, as well as large-scale changes such as the recent mangrove dieback event (see Section 2.1.4).

⁴⁶ Australian Bureau of Meteorology

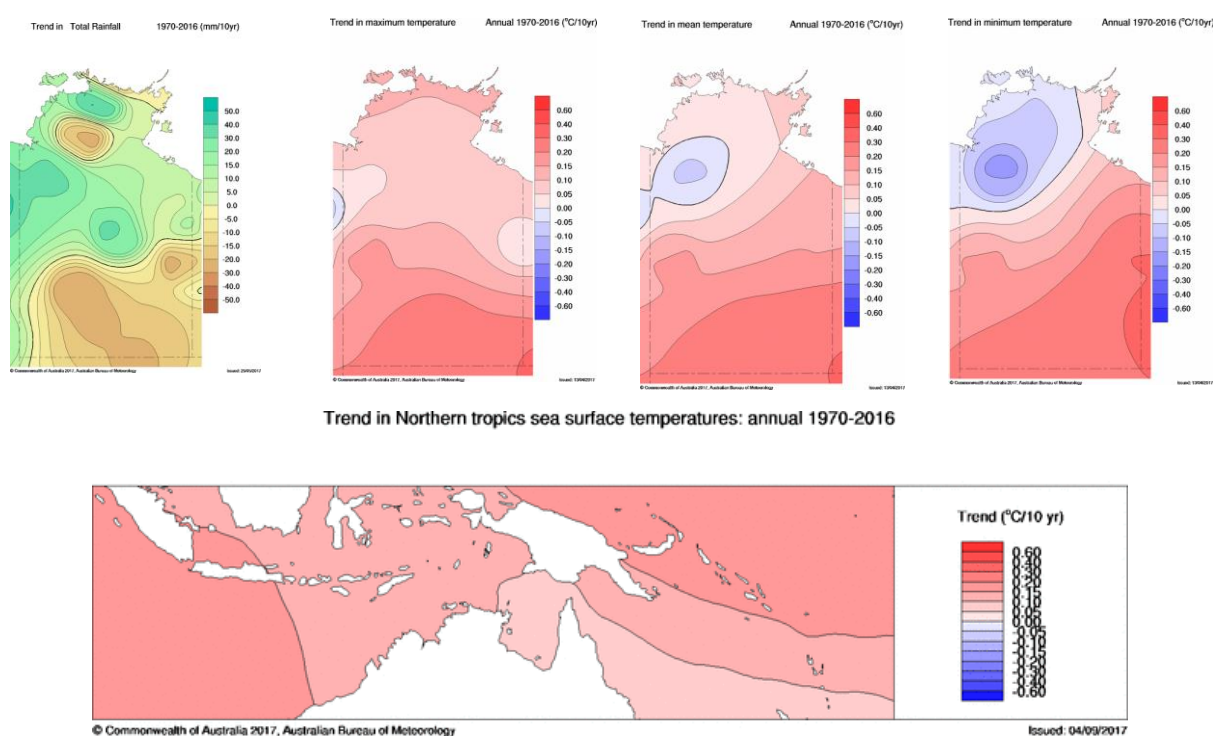


FIGURE 13 – NORTHERN TERRITORY CLIMATE VARIABILITY AND CHANGE TREND MAPS (1970 TO 2016)

The Northern Territory marine environment also plays a key role in the mitigation of the impact of climate change. Mangroves, saltmarshes and seagrasses that are common to the Northern Territory marine environment fix carbon from the atmosphere and ocean and estuarine waters and preserve the captured carbon efficiently in deep, organic rich sediments. These ecosystems are very efficient at natural carbon capture and storage because methane emissions are dramatically reduced in saline environments and biochemical conditions in tidal wetlands are conducive to long-term carbon retention. Research indicates that the mean organic carbon burial rate for saltmarsh is 1.51 tonnes per hectare per annum and 1.39 tonnes per hectare per annum for mangrove, which is six to ten times the maximum carbon burial rate of undisturbed Amazonian forest.⁴⁷

2.7. Evolving Regulatory Framework

Much of the Northern Territory regulatory framework is dated, having been mostly developed in an environment where there was limited economic and population growth, and pressures on the environment were mostly relatively diffuse. As illustrated by past and more recent commitments to major reforms in environmental assessment and resource management law, there is a well-recognised need to transition the Northern Territory's current regulatory frameworks to a contemporary framework.

The marine science knowledge needs of Northern Territory and Commonwealth regulators of the Northern Territory marine environment are discussed in Section 5.

2.8. Evolving Multi-jurisdiction Regulatory Framework

The regulatory framework that affects the Northern Territory marine environment is multi-jurisdictional involving influence of the Commonwealth Government, decisions made by the

⁴⁷ Duarte, C., Middleburg, J., and Caraco, N. (2005), Major role of marine vegetation on the oceanic carbon cycle', *Biogeosciences*, 2:1-8

governments of Western Australia and Queensland and foreign governments of particularly the Republic of Indonesia, Timor-Leste and Papua New Guinea. This brings with it some complexity with respect to regulating the Northern Territory marine environment, complexity which is exacerbated by the evolving nature of this multi-jurisdictional environment.

Contemporary Northern Territory is best described as a self-governing Territory that does not have the same rights under the Australian Constitution as the States that comprise the Australian federation. This results in an inherently complex mix of Territory and Commonwealth powers and obligations with respect to the management of the Northern Territory marine environment. However, while the potential for Commonwealth Government intervention is ever present, jurisdictional ambiguity with respect to the management of the Northern Territory marine environment is limited.

The major dynamics from a national perspective revolve around increasing devolution of regulatory powers from the Commonwealth Government to the Northern Territory Government, as well as a need for increased regulatory collaboration between Western Australia, Queensland and the Northern Territory. Indeed, a main thrust of the Commonwealth's developing northern Australia policy platform (see Section 2.2.2) is to drive increased governance of development coordination across the north of the Nation. This extends to developments in the marine environment and will require increased collaboration between the Northern Territory, Western Australia and Queensland in areas such as fisheries management.

Finally, marine resources in the Timor and Arafura Seas are to a large degree co-managed by the Republic of Indonesia, Timor-Leste, Papua New Guinea and Australia. This occurs under formal bilateral arrangements such as the Joint Petroleum Development Area (JPDA), Timor Sea Treaty and Perth Treaty Area, as well as a matter of circumstance whereby, for example, operators from these jurisdictions target the same fishery resources. This international dimension will also continue to evolve.

3. Aboriginal Custodianship of and Interests in the Marine Environment

Under Commonwealth and Northern Territory Law, Aboriginal people are owners, holders of resource rights, managers and wider stakeholders in the Northern Territory marine environment. Access to approximately 85 percent of the intertidal zone along the Northern Territory coastline is controlled by Aboriginal interests, including significant areas of the coast that are the subject of Aboriginal freehold title. In most cases, development on and adjacent to the Northern Territory coast requires the informed consent of relevant Aboriginal groups or individuals, obtained on a case by case basis or through overarching agreements with government.

These formal rights, combined with the fact that the vast majority of the population residing on the coastline outside of the Darwin-Palmerston area is comprised of Aboriginal people and that there are significant Aboriginal cultural rights in the marine estate that are also protected in law, mean that Aboriginal people are stakeholders with a paramount interest in the Northern Territory marine environment. These rights and circumstances combined with cultural obligations and often severe socio-economic disadvantage among coastal communities means that Aboriginal owners of the marine estate are entitled by law and compelled by both cultural obligation and economic need to rigorously prosecute their interests in the Northern Territory marine environment.

An understanding of the extent of Aboriginal legal interests in sea country in the Northern Territory is fundamental to understanding not only marine science priorities, but also the necessary role that Aboriginal people play in addressing those marine science priorities.

3.1. Legal Basis of Aboriginal Custodianship of the Marine Environment

3.1.1. Aboriginal Land Rights Act

Formed as a response to the Gove Land Rights Case,⁴⁸ the Woodward Land Rights Commission recommended the Commonwealth enact legislation converting existing Aboriginal reserves in the Northern Territory to fee simple (freehold) title, focusing on the right to exclude all others. The Woodward Commission accepted the historical understanding of territorial waters also belonging to the clan whose lands they bordered but recognised the impracticality of granting the usual 12 nautical mile exclusion zone, instead recommending a two kilometre buffer zone along the shoreline. The Commonwealth Parliament did not enact this defined buffer zone and instead left the exact area to be granted to be determined on a case by case basis upon application by Aboriginal groups, in addition to automatically converting existing reserves. This is enshrined in the ALRA.

As a result, the existing Aboriginal reserves (which extended on the seaward side to the low water mark), once converted, gave freehold title under the ALRA to the areas of the marine estate between the high and low water mark. Section 71 of the ALRA enshrines the rights of Aboriginal people to enter, use and occupy Aboriginal land in accordance with tradition

⁴⁸ *Milirrpum v Nabalco Pty Ltd* (1971) 17 FLR 141

governing the use and occupation of that land. The traditional land claims process under the ALRA has secured Aboriginal control of substantial areas of the Northern Territory coast.

3.1.2. Other Relevant Northern Territory Legislation

Section 73 of the ALRA enables the Northern Territory parliament to make reciprocal legislation for the following purposes:

- **Protection of sacred sites**, which provide for the right of Aboriginal people to access and manage those sites in accordance with Aboriginal tradition;
- **Access to Aboriginal land**, which provide for the right of Aboriginal people to enter Aboriginal land in accordance with Aboriginal tradition;
- **Protection or conservation of wildlife**, particularly laws for wildlife management on Aboriginal land that are formulated in consultation with Aboriginal people using the land to which the wildlife management scheme applies and provide for the right of Aboriginal people to utilise wildlife resources; and
- **Regulating or prohibiting people or controlling fishing or other activities in the sea adjoining and within two kilometres of Aboriginal land**, providing for the right of Aboriginal people to enter and use the resources of those waters in accordance with Aboriginal tradition.

The Northern Territory Government responded to the powers afforded to it under Section 73 of the ALRA through the following legislations, which collectively form an important part of the wider legal mechanism that underpins Aboriginal management of marine areas⁴⁹:

- **Aboriginal Sacred Sites Act 1978 (NT)**
This Act provides for the protection of sacred sites and the land that hosts those sacred sites in the Northern Territory. Section 3 of this Act defines 'land' as 'land covered by water (including such land in the Territorial sea) and the water covering land' and can include extensive areas (see Section 5.4.5).
- **Aboriginal Land Act 1978 (NT)**
Among other things, this Act enables marine areas as far as two kilometres offshore adjacent to Aboriginal land to be declared 'closed'. 'Closed seas' provide exclusive access to Traditional Owners and permission from the land owners is required to access 'closed seas'. To date, sea closures at the Milingimbi, Crocodile Islands and Glyde River areas were gazetted in 1981 and in the Castlereagh Bay and Howard Island areas in 1988. These areas are adjacent to Aboriginal land and extend two kilometres seaward of the low tide watermark.
- **Territory Parks and Wildlife Conservation Act 1991 (NT)**
Among other things, this Act provides a process for establishing joint management of parks or reserves between Traditional Owners and the Northern Territory Government.
- **Fisheries Act 1988 (NT)**
Section 53 of this Act recognises the rights of Aboriginal people to fish in a traditional manner and acknowledges the right of Aboriginal people who have traditionally used the resources of an area of land or water in a traditional manner to continue to use those resources in that manner.

⁴⁹ Butterly, L. (2013), 'Changing tack: Akiba and the new way forward for Indigenous governance of sea country', *Australian Indigenous Law Review*, 17:2

3.1.3. Native Title Rights

The decision in the *Mabo Case*⁵⁰ recognises that traditional law and custom can be a basis for claiming land ownership by Indigenous people. The subsequent *Native Title Act 1993* (Cth), together with corresponding legislation in the States and Territories, established the procedure for making Native Title claims.

The *Native Title Act 1993* (Cth) provides that Native Title can be claimed over both land and waters, including the sea and the shore between the high water and low water marks. Litigated Native Title determinations relating to sea country have recognised non-exclusive Native Title rights to areas of the sea,⁵¹ with the *Akiba Case*⁵² being the largest sea claim in Australia and includes the first recognition of commercial rights. These determinations, in accordance with and subject to traditional laws and customs, are recognised rights under common law, provide Aboriginal people the rights to access sea for travel, non-commercial fishing and hunting, visiting and protecting places of cultural and spiritual importance and for safeguarding cultural and spiritual knowledge.⁵³

Non-exclusive Native Title determinations cover sea country surrounding Croker Island in west Arnhem Land and in the north region of Blue Mud Bay in east Arnhem Land (see Section 3.1.4).

Increasingly, legal and customary rights and interests held by Aboriginal people are being recognised by courts as encompassing rights and interests of a commercial nature. For example, in litigation known as the *Akiba Case*,⁵⁴ the High Court held that Native Title rights and interests could comprise a right to access resources and take for any purpose resources in the Native Title claim area. The right could be exercised for commercial or non-commercial purposes. In another litigation known as the *Borroloola Case*,⁵⁵ the Federal Court recognised the rights of the *Rrumburriya Borroloola People*, being the Traditional Owners of Borroloola and members of the wider *Yanyuwa Group*, to exclusive possession over vacant crown land in the town, and to take and use resources for any purpose, including commercial purposes.

3.1.4. The Blue Mud Bay Case

The *Blue Mud Bay Case*⁵⁶ represents a landmark event acknowledging the strength of Aboriginal property rights under the ALRA. The High Court confirmed that Traditional Owners of the Blue Mud Bay region in northeast Arnhem Land, together with Traditional Owners of much of the Northern Territory coastline, have exclusive access rights to tidal waters overlying Aboriginal land. The Court affirmed that the grant of a fishing licence by the Northern Territory Director of Fisheries does not authorise the holder to enter waters within the boundaries of Aboriginal land. In coastal areas, grants of 'Aboriginal Land' under the ALRA are made to the low water mark and as such include the intertidal zone, which encompasses river mouths and estuaries along much of the Northern Territory coastline where much fishing activity occurs. The decision recognises the right to exclude others as both freehold grant holders under the

⁵⁰ *Mabo v Queensland (No.2)* (1992) 175 CLR 1

⁵¹ *Yarmirr v Commonwealth* (2001) 208 CLR 1; *Lardil Peoples v State of Queensland* (2004) FCA 298, *Gumana v Northern Territory* (2005) 141 FCR 457; and *Akiba v Queensland (No 3)* (2010) 204 FCR 1.

⁵² *Akiba v Queensland (No 3)* (2010) 204 FCR 1

⁵³ *Yarmirr v Commonwealth* (2001) 208 CLR 1

⁵⁴ *Akiba on behalf of the Torres Strait Regional Seas Claim Group v Commonwealth* (2013) HCA 33; 250 CLR 209

⁵⁵ *Rrumburriya Borroloola Claim Group v Northern Territory of Australia* (2016) FCA 776

⁵⁶ *Northern Territory of Australia v Arnhem Land Aboriginal Land Trust* (2008) HCA 29

criminal trespass provision pursuant to Section 70 of the ALRA. This decision creates a strong bargaining position for coastal Aboriginal people to negotiate joint participation arrangements between government, business and Indigenous people in commercial fisheries.⁵⁷

During the period between the Blue Mud Bay decision and 31 December 2016, interim access arrangements were entered into between the Northern Territory Government and the Northern Land Council to ensure continuing access for recreational and commercial fishers. During this period, relevant Land Councils and Traditional Owners negotiated with the Northern Territory Government and other fisheries stakeholders on how to best address the issue of access. On 31 December 2016, the Northern Land Council announced a requirement for permits to access Aboriginal controlled water and subsequently waived that requirement on an interim basis, recently extending this waiver out to 31 December 2018.

As discussed previously in this report, in addition to being custodians of sea country under Indigenous law, approximately 6,050 kilometres or 85 percent of the intertidal zone along the Northern Territory coastline is owned by Traditional Owner groups under Australian law.⁵⁸ By way of example, the following Figure 14⁵⁹ illustrates the extent to which the intertidal zone in parts of the Northern Territory that are in the jurisdiction of the Northern Land Council are the subject of Aboriginal control. The green lines represent areas where Intertidal Fishing Access Agreements have been settled, red lines where Traditional Owners control access and yellow lines where permit access has been waived.

⁵⁷ Brennan, S. (2008), 'Wet of dry, its Aboriginal land: The Blue Mud Bay decision on the intertidal zone', *Indigenous Law Bulletin*, 7(7)

⁵⁸ Ibid

⁵⁹ Northern Land Council

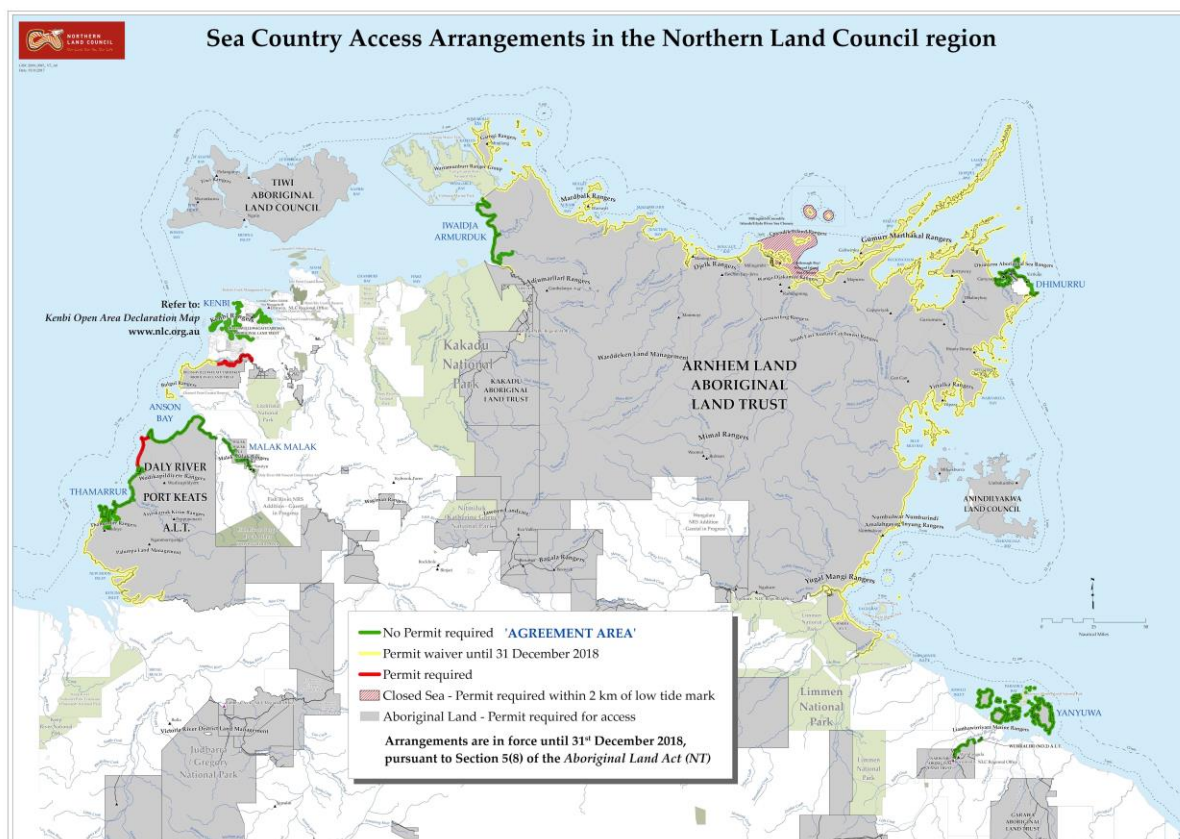


FIGURE 14 – SEA COUNTRY ACCESS ARRANGEMENTS IN THE NORTHERN LAND COUNCIL REGION

3.1.5. Concluding Remarks

Taken together, the ALRA, additional Northern Territory legislation proclaimed pursuant to the ALRA, relevant Native Title determinations and the Blue Mud Bay decision affirm that Aboriginal people own the vast majority of the Northern Territory coast, hold rights to control access to that coast, control access to significant closed seas in the Arnhem Region and are important users of marine resource under Native Title. Further, those rights extend beyond customary use to include commercial activities.

3.2. Coastal Aboriginal Communities, Management of the Marine Environment and Economic Participation

3.2.1. Coastal Communities

As summarised in Table 5, there are approximately 40,000 Aboriginal people living in Northern Territory LGAs that have a coastline, representing an average of 24 percent of the population of these coastal LGAs. Outside of the greater Darwin Harbour Area, Aboriginal people comprise an average of 80 percent of the population.

Outside of the greater Darwin Harbour Area, coastal Aboriginal people live in towns and discrete Aboriginal communities that extend along the Northern Territory coastline. These

towns and communities are discussed in detail in Section 14.2 and, as illustrated in Figure 15⁶⁰ below, are variable in size and demonstrate a density that is only replicated in central Australia, parts of the Kimberley Region of Western Australia and Cape York in Queensland.

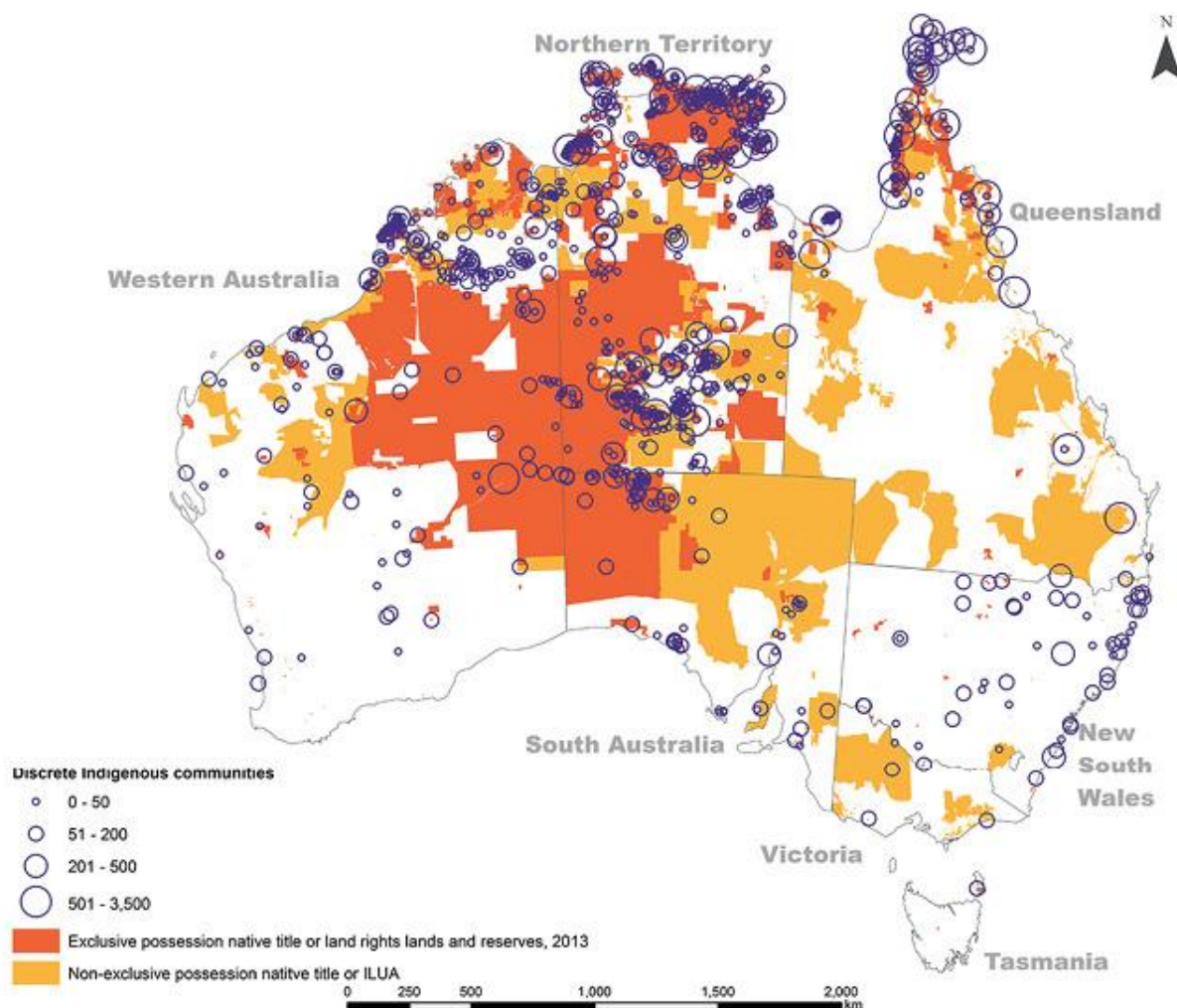


FIGURE 15 – DISCRETE ABORIGINAL COMMUNITIES

3.2.2. Management of the Marine Environment

In a sparsely populated, financially constrained jurisdiction such as the Northern Territory, it is important that the limited resources devoted to environmental management are efficiently and effectively applied.

One of the few sources of reliable employment in isolated (including coastal) regions of the Northern Territory is the supply of environmental services. In the marine environment, the services are primarily delivered through IPAs (see Section 4.3) and Aboriginal Rangers.

Aboriginal Ranger Groups perform a range of, among other things, marine conservation and resource management and enforcement activities. Additionally, some Ranger Groups have

⁶⁰ Altman, J. (2015), 'The quest for the good life: Kuniñjku perspectives', *Land Rights News – Northern Edition*, April 2015, Edition 2, Northern Land Council, Darwin

fee-for-service arrangements with the Commonwealth and/or Northern Territory Governments or industry for specific service provision such as quarantine enforcement or environmental survey. Moves are underway to expand the role of Aboriginal Sea Rangers to include fisheries enforcement and related work and many communities are eager to see local Ranger Groups used more extensively to replace non-Indigenous environmental service providers operating in remote areas on Aboriginal lands.

Table 6 lists Aboriginal Ranger Groups that are active in the Northern Territory marine environment.

Ranger Group	Ranger Group
Thamarrurr Rangers	South East Arafura Rangers
Bulgul Land and Sea Rangers	Gumurr Marthakal Rangers
Tiwi Islands Marine Rangers	Dhimurru Rangers
Garngi Rangers	Yirralka Rangers
Mardbalk Marine Rangers	Anindilyakwa Rangers
Djelk Rangers	Numbulwar Numburindi Amalahgayag Injung Rangers
Crocodile Islands Rangers	Li-Anthawirriyarra (Boorooloola) Sea Rangers
Wanga Djakamirr Rangers	Yugul Mangi Rangers
Gurruwilling Rangers	

TABLE 6 – NORTHERN TERRITORY COASTAL ABORIGINAL RANGER GROUPS

3.2.3. Economic Participation

Generally speaking, there is growing interest among coastal Aboriginal people to engage in enterprise and there is evidence that entrepreneurial capacity is increasing. For example, 80 Office of the Registrar of Indigenous Corporations (ORIC) Top 500 Aboriginal Corporations are domiciled in the general area of interest, namely Arnhem Land and Groote Eylandt, and Top End and Tiwi Island Areas. While this sample includes hinterland as well as coastal-based enterprise, these Top 500 Aboriginal Corporations account for 16 percent of all ORIC Top 500 Aboriginal Corporations and have current annual income well above the national average of \$3.8 million. This is summarised in Figure 16⁶¹ below. ORIC Top 500 companies in Arnhem Land and Groote Eylandt have the highest average income of all regions across Australia.⁶²

⁶¹ Office of the Registrar of Indigenous Corporations (2017) *The Top 500 Aboriginal and Torres Strait Islander Corporations 2015-16*, Australian Government, Canberra

⁶² Ibid

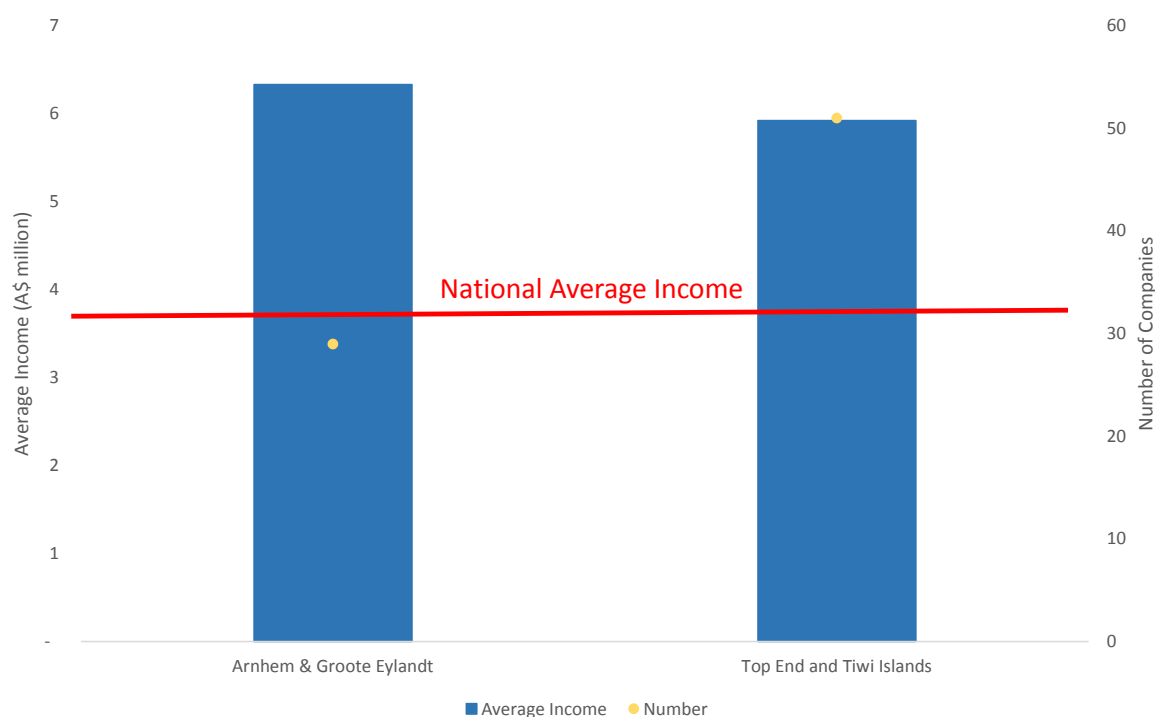


FIGURE 16 – TOP 500 OFFICE OF THE REGISTRAR OF INDIGENOUS CORPORATIONS DOMICILED IN PROXIMITY TO COASTAL AREAS OF THE NORTHERN TERRITORY (2016)

It is highly likely that coastal Aboriginal communities will increasingly seek to appropriate economic value from the marine resources that are in their control.

3.3. Aboriginal Interests in Marine Science Research

Before discussing specific marine science knowledge needs of Aboriginal owners, custodians and stakeholders in the Northern Territory marine environment it is important to understand both the role that conventional marine science plays in decisions made by Aboriginal people and the need to fully involve Aboriginal people in the process that generates marine science knowledge. This is discussed in the following subsections.

3.3.1. Knowledge to Inform Decision Making Generally

Like all other landowners, Traditional Owners seek access to the best information available to optimally inform decisions on issues such as those pertaining to caring for country, community safety, fostering and adopting rewarding livelihoods and exploring and capitalising on commercial opportunity. At the most general level, better and more accessible marine science knowledge will facilitate sound and timely decision making in this regard.

3.3.2. A Component of a 'Fully Informed' Decision

In accordance with various laws relating to development and infrastructure on Aboriginal and Native Title land, project proponents and government must consult with, or have consent from, Traditional Owners. Land rights law requires that Aboriginal landholders and communities understand the nature and purpose of a development or infrastructure proposal, the effects the development activities will have on their lands and seas, and likely effectiveness and implications of methods proposed to minimise adverse impacts that might arise from the proposed development. In other words, project proponents and governments are required to

attain informed consent from Traditional Owners prior to proceeding with projects or infrastructure development on Aboriginal and Native Title lands.

Without relevant and accessible information on benefits and risks associated with development, especially potential impacts on country and prospects for active local involvement, Traditional Owners cannot make fully informed decisions or give free and informed consent to projects under the law. Better and more accessible relevant marine science knowledge helps Traditional Owners to make an informed assessment as to whether consent should be provided.

3.3.3. Aboriginal People Have Considerations Other Than Formal Science

While Indigenous and non-Indigenous people share interest in and needs for high-quality marine science information, the premise underlying these interests and needs may be different.

Formal science is valued by Aboriginal people, but not necessarily regarded as the only or best source of information for good decision making with respect to maintaining natural and heritage values or allowing Aboriginal people to draw optimal benefits from resource use. This means that:

- Industry, government and non-government organisations, including research organisations, cannot assume that the returns they desire to extract nor the values they desire to protect are equally important to Aboriginal owners or right holders;
- Trade-offs that are acceptable in other situations may not be acceptable in some Aboriginal settings;
- Preferred approaches and methods for extracting benefits and/or reducing costs or impact on natural or cultural heritage may differ;
- Offering opportunity for Aboriginal people to choose among research questions or priorities assembled within an orthodox scientific and resource management framework may address few of their interests or concerns; and
- The values requiring protection are not necessarily the same as those recognised in formal statements of natural and heritage value.

3.3.4. Participation in the Full Research Process

It is essential that Traditional Owners influence the direction of scientific research and the way it is presented by being recognised as key end users of science. It follows from the above subsections that the only equitable and effective way of managing gaps and differences between Aboriginal and non-Aboriginal weighting and interpretation of science is to engage closely with Aboriginal owners and managers in all aspects of problem framing, research design, conduct of research and its interpretation and implementation of responses.

3.3.5. Protocols for Engagement with Aboriginal People in Scientific Research

The basis of all collaboration must be an awareness of different systems of knowledge and avoiding simplistic assumptions about shared understandings that may exist between groups. All collaboration must be grounded in a mutual respect for the different knowledge systems and values that coexist in this context.

In the context of cross-cultural research, the underlying partnerships and processes adopted in the conduct of projects are of critical importance. This must be underpinned by proper engagement frameworks for best practice collaborative research. Some key principles for engaging Aboriginal people in this regard include:

- Know and respect local rights, interests and aspirations;
- Wherever possible, engage people in the research agenda;
- Discuss the value and legacy of research for the respondents and their communities;
- Deliver useful information, explaining the context in which that information will be used and how it will be useful;
- Use the opportunity to employ local Aboriginal people and to transfer skills;
- Respect local timeframes in decision making and delivery;
- Make sure the project is engaging the right people for the right country;
- Manage expectations; and
- Use local language or parlance.

The additional demands that these expectations place on research providers and on the communities in which researchers seek to work must be acknowledged. All research tasks, including those ostensibly directed at entirely biophysical questions, will require a socio-cultural overlay, arguably best addressed through action research methods. At least one member of the research team should have responsibility to optimise enduring benefits to participating communities from collaboration and to document the research process, reflecting on ways to improve it.

3.4. Key Issues and Marine Science Knowledge Needs

The following subsections describe the key issues that the specific marine science knowledge needs identified by the limited consultation undertaken by NAILSMA revolve around. Table 7 provides details of specific marine science knowledge requirements that have been identified.

3.4.1. Causes of Coastal Vegetation Dieback

Recent incidence of Mangrove and Paperbark (Ti Tree) dieback along the northern Australian coastline are of concern to Aboriginal interests in the marine estate. Understanding the potential impact of these events and their causes is key to understanding the sustainability of livelihood, and commercial and cultural interests that are dependent on the ecosystems they support.

3.4.2. Knowledge to Support Sustainable Harvest

Many coastal Aboriginal communities sustainably harvest eggs from the nests of various seabirds for the purposes of the customary economy. Increased access to some islands that host seabird nesting areas (see Appendix 3) is raising concerns that harvests may be compromising the sustainability of the resource.

3.4.3. Population Baselines, Pressures on Key Species and Management Frameworks

There are several marine species that are of key importance to Aboriginal communities from a customary economy, environmental, livelihood and commercial perspective. Understanding issues affecting these species is important for obligations to country and sustaining these interests. Improved frameworks for managing these species that take into account Aboriginal interests are also required.

Several additional marine and coastal animals including seahorses, hermit crabs, curlews and the Atlas Moth were discussed during consultations. However, these were identified as being of interest largely due to current or previous externally driven research collaborations, rather than because of any cultural significance attached to the species. As such, it would not be appropriate to assign priority to these species over others. This reflects the difficulty of prioritising interests given the great variation in exposure of communities to research issues and options, based as it is on idiosyncratic interactions with external agendas rather than comprehensive planning that is designed to meet local needs.

3.4.4. Habitat Status, Pressures and Management Frameworks

The health of and pressures on habitats that support species that are important from a customary economy, environmental, livelihood and commercial perspective is of equal importance and is fundamental to ensuring the sustainability of those species. Key habitats of concern include coral reef, benthic and coastal habitats, including the influence of water quality and other factors on the health of these habitats.

3.4.5. Biosecurity Threats

The potential introduction of exotic organisms through vectors such as ballast water and the hulls of visiting vessels potentially places marine environmental values and resources that are of importance to Aboriginal communities at risk. Understanding this threat and effective mitigation measures is important for protecting these interests.

3.4.6. Impacts of Large Anthropogenic Disturbance

Understanding the impact of large-scale anthropogenic disturbances on the local and regional marine environment, as well as cultural assets is of key importance. Such disturbances include current and future terrestrial minerals extraction and irrigated agriculture, as well as potential future disturbances such as shale oil and gas extraction and subsea mining.

3.4.7. Adequacy of the Marine Conservation Estate

The declaration of significant areas of marine conservation reserves is a relatively recent initiative in the Northern Territory marine environment. Ensuring that these areas adequately protect marine environmental values that are of importance to Aboriginal people as well as important cultural values is of paramount importance.

3.4.8. Communication and Governance of Aboriginal Interests in the Marine Estate

Both statute and case law discussed in Section 3.1 is providing Traditional Owners with an increasingly strong legal basis from which to prosecute their custodianship, customary economy, livelihood and commercial interests in the Northern Territory marine environment. This is a relatively new and evolving paradigm for both Aboriginal communities and other users of the Northern Territory marine environment to navigate and come to terms with.

Achieving widespread and better understanding of Aboriginal rights to the marine estate and resources will assist and clarify the process of seeking access to Aboriginal controlled waters for industry and recreational fishers and other industry. Further, protection of cultural heritage values and understanding the importance and role of traditional knowledge in decisions pertaining to Aboriginal controlled and adjacent waters across the broader Northern Territory

community is of paramount importance. The impact of unauthorised access to sacred sites is a key concern common to all users of the coastal environment.

Social science that leads to effective governance arrangements and processes regarding these issues, as well as effective communication of these issues and those arrangements and processes will become increasingly important if the full potential of the Northern Territory marine resource is to be realised.

3.4.9. Employment Opportunities and Enterprise Development

Aboriginal people are eager to develop and sustain livelihoods and/or commercial enterprise that revolve around marine resources and their interests in marine resources. However, there are several challenges that need to be overcome, particularly with respect to developing commercial opportunities. These include developing specific 'employable' skills, building entrepreneurial and management capacity, accessing adequate infrastructure, including that which provides access to markets, and removing regulations that are serving as unnecessary barriers to the deployment of new enterprise models in Aboriginal communities.

3.4.10. Aboriginal Environmental Services Sector

Coastal Aboriginal communities are eager to see the localised Aboriginal environment services sector operating in their region grow and become increasingly effective at conserving and managing the sustainable development of marine resources on local sea country. For this to be achieved, a range of marine science knowledge needs specific to this sector are required.

Key Issue	Description	Specific Marine Science Needs
COASTAL VEGETATION DIEBACK		
Mangrove Dieback	<p>As discussed in Section 2.1.4, mangrove forests perform critical functions in the Northern Territory marine environment and in climate regulation more generally. In addition to these functions, the destruction of mangroves influences the customary economy and community livelihoods that are dependent on the ecosystems those mangroves support. The precise cause of mangrove dieback is not understood but is suspected of being the result of climate change, changes in sedimentation, damage caused by boats and/or other forms of pollution. This issue is of particular concern to communities in the Darwin Harbour Area and Borrooloola.</p>	<p>Understanding the extent and severity of current and future likely change to mangroves.</p> <p>Understanding the causes of changes to mangrove forests.</p> <p>Understanding the impact of current and likely future resulting change in carbon stocks.</p>
Paperbark (Ti-tree) Dieback	<p>Coastal landscapes and ecosystems around some communities are dependent on healthy Paperbark Tree populations. Increased intrusion of saline waters and rising sea-levels are affecting the health of some of these populations. This is of particular concern to communities around Borrooloola and Darwin</p>	<p>Understanding causes of change to Paperbark Tree populations on the Northern Territory coastline.</p>
KNOWLEDGE TO SUPPORT SUSTAINABLE HARVEST DECISIONS		
Harvest of Seabird Eggs	<p>The customary economy of some Aboriginal communities includes the harvesting of eggs from the nests of various species of seabird. Obligations to care for country, demand that this practice is undertaken in accordance with principles of sustainability. Increased access to some of the islands where various species of seabird nest, is</p>	<p>Understanding and quantifying the extent of current harvest activity.</p> <p>Defining the level of sustainable harvest.</p>

Key Issue	Description	Specific Marine Science Needs
	<p>raising concerns that the harvest may increase to unsustainable levels, placing at risk obligations to country. This issue is of particular concern to the Maningrida community.</p>	
POPULATION BASELINES, PRESSURES ON KEY SPECIES AND MANAGEMENT FRAMEWORKS		
Marine Mammals	<p>Marine mammals perform an important role in the customary economy and are a major focus of caring for country for many Aboriginal communities. There is increasing concern that port development and operations, commercial fishing activity, increased and unregulated vessel traffic, defence operations and marine noise (including seismic noise) is placing adverse pressure on marine mammal populations, principally because of dredge spoil and footprint, boat strike, pollution generally and as by-catch. This issue is of particular concern to communities in the Darwin Harbour Area.</p>	<p>Abundance, distribution and structure of marine mammal populations.</p> <p>Extent of changes in marine mammal populations and causes of those changes.</p>
Marine Turtles	<p>Marine turtles are a valuable customary resource and are also central figures in the cultural landscape. As such, they are a major focus of caring for country for many Aboriginal communities. There is increasing concern that commercial fishing and increased unregulated vessel traffic is placing pressure on populations of marine turtles, primarily through by-catch and boat strike. This issue is of particular concern to communities in the Borroloola (southwestern Gulf of Carpentaria) region and Tiwi Islands.</p>	<p>Abundance, distribution and structure of marine mammal populations.</p> <p>Incidence and cause of mortalities.</p> <p>Identification of nesting areas and behaviours.</p>

Key Issue	Description	Specific Marine Science Needs
Shellfish	<p>Various species of shellfish, including Mud Muscles, are important to the customary economy and are a focus of caring for country. Ensuring that various species are fit for human consumption is also important from a human health perspective. The potential for pollution to affect both the population of these species of shellfish as well as their suitability for human consumption (i.e. toxicology) is of key concern to many coastal Aboriginal communities. Furthermore, species whose habitat is the shoreline are subject to increased predation from invasive species such as Feral Pigs. This issue is of particular concern to communities in the Darwin Harbour Area.</p>	<p>Abundance, distribution and structure of important shellfish populations.</p> <p>Extent of changes in important shellfish populations and causes of those changes.</p> <p>Human health risk assessments of important shellfish populations.</p>
Mud Crab	<p>Mud crabs perform an important role in the customary economy and livelihoods for many coastal Aboriginal communities. There is concern that over-harvest and failure to observe size and other restrictions may be influencing the abundances of Giant Mud Crabs and Orange Mud Crabs. This issue is of particular concern to communities in the Darwin Harbour and Borroloola Areas.</p>	<p>Assessment of the current mud crab fishery management framework and efficacy of enforcement of that framework.</p> <p>Development of options for improved regulatory systems and compliance performance measurement with respect to the mud crab fishery.</p>
Finfish	<p>A wide range of marine finfish species are important to the customary economy and livelihood of all coastal Aboriginal communities. There is concern that over-harvest and bycatch discards that are the result of some commercial harvest methods and increased fishing tourism (including through fishing charter operations) may be impacting the sustainability of populations of some finfish species. This issue is of particular concern to</p>	<p>Assessment of the quality of current resource allocation and other fishery resource management prescriptions.</p> <p>Assessment of the nature and quantum of by catch.</p>

Key Issue	Description	Specific Marine Science Needs
Salt Water Crocodiles	<p data-bbox="696 268 1442 331">communities in the Maningrida, Borroloola, Darwin Harbour, Nhulunbuy and Tiwi Island Areas.</p> <p data-bbox="696 411 1442 738">The Salt Water Crocodile is important for the livelihood of many coastal Aboriginal communities and is also a threat to human safety for some communities where there are large number of Salt Water Crocodiles in proximity to the community. In some areas, over-abundance of animals is resulting of intrusion of crocodiles into human population centres from natural areas of high crocodile density, presenting a risk to human safety. This issue is of particular concern to communities in the Darwin Harbour Area.</p>	<p data-bbox="1469 268 2033 371">Development of options for improved allocations, regulatory systems and performance measurement.</p> <p data-bbox="1469 411 2033 738">Assessment of options for the transfer of management responsibility and systems to Aboriginal interests where crocodile populations present a human safety risk, so that Salt Water Crocodile populations can be effectively managed in accordance with the demands for livelihoods based on crocodile products and customary practice.</p>
HABITAT STATUS, PRESSURES AND MANAGEMENT FRAMEWORKS		
Coral Reefs	<p data-bbox="696 855 1442 1222">Coral reefs that are characteristic of the Northern Territory marine environment (see Section 2.1.6) are in themselves important for the customary economy and provide habitat for other species that are important for the customary economy and livelihoods for a number of coastal Aboriginal communities. There is concern that rising seawater temperatures associated with climate change are causing degradation and destruction of these coral reefs. This issue is of particular concern to communities around Maningrida.</p>	<p data-bbox="1469 855 2033 919">Understanding the extent and severity of degradation and destruction of coral reefs.</p>
Benthic Topography and Habitats	<p data-bbox="696 1262 1442 1366">Benthic environments in the Northern Territory marine environment provide habitats for a wide range of species and perform an overall important role in the food chain for</p>	<p data-bbox="1469 1262 2033 1366">Development of a benthic topography and habitat baseline in Darwin Harbour and understanding causes of change.</p>

Key Issue	Description	Specific Marine Science Needs
Marine Water Quality	<p>various species. Aspects of the benthic topography in Darwin Harbour also have important cultural heritage significance. There is concern that changing sea-levels associated with climate change and the impacts of development are altering the benthic environment and topography in Darwin Harbour.</p>	<p>Identification and quantification of risks associated with chronic and catastrophic pollution.</p> <p>Options for reducing risks and improving monitoring and reporting systems.</p> <p>Understanding the specific risks that pertain to continued access to important marine resources for customary purposes.</p>
Coastal Land Condition	<p>The importance of maintaining coastal lands in a condition that supports habitat and breeding functions for a wide range of wildlife and perform carbon storage</p>	<p>Understanding and quantifying the impact of feral animals on habitat condition and</p>

Key Issue	Description	Specific Marine Science Needs
	<p>functions is important for the customary economy and livelihoods of most coastal Aboriginal communities. The threat of feral animals and enterprise that is incompatible with maintaining coastal lands in suitable condition is of increasing concern. This issue is of particular concern to the communities in the Maningrida Area.</p>	<p>carbon storage capacity associated with coastal land condition.</p> <p>Understanding the extent to which certain enterprise is incompatible with maintaining coastal land condition.</p>
BIOSECURITY THREATS		
Introduction of Exotic Organisms	<p>The potential introduction of exotic marine pests has the potential to adversely affect marine resources that are important to the customary economy, livelihoods and commercial enterprise of all coastal Aboriginal communities. There is increasing concern that vectors such as ballast water from and hulls of increasing vessel traffic between Asia, the east coast of Australia and the Northern Territory marine environment increases the risk of the introduction of exotic organisms. This issue is of particular concern to communities in the Darwin Harbour Area.</p>	<p>Assessment of the risks associated with the current regulation pertaining to the monitoring and control of the potential introduction of exotic pests and enforcement of that regulation.</p> <p>Recommended improvements to frameworks and enforcement, including a defined role for Aboriginal Ranger Groups.</p>
IMPACT OF LARGE-SCALE ANTHROPOGENIC DISTURBANCES		
Impact of Large-scale Physical Disturbance of Marine Landscapes	<p>Human health and the sustainability of customary economies and obligations for caring for country all require confidence that any large-scale disturbance to the marine environment does not compromise customary economies or the ecosystem more generally. There is increasing concern that potential future shale oil and gas extraction, seabed mining and terrestrial mining activity could result in loss of access to country or breaking of</p>	<p>Understanding options for reducing risk and impacts associated with large-scale physical disturbances, including risks of chronic and acute affects.</p> <p>Design and implementation of monitoring and reporting systems to assess the impacts of large-scale disturbances.</p>

Key Issue	Description	Specific Marine Science Needs
Impact of Long-term Infrastructure in the Marine Environment	connections in cultural landscapes (such as interruption of songlines) and compromise sustainability more generally. This issue is of particular concern to communities in the Borroloola Area.	Understanding the impact of large-scale disturbances on continued access for customary purposes.
	The sustainability of customary economies and obligations for caring for country require confidence that long-term infrastructure that has the potential to impact on the marine environment does not compromise customary economies or the ecosystem more generally. This issue is of particular concern to communities on the Tiwi Islands.	Ensuring that environmental and social impact studies undertaken for the approval of long-term marine-oriented infrastructure are undertaken rigorously using the best available marine science and in consultation with the affected Aboriginal communities.

ADEQUACY OF THE MARINE CONSERVATION ESTATE

Efficacy of the Marine Conservation Estate	Protection of the customary economy and livelihoods of Aboriginal coastal communities requires that the marine conservation estate adequately protects those interests and that Aboriginal people participate significantly in decisions pertaining to the boundaries and management of the marine conservation estate. There is concern that ongoing loss of ecosystem services and cultural values from the Northern Territory marine environment is a result of limited participation of Aboriginal people in decisions pertaining to the marine conservation estate. This issue is of particular concern to communities in the Darwin Harbour Area.	Understanding and defining the role of marine reserves in maintaining ecological and cultural values.
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Key Issue	Description	Specific Marine Science Needs
COMMUNICATION AND GOVERNANCE OF ABORIGINAL INTERESTS IN THE MARINE ESTATE		
Observance of Aboriginal Rights	While they are enshrined in legislation and articulated in various agreements with government and industry, there remains poor wider public and agency understanding of Aboriginal rights as far as they pertain to the Northern Territory marine environment. This leads to conflict between Aboriginal right holders and other users of the marine environment and challenges to the actions of others. This issue is of particular concern to communities in the Darwin Harbour and Tiwi Islands Areas.	Clarification of existing and emerging Aboriginal and non-Aboriginal user rights and methods for effectively communicating those rights to the wider community.
Integration of Traditional Knowledge in Decision Making	There is a lack of recognition of the value of traditional knowledge among the wider community, leading to a lack of its application in decisions pertaining to the management of the Northern Territory marine environment. The exclusion of Sea Rangers and those with traditional knowledge in decision making is resulting in compromised management outcomes and rejection by Aboriginal communities of management prescriptions that exclude IEK. This issue is of particular concern to communities in the Nhulunbuy and Groote Eylandt Areas.	Optimisation of systems for joint application of IEK and formal science in decision making pertaining to the management of the Northern Territory marine environment.
Arresting and Reversing Progressive Alienation from Country	Increased urbanisation is restricting the ability of Aboriginal people to maintain connection to country, including sea country. The absence of a formal role for Traditional Owners in land-use planning is eroding rights and opportunities in this respect.	Development of options for assertion of influence over use of country in land-use planning and development more generally.

Key Issue	Description	Specific Marine Science Needs
Customary Access to Country	The customary economy and exercising of Native Title rights and obligations requires that Traditional Owners have access to country for customary purposes. Land-use planning activities that give effect to such things as foreshore closures and pollution of creeks restrict these rights. This issue is of particular concern to communities in the Darwin Harbour Area.	Exploration into legal issues in Native Title and exclusions and chronic losses of customary land use.
Fishing and Other Access to Aboriginal Lands and Seas	Cultural obligations to lands and seas and the maintenance of the customary economy and community livelihoods require that Aboriginal people can protect and enforce their interests in the Northern Territory marine environment. Unauthorised access to Aboriginal waters and lands from commercial, recreational and/or fishing tourism operators results in gross offence, loss of trust and confidence in management authorities and fishers and an unwillingness to grant further access. Furthermore, it can result in damage and other violations of sacred sites, other illegal activity such as taking of wildlife or discarding fishing gear and further conflicts between interests in the fishery. The same concern applies to entry to Aboriginal lands and seas for purposes other than fishing. This issue is of particular concern to communities in the Galiwin'ku, Borrooloola, Maningrida, Darwin Harbour, Groote Eylandt and Tiwi Islands Areas.	Exploration of options for the redesign of laws and approaches to enforcement of access prescriptions and education of users of the marine resource.
Preservation of Cultural Heritage in Sea Country	The Northern Territory marine environment hosts significant cultural heritage values for Aboriginal people. Traditional Owners and Sea Rangers have important roles to perform in preserving these cultural heritage values. A lack of	Identification of approaches to devolution of enforcement powers to local Aboriginal communities.

Key Issue	Description	Specific Marine Science Needs
	<p>recognition and respect for these values by the wider community can result in damage to sacred sites and can create at least a perception of weaker enforcement. This issue is of particular concern to communities in the Maningrida, Borrooloola, Nhulunbuy, Tiwi Islands and Darwin Harbour Areas.</p>	<p>Identification of methods for improved protection of archaeological sites.</p> <p>Consultation with all stakeholders to manage perceived key threats to sacred sites from commercial and amateur fishing, seabed mining, seismic surveys and pollution.</p>
<p>Aboriginal Influence over Fisheries Management</p>	<p>Obligations to country and culture, and maintenance of the customary economy and livelihoods in coastal Aboriginal communities requires that Aboriginal people influence the management of Northern Territory fisheries. Inadequate influence over the management of Northern Territory fisheries is resulting in insufficient awareness or respect for Aboriginal views and interests, competition of licence holders with local initiatives and poor and politically oriented fishery resource allocation decisions. In turn, this leads to gross offence, loss of trust and confidence in management authorities and fishers and an unwillingness of Aboriginal people to grant fishers access to Aboriginal controlled waters. This issue is of particular concern to communities in the Borrooloola, Tiwi Island, Groote Eylandt and Darwin Harbour Areas.</p>	<p>Identification of new systems for fisheries governance that provide for increased Aboriginal participation in decision making, including options for the redesign of fisheries management bodies to include Aboriginal participation and overall fisheries law reform.</p>
<p>EMPLOYMENT OPPORTUNITIES AND ENTERPRISE DEVELOPMENT</p>		
<p>Spatial Mapping of Opportunities in Sea Country</p>	<p>Spatial mapping of sea country to determine areas that are suitable for commercial development such as new commercial fisheries and aquaculture, taking into consideration marine science baselines, IEK, cultural</p>	<p>Development and integration of baseline, IEK and cultural datasets to identify potential</p>

Key Issue	Description	Specific Marine Science Needs
	<p>knowledge and an understanding of pressures on environmental and cultural values. This issue is particularly important for groups on Groote Eylandt.</p>	<p>areas of sea country suitable for commercial development.</p> <p>Understanding of the various pressures on environmental and cultural values in sea country, the likely impact of those pressures on those values and the resilience of those values to those pressures.</p>
<p>Role of Aboriginal People in Survey and Monitoring</p>	<p>Surveying and monitoring activity in the Northern Territory marine environment is likely to increase. From a community well-being and social cohesion perspective, the engagement and employment of local communities in this activity is highly desirable. However, few opportunities for engagement through the application of skills and values pre and post development are made available to local communities, resulting in reduced employment and enterprise opportunities in communities and inadequate pathways for other employment. This issue is particularly important for communities in the Darwin Harbour, Groote Eylandt and Nhulunbuy Areas.</p>	<p>Improving governance structures for the design and implementation of marine survey and monitoring.</p> <p>Assessment of policy options designed to create employment and enterprise opportunities for coastal Aboriginal communities in marine survey and monitoring such as procurement policy.</p>
<p>Role of Aboriginal People in Research</p>	<p>From a social cohesion and human health perspective, participation and employment associated with conducting scientific research is highly desirable for many coastal Aboriginal communities. However, there are limited pathways presented to these communities. This issue is particularly important for communities in the Groote Eylandt and Maningrida Areas.</p>	<p>Identification of optimal approaches for building on benefits of engagement in research to expand the range of opportunities.</p>

Key Issue	Description	Specific Marine Science Needs
Aboriginal Participation in Commercial Wild-catch Fisheries	While many existing commercial fisheries are in conflict with the customary economy, Aboriginal participation in commercial wild-catch fishing can be compatible with cultural obligations. Poor access to capital, stigma attached to past failures, limited capacity and exclusion from serious consideration in fishery resource allocation decisions work to restrict opportunity for Aboriginal people to acquire commercial fishing interests. This issue is of particular interest to Aboriginal communities in the Galiwin'ku and Tiwi Islands Areas.	<p>Identification of improved models for Aboriginal engagement in commercial fishing.</p> <p>Identification of business structures for small-scale geographically bounded enterprises.</p> <p>Identification of options for Aboriginal fishing cooperatives.</p>
Aboriginal Aquaculture	Aquaculture is consistent with the needs of the customary economy. However, inadequate infrastructure to support aquaculture operations in many coastal communities and a skills base in many communities that is not suited to managing intensive aquaculture systems, together with stigma associated with a history of failed aquaculture enterprises, act as a hindrance to aquaculture development in many coastal Aboriginal communities. There is also a need to identify potential commercial species that are aligned with the aspirations of communities. These issues are of particular interest to communities in the Maningrida, Groote Eylandt and Darwin Harbour Areas.	Identification of models for low intensity and low technology methods of aquaculture production that are based on management of natural systems and focus on species that are aligned with the aspirations of the community.

ABORIGINAL ENVIRONMENTAL SERVICES SECTOR

Informative and Cost-effective Metrics for Biophysical (Including Biodiversity), Social and Cultural	Review of existing systems and design and testing of new systems.	Metrics relevant to off-site impacts of action in terrestrial and freshwater environments
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Key Issue	Description	Specific Marine Science Needs
Products of Payments for Ecosystem Services (PES) schemes		considered relevant by Aboriginal and other community interests.
Proper Recognition of Indigenous Interests and Values	Criteria and frameworks for recognising Indigenous values in PES products.	Metrics and associated methods designed explicitly to demonstrate that PES products are compatible with Indigenous obligations to sea country.
Developing New Carbon Management Methods	Methods for generating and accounting for carbon benefits of management interventions.	Investigating plausibility and carbon benefits of enhancing carbon storage in marine systems (e.g. restoring degraded mangroves).
Development of a Northern Territory Environmental Offsets Industry	Reconcile Northern Territory products and metrics for offset benefits with existing and emerging policy and practice in local, interstate, national and international offset regimes and markets.	Specific attention to options in marine environments.
Framework for Diversification of Activity on Large Indigenous and Pastoral Estates to Include Commercial Delivery of Ecosystem Services	Viable options, regulatory systems and policies for multiple use of large sites to maintain or enhance (marketable) ecosystem/environmental services.	Frameworks and criteria for recognising environmental services in landscapes with direct and indirect connections to marine systems, and design principles for optimising regulatory settings to expand commercial options available in production landscapes.

TABLE 7 – KEY MARINE SCIENCE KNOWLEDGE NEEDS OF A SELECTION OF COASTAL ABORIGINAL COMMUNITIES

4. Northern Territory Marine Conservation Estate

The Northern Territory marine conservation estate includes a limited area of Northern Territory marine parks, coastal reserves and IPAs, and a relatively extensive network of Commonwealth Marine Parks. Different levels of access and activity are allowed in different areas of this marine conservation estate.

The individual conservation areas are designed to protect specific threatened species and ecosystems and identified important Aboriginal cultural marine values. They are also designed to ensure that a connected network of ecosystems that are representative of those that are characteristic of the Northern Territory marine environment are preserved.

Each of these conservation areas is briefly described in the following subsections. The marine science knowledge needs of the managers of this marine conservation estate are discussed in Section 5.

4.1. Commonwealth Marine Parks

Commonwealth Marine Parks are organised into eight groups, aimed at establishing a representative network of protection encompassing species, ecosystems, sites of special significance and known ecological relationships between these variables under the National Representative System of Marine Protected Areas.⁶³

There are six Commonwealth Marine Parks located in the Northern Territory marine environment, two of which (Oceanic Shoals and Joseph Bonaparte Gulf) also extend into waters off Western Australia. It is worth noting that while the Limmen Marine Park has been declared, the ongoing process of setting management plans discussed further below means that at present the Limmen Marine Park is not actively managed.

As illustrated in Figure 17⁶⁴ (which shows the original zoning of the Commonwealth Marine Parks), these reserves form part of the larger North Network of the Commonwealth conservation estate.

⁶³ *Australian Marine Parks (Commonwealth Marine Reserves)*, published Cth DoEE, available www.environment.gov.au

⁶⁴ Adapted from *North Network*, in *Australian Marine Parks (Commonwealth Marine Reserves)*, published Cth DoEE, available www.environment.gov.au

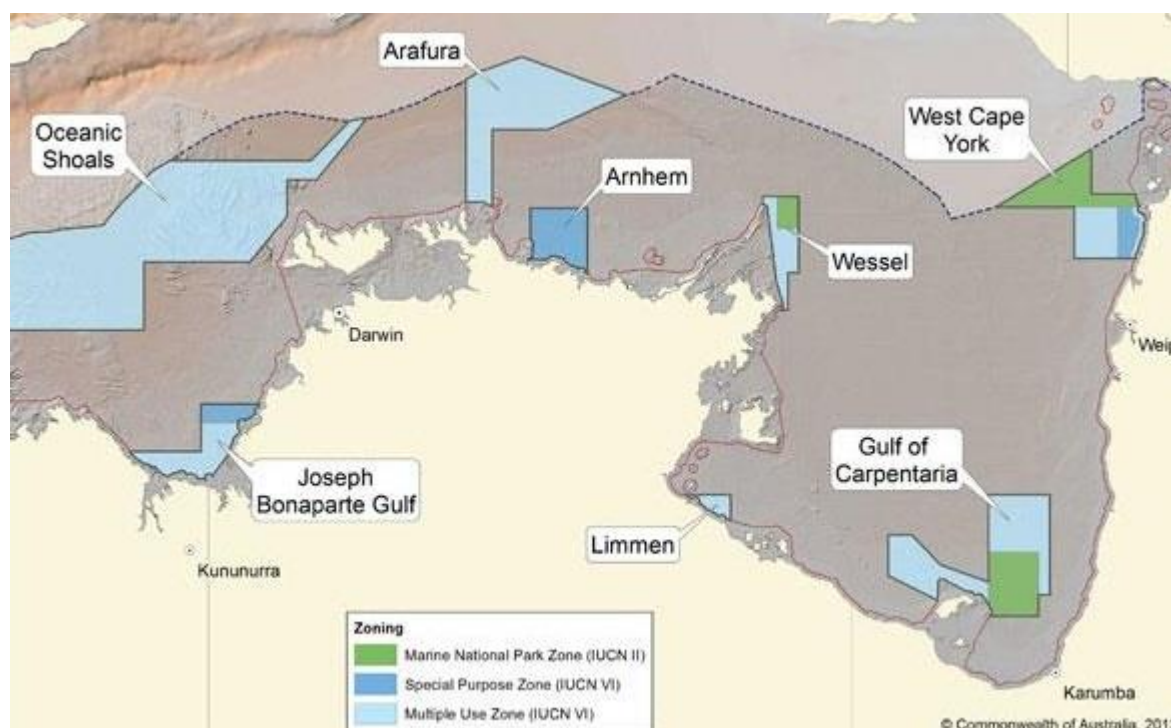


FIGURE 17 – NORTH NETWORK OF COMMONWEALTH MARINE PARKS – ORIGINAL ZONING

The 'North Network' is characterised by a diverse array of species dependent on the warmer waters of the Arafura Sea and the ITF, and a wide range of muddy, sandy and rocky habitats supporting corals, sponges and seagrass beds. A number of TEPS are found in the area, including the Snubfin Dolphin; Green, Flatback, Hawksbill and Olive Ridley Turtles; sawfish species; Dugong; sea snake species; a number of shark species; whale species, and large numbers of marine waterbirds (including the Common Noddy and Bridled, Roseate and Crested Terns). By protecting a range of representative ecosystems and bioregions representing breeding and feeding habitats for a variety of species, the North Network aims to increase the resilience of the overall marine environment, and reduce the susceptibility to natural and anthropogenic pressures such as cyclones, climate change and potential hydrocarbon spills.

The majority of these reserves are currently classed as 'multiple use zones' or Category VI under IUCN protection schemes.⁶⁵ This zoning, known as 'protected area with sustainable use of natural resources', applies to ecosystems and habitats that are associated with cultural (usually traditional) values and usage, together with natural resources management systems that allow sustainable non-industrial use of resources. Priorities in management are the balancing of ecological, social and economic dimensions, with a focus on inter-generational security of livelihood for local communities.⁶⁶ Most of the marine reserves in Australia are Category VI, reflecting the role that sustainable resource usage plays as a major source of employment and income in many local communities and, particularly in the Northern Territory, recognising the high degree of traditional Indigenous usage of the marine estate.

Since being declared in November 2012, the management and control of these Marine Parks has been in a state of flux. Existing and newly made widely permissive management plans

⁶⁵ www.iucn.org

⁶⁶ *Category VI: Protected area with sustainable use of natural resources*, published IUCN, available www.iucn.org

pertaining to these reserves were set aside in December 2013, with an ongoing review into the internal zoning and management arrangements (the Commonwealth Marine Reserves – ‘CMR’ – Review). In the meantime, transitional arrangements have applied, with no ‘on water’ changes restricting the current usage of the marine estate for any party.

Draft management plans were released by the Commonwealth in July 2017⁶⁷ following an in-depth process of parallel reporting by the Bioregional Advisory Panel (BAP), headed by the Commonwealth Department of Environment aiming to consult with stakeholders to identify concerns with the proposed zoning arrangements, and the Expert Scientific Panel (ESP) reviewing the marine science input into zoning and recommending future research priorities. After significant community consultation, the BAP report was finalised in late 2015⁶⁸ before being published in 2016, and recommended several changes to the proposed zoning, including a large increase in highly protected areas. Notably, the BAP was not empowered to respond to stakeholder input on the siting of the reserves, merely the internal zoning.⁶⁹ A key issue noted by the BAP was the desire of stakeholders for certainty, given the lengthy period that had elapsed since the initial declaration. A final decision either way would allow stakeholders to make such changes to their operations as were required, and allow either business or community investment to proceed, or for plans to wind-up and exit industry to be laid.

The EPS report was completed at around the same time⁷⁰ and provided its own expert commentary on the status and proposed changes to the system of Marine Parks in addition to informing the deliberations of the BAP. While the ESP was similarly not empowered to propose changes to the extent of siting, it provided a review of the adequacy and performance of the existing network of Marine Parks against key goals and outcomes. While the North Network in its current form was rated as providing ‘very good coverage’ of a range of different habitats, the ESP noted significant concerns with the level of protection provided. In particular, the North Network had the lowest proportion of areas zoned ‘Sanctuary’ or ‘Marine National Park’ of the whole Commonwealth network, an outcome the ESP rated as unsatisfactory given the importance of no-take zones in achieving the desired environmental outcome.⁷¹

The final proposed zoning for the North Network recommended by the expert reviewers is shown in Figure 18⁷² below.

⁶⁷ *Draft – North Network Management Plan 2017* (2017), published Australian Marine Parks, available <https://parksaustralia.gov.au>

⁶⁸ *Bioregional Advisory Panel Report* (2015), Buxton, C, Cochrane, P, published Department of Environment, available <https://parksaustralia.gov.au>

⁶⁹ *Ibid*

⁷⁰ *Bioregional Advisory Panel Report* (2015), Buxton, C, Cochrane, P, published Department of Environment, available <https://parksaustralia.gov.au>

⁷¹ Beeton, R. (2015), *Report of the Expert Scientific Panel*, Department of Environment, Northern Territory Government

⁷² Buxton, C., and Cochrane, P. (2015), *Bioregional Advisory Panel Report*, Department of Environment, Australian Government, Canberra

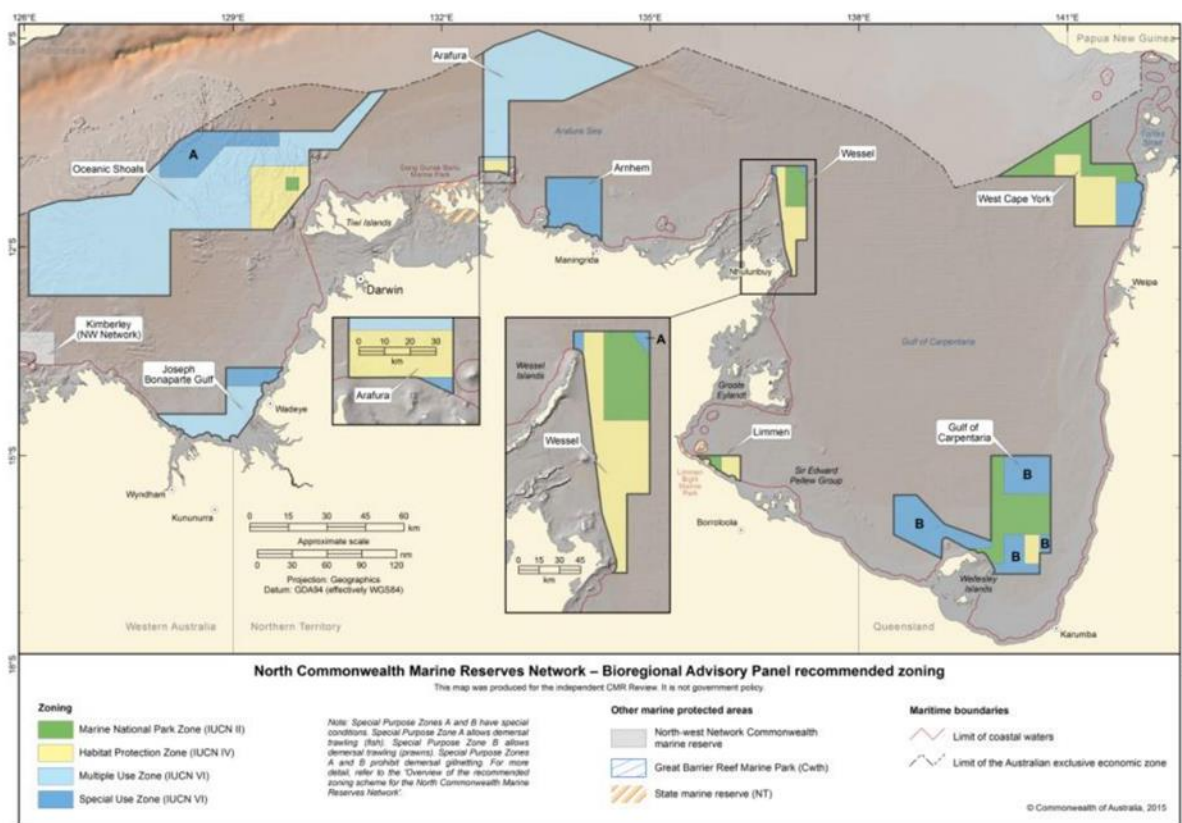


FIGURE 18 – COMMONWEALTH NORTH NETWORK – INDEPENDENT ADVISORY PANEL RECOMMENDED ZONING

Upon receipt of the ESP review, the Commonwealth Department of Environment produced draft management plans for the North Network, together with zoning changes. These are illustrated in Figure 19.⁷³ Broadly, the significant increase in areas zoned as Habitat Protection (IUCN Category IV) has been carried through. However, there is a reduction in the area given the highest level of protection (IUCN Category II). In the Northern Territory, significant new areas of higher protection are proposed for the Limmen and Oceanic Shoals Marine Parks, while the use of trawl gear is explicitly permitted in other – areas of high importance to the commercial fishery. The Wessel Marine Park loses its existing enclave of IUCN Category II status, which is instead opened to commercial trawling.

⁷³ Adapted from *Draft – North Network Management Plan 2017*, (2017), published Australian Marine Parks, available <https://parksaustralia.gov.au>

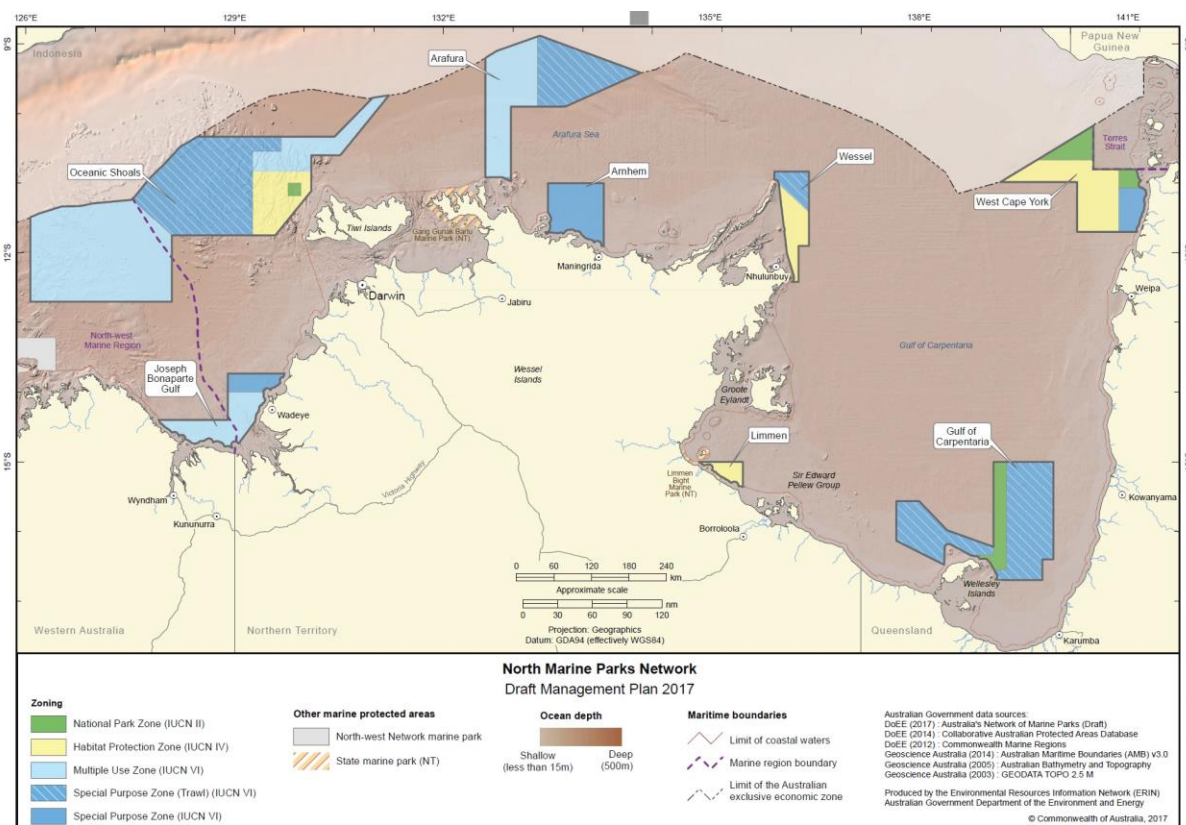


FIGURE 19 – COMMONWEALTH MARINE PARKS – PROPOSED DRAFT ZONING FOR THE NORTH NETWORK

The Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) modelling on the impact of these proposed changes to the commercial fishing industry,⁷⁴ examining the potential displacement to total catch, gross value of product (GVP) and flow of impacts to ports and regional economies, found the total impact of the proposed new restrictive zoning would be small. This is particularly true for fisheries based solely in the Northern Territory jurisdiction, with an estimated decline of 2.4 tonnes (82.8 to 80.4) of total catch for a loss of \$7,800 GVP (\$192,000 to \$184,200).⁷⁵ In comparison to the entire North Network, however, taking in fisheries also operating from Western Australia and Queensland, the proposed changes represent the second largest total drop in both catch and GVP, with a drop of 120.1 tonnes of catch for a reduction in GVP of \$1.3 million. This large disparity is a consequence of the small scale of the fishery in the Northern Territory and has implications for the ability of Territory fishing operations to scale in size.

It should be noted that a review of the ABARES study commissioned by the Commonwealth Fisheries Association⁷⁶ identifies several limitations with respect to a full and accurate assessment of the impact. In particular, the Commonwealth Fisheries Association commissioned study notes that the ABARES study does not consider costs associated with:

⁷⁴ Larcombe, J, and Marton, N (2017) *Potential displacement of commercial fisheries by a Commonwealth marine reserve zoning scheme: report on draft management zoning*, published ABARES, available <https://parksaustralia.gov.au>

⁷⁵ Table 4: potential commercial fisheries' catch and GVP displacement by jurisdiction for the 2012 and 2017 zoning, in *Potential displacement of commercial fisheries*, *ibid*

⁷⁶ Ernst & Young (2012), *Review of ABARE's Social and Economic Assessment of the Proposed Commonwealth Marine Reserves Network*, Commonwealth Fisheries Association.

- The loss of prospective revenues and earnings associated with current licences;
- The impacts on the downstream processing industry;
- The impacts on charter fishing, tourism and recreational fishing; and
- The costs of implementing the Marine Reserves Proposal, including enforcement costs.

Furthermore, the Commonwealth Fisheries Association commissioned report notes specific limitations with respect to the assessed impact on commercial fishers, namely:

- Only GVP displaced for a representative year is considered and a true measure of economic value needs to net off the associated production costs from GVP (i.e. the producer's surplus);
- No consideration of prospective impacts on producers' surplus, that is GVP foregone with the development of new fisheries or increases in production costs due to operational inefficiencies caused by the marine reserve;
- No consideration of the discounted present value of the future stream of impacts; and
- Any reduction in industry profits caused by the proposal will ultimately lead to a reduction on licence asset values.

The individual reserves that comprise the Commonwealth North Network that are in the Northern Territory marine environment, together with their respective zoning, management plan status, ecological features and conservation values are detailed in Appendix 4.

As part of the marine management strategy and ongoing performance monitoring, eight key ecological features (KEFs) are identified by the Commonwealth Government as occurring within the Northern Territory marine environment. In the context of marine bioregional plans, these are features that are critical for regional biodiversity, ecosystem function and integrity, both near the feature and in the context of the region as a whole. These include:

- Pinnacles of the Bonaparte Basin;
- Carbonate bank and terrace system of Van Diemen Rise;
- Shelf break and slope of the Arafura Shelf;
- Tributary canyons of the Arafura Depression;
- Gulf of Carpentaria Basin;
- Plateaus and saddle northwest of the Wellesley Islands;
- Submerged coral reefs of the Gulf of Carpentaria; and
- Gulf of Carpentaria coastal zone.

Appendix 7 contains details of the relevant Northern Territory KEFs.

4.2. Northern Territory Marine Parks and Coastal Reserves

The Northern Territory marine conservation estate also includes a number of marine parks and coastal reserves, most of which also include terrestrial protected areas that have been proclaimed in Northern Territory waters by the Northern Territory Government. The portfolio of the Northern Territory Government's marine conservation estate includes:

- Limmen Bight Marine Park;
- Garig Gunag Barlu/Coburg Peninsula National Park;
- Casuarina Coastal Reserve;
- Channel Point Coastal Reserve;
- Shoal Bay Coastal Reserve;
- Indian Island Conservation Area;
- Charles Darwin National Park;
- Tree Point Conservation Area;
- Vernon Islands Conservation Reserve;

- Melacca Swamp Conservation Area;
- Djukbinj National Park;
- Mary River National Park;
- Kakadu National Park;
- Barranyi National Park; and
- Finucane Island National Park.

These parks and reserves are described in detail in Appendix 5.

4.3. Indigenous Protected Areas

The final component of the Northern Territory marine conservation estate is comprised of IPAs. IPAs are areas of land and/or sea country voluntarily dedicated by Traditional Owners as non-legislated protected areas, recognised by all Australian governments as part of the National Reserve System of Protected Areas. IPAs are managed by Indigenous Rangers and partner organisations according to protected area guidelines of the IUCN.

IPAs are supported by the Commonwealth Government's Indigenous Protected Areas Program, which provides assistance in IPA planning and management, as well as many other government and non-government partners who share their expertise and resources to achieve the conservation and sustainability goals of the IPA.

There are seven IPAs in the Northern Territory marine environment, all of which also have a terrestrial component, namely:

- Marri-Jabin (Thamurrurr) Stage 1;
- Djelk;
- Dhimurru;
- Laynhapuy;
- Anindilyakwa;
- Yanyuwa (Barni-Wardimantha Awara);
- Marthakal Stage 1; and
- South East Arnhem Land.

These IPAs and their respective location, zoning, managing body, conservation values and permitted activities are detailed in Appendix 6.

5. Regulators of the Northern Territory Marine Environment

5.1. Policy Making Environment in the Northern Territory

As a Territory rather than a State of Australia, the Northern Territory only obtained most of the hallmarks of self-government relatively recently. Adopted as a Territory from the State of South Australia in 1910, the Territory was granted self-government in 1978 by the *Northern Territory (Self Government) Act 1978 (Cth)*. This Act functions in a similar manner to a State Constitution, but reserves some powers of government for the Commonwealth, including acquisition of land from the Territory and Indigenous land rights. In 2011, further important amendments to the Act were made by the Commonwealth Parliament,⁷⁷ which removed the ability of the Governor-General to, upon the advice of the Federal Executive, disallow or recommend alteration of a law of the Northern Territory.

Accordingly, the current situation is that the Northern Territory does not possess the power to legislate in relation to certain limited matters, but laws passed by the Northern Territory parliament may not be simply disallowed by the incumbent Federal Government. Importantly, the 'constitution' of the Territory remains ordinary law of the Commonwealth, and as such may be altered from time to time by the Commonwealth Parliament, which potentially has the effect of restricting the scope of authority of the Northern Territory in governing itself. As a matter of practicality, the Territory has been treated as a State for most purposes (including, importantly, financial matters and distribution of Commonwealth grants) since the late 1980s, and despite the failed statehood referendum in 1998, strong interest remains on the part of both the Commonwealth and the Northern Territory government to see the Northern Territory transition to full Statehood.

Consequently, the primary policy maker in relation to the Northern Territory marine environment is the Northern Territory Government, however, the Commonwealth Government remains an interested party, particularly in relation to those parts of the marine estate that touch on international or inter-state affairs. The reservation of powers relating to Indigenous land rights to the Commonwealth, as realised through the ALRA, means that the Aboriginal Land Trusts are and will remain critical stakeholders. Further, the potential for the Commonwealth to compulsorily acquire land without compensation (as happened relatively recently in 2005 with the acquisition of Northern Territory land for a radioactive waste dumping site⁷⁸) has the potential to impact marine estate usage, particularly with respect to matters such as expanding defence interests (bases and training areas), pursuing conservation objectives or other Commonwealth policy objectives.

⁷⁷ *Territories Self-Government Legislation Amendment (Disallowance and Amendment of Laws) Act 2011 (Cth)*

⁷⁸ *Commonwealth Radioactive Waste Management Act 2005 (Cth)*

5.2. Fisheries Regulators

5.2.1. Department of Primary Industry and Resources

Fisheries NT (Fisheries Group)

Fisheries matters, including commercial, customary and recreational fishing, fishing charters, aquaculture and pearling operations and conservation of fish species are subject to the jurisdiction of the *Fisheries Act 1988* (NT), which is administered by a division of the Northern Territory Department of Primary Industry and Resources known as Fisheries NT or the Fisheries Group. The objectives of this Act are:

- To manage the aquatic resources of the Northern Territory in accordance with the principles of ecologically sustainable development;
- To protect the environment, people and economy of the Northern Territory from the introduction and spread of aquatic noxious species and diseases;
- To maintain stewardship of aquatic resources that promotes fairness, equity and access to aquatic resources by all stakeholder groups, including:
 - Indigenous people;
 - The commercial fishing, aquaculture and fishing tourism industries;
 - Amateur fishers;
 - Others with an interest in the aquatic resources of the Northern Territory; and
- To promote the optimum utilisation of aquatic resources to the benefit of the community.

Key services provided by Fisheries NT include:

- Facilitating the sustainable commercial catch, sale and processing of fish and aquatic life through licence allocation;
- Encouraging industry development;
- Engaging in and transfer of national policy and direction into the Northern Territory fisheries regulation framework;
- Supporting recreational fishing industries;
- Preventing the introduction of aquatic pests into the Northern Territory;
- Contributing to the research needs for each Northern Territory fishery including in the areas of aquaculture and biosecurity;
- Working in partnership to address the needs of the aquaculture industry including provision of hatchery and other support services;
- Operating the commercial barramundi hatchery/nursery business;
- Assisting Indigenous communities in relation to fishing issues; and
- Providing education resources for schools and delivering community education.

Primary Industry Group

The Department of Primary Industry and Resources also regulates agriculture in the Northern Territory. Because some agricultural activity in the Northern Territory involves the diversion of groundwater resources for the purposes of irrigation, the regulation and development of irrigated agriculture is relevant to this study. In this context, the services provided by the Department include:

- Research and extension programmes to help producers sustainably lift crop and stock yields and capacity;
- Development of best-practice farming methods for specific environments; and
- Indigenous pastoral and horticultural economic development.

5.2.2. Australian Fisheries Management Authority

The Australian Fisheries Management Authority (AFMA) is the Australian Federal Government agency responsible for the efficient management and sustainable use of the Commonwealth fish resource. AFMA has jurisdiction from the three nautical mile mark (boundary of State waters), out to the boundary of the EEZ and is given its powers and obligations pursuant to the *Fisheries Administration Act 1991* (Cth) and *Fisheries Management Act 1991* (Cth). AFMA is compelled by this legislation to pursue the following objectives:

- Implementation of efficient and cost-effective fisheries management on behalf of the Commonwealth;
- Ensure that the exploitation of fisheries resources and the carrying on of any related activities are conducted in a manner consistent with the principles of ecologically sustainable development (including the exercise of the precautionary principle), particularly the need to have regard to the impact of fishing activities on non-target species and the long-term sustainability of the marine environment;
- Maximising net economic returns to the Australian community from the management of Australian fisheries;
- Ensuring accountability to the fishing industry and to the Australian community in AFMA's management of fisheries resources; and
- Achieving government targets in relation to the recovery of AFMA's costs.

In pursuing these objectives, AFMA is also bound by legislation to give regard to:

- Ensuring, through proper conservation and management measures, that the living resource of the Australian Fishing Zone (AFZ) are not endangered by over-exploitation;
- Achieving the optimum utilisation of the living resource of the AFZ;
- Ensuring that conservation and management measures in the AFZ and the high seas implement Australia's obligations under international agreements that deal with fish stocks; and
- To the extent that Australia has obligations under international law or agreement in relation to fishing activities by Australian-flagged boats on the high seas, ensuring that Australia implements its obligations.

AFMA must ensure that, as far as practicable, measures adopted in pursuit of its objectives are not inconsistent with the preservation, conservation and protection of all whale species.

5.3. Marine Safety Regulators

5.3.1. Northern Territory Department of Infrastructure, Planning and Logistics

Responsibility for the management and oversight of marine safety in Northern Territory waters and the safe operation of ports resides with the Director of Marine Safety and Regional Harbourmaster in the Northern Territory Department of Infrastructure, Planning and Logistics.

5.3.2. Australian Marine Safety Authority

The Australian Marine Safety Authority (AMSA) is a statutory authority established under the *Australian Maritime Safety Authority Act 1990* (Cth). The main functions of AMSA are as follows:

- Promote maritime safety and protection of the marine environment;
- Prevent and combat ship-sourced pollution in the marine environment;
- Provide infrastructure to support safety of navigation in Australian waters; and
- Provide a national search and rescue service to the maritime and aviation sectors.

5.4. Environmental Regulators and Managers of the Marine Conservation and Heritage Estate

5.4.1. Northern Territory Environmental Protection Authority

The Northern Territory Environmental Protection Authority (NTEPA) is an independent authority established under the *Northern Territory Environmental Protection Authority Act*. The NTEPA is comprised of a chairperson and four members appointed by the Administrator of the Northern Territory and the Chair of the Northern Territory Planning Commission.

The objectives of the NTEPA are to:

- Promote ecologically sustainable development;
- Protect the environment, having regard to the need to enable ecologically sustainable development;
- Promote effective waste management and waste minimisation strategies; and
- Enhance community and business confidence in the environmental protection regime of the Northern Territory.

The specific functions of the NTEPA are:

- Assessment of the environmental impact of development proposals through the administration of the *Environmental Assessment Act* to ensure that development decisions in the Northern Territory take environmental impact into consideration;
- Issuing of licences to regulate activities subject to the *Waste Management and Pollution Control Act* and the *Water Act*;
- Administration of the container deposit scheme under the *Environment Protection (Beverage Containers and Plastic Bags) Act*;
- Compliance and enforcement activities to reduce the likelihood of environmental harm resulting from pollution;
- Provision of technical advice to government and the community on waste and pollution management issues;
- Development of guidance material to promote good environmental practice;
- Development and implementation of environmental policies and programmes including grants programmes to assist the community, business and government to adopt sustainable practices; and
- Implementation of national standards that have been adopted in the Northern Territory.

It is evident from the 2016 to 2018 strategic plan for the NTEPA, as summarised in Table 8, that the NTEPA has a significant immediate term focus on several issues associated with the Northern Territory marine environment

Goals	Address priority environmental issues	Minimise environmental impacts	Engage and inform government, community and business	Build organisational capability and capacity
Priorities	<p>Improve waste management across the NT</p> <p>Improve the quality of stormwater entering the Darwin Harbour</p> <p>Improve the management of contaminated sites in the NT</p> <p>Improve the management of air emissions from NT industry</p> <p>Improve the management of noise emission in the NT</p>	<p>Advise on regulatory reform to establish a contemporary environmental protection framework</p> <p>Undertake risk-based assessment of potential environmental impacts to inform approvals and compliance</p> <p>Develop policy, guidelines and standards to inform leading environmental management practice</p> <p>Improve the management and compliance of waste and pollution</p> <p>Support responses to major incidences with environmental impacts</p>	<p>Work effectively with stakeholders and partners to improve environmental management</p> <p>Increase knowledge and awareness of environmental laws, impacts of activities and people's duty of care</p> <p>Encourage industry and community bodies to contribute to the resolution of issues of environmental significance or public concern</p> <p>Advise government on environmental issues under Part 3 of the NTEPA Act</p>	<p>Ensure integrated systems and processes to support decision making</p> <p>Ensure our people have the training and tools to effectively and efficiently manage environmental issues</p> <p>Maintain strong governance</p> <p>Maintain safe work environment</p>
Outcomes	<p>Environmental issues and legacies are identified and effectively managed</p> <p>Exposure to environmental contaminants and noise is within acceptable limits</p>	<p>Improved compliance and enforcement of environmental legislation</p> <p>Impacts have been identified and mitigated to an acceptable level</p> <p>Improved management of waste and pollution issues in remote communities</p>	<p>Environmental information is more accessible and easier to understand</p> <p>Public awareness and community involvement in the NT EPA's processes</p>	<p>Effective planning and reporting on organisational performance</p> <p>Staff have the appropriate competencies and expertise to achieve NTEPA outcomes</p>
Outputs	<p>Waste strategy implemented</p> <p>Stormwater strategy implemented</p> <p>Management frameworks for contaminated sites</p> <p>Advise to Minister on recommendations for a noise framework</p> <p>Management framework for air emissions including odour</p>	<p>Advice on environmental impact assessment reform</p> <p>Reviewed Waste Management and Pollution Control Act</p> <p>Advice to government on environmental management of major developments</p> <p>Revised compliance and enforcement policy</p>	<p>Communication and engagement approach is developed</p> <p>Information and education activities</p> <p>Seabed mining report</p> <p>Advice on onsite peri urban sewerage treatment options</p>	<p>Integrated database</p> <p>Capability framework</p> <p>Strategic, business and individual development plans</p> <p>Effective delivery of NTEPA objectives</p>
Principles	<p>Transparent processes and independent decision making</p> <p>A strong focus on collaboration and partnerships</p> <p>Science and evidence underpins decision making</p>			

TABLE 8 – NORTHERN TERRITORY ENVIRONMENTAL PROTECTION AUTHORITY STRATEGY 2016–2018

An area of significant contemporary focus for the NTEPA is that of seabed mining. There is currently a moratorium on seabed mining in the Northern Territory, with the government currently waiting on advice from the NTEPA before a decision to maintain or lift the ban will be made. The NTEPA, in turn, is waiting for the outcomes and findings from a New Zealand High Court challenge with respect to the anticipated scale of disturbance from subsea mining operations in that jurisdiction.

Staff, facilities and other resources that are necessary for the NTEPA to fulfil its functions are provided by the Northern Territory Department of Environment and Natural Resources (DENR).

5.4.2. Northern Territory Department of Environment and Natural Resources

The DENR was established in 2016 to create a single department of the Northern Territory Government that manages all the government functions that foster and protect the environment and natural resources in the Northern Territory. These functions include water, land resources management and environment and are managed across the following divisions of the Department:

- Flora and Fauna;
- Rangelands;
- Bushfires NT;
- Water Resources; and
- Environment.

5.4.3. Parks and Wildlife Commission of the Northern Territory

The Parks and Wildlife Commission of the Northern Territory is a division of the Northern Territory Government Department of Tourism and Culture. The Department is responsible for increasing visitation to the Northern Territory, delivering and supporting the protection, conservation and management of the Northern Territory's parks and native wildlife, creating a thriving, imaginative and innovative creative economy and encouraging lifelong involvement in sport and recreation.

The Parks and Wildlife Commission is responsible for the care, control and management of the 87 terrestrial and marine parks and reserves managed by the Northern Territory Government (see Section 4.2).

5.4.4. Power and Water Corporation

Pursuant to the *Government Owned Corporations Act 2014 (NT)*, the Power and Water Corporation (PWC) is a Northern Territory Government owned corporation. It is responsible for electricity transmission and distribution and process water and sewerage services across the Northern Territory. It also supplies electricity generation and retail services to 72 remote communities through its not-for-profit subsidiary, Indigenous Essential Services.

It is also responsible for issuing wastewater disposal licences.

5.4.5. Aboriginal Areas Protection Authority

The Aboriginal Areas Protection Authority (AAPA) is an independent statutory authority established under the *Aboriginal Sacred Sites Act 1978 (NT)* (see Section 3.1.2). In accordance

with this Act, AAPA is responsible for overseeing the protection of Aboriginal sacred sites on land and sea across the Northern Territory.

The operations of the AAPA are overseen by a board comprised mainly of senior male and female Aboriginal custodians from across the Northern Territory. The AAPA maintains records of all sacred sites that it has identified in the Northern Territory. This includes recorded sacred sites that have been made known to AAPA from a variety of sources and in many cases recorded sacred sites have not been comprehensively documented, as well as registered sacred sites that Aboriginal custodians have asked the AAPA to protect and these have been comprehensively documented and evaluated.

The AAPA currently has records of approximately 12,000 sacred sites across the Northern Territory, approximately 500 of which are in the marine environment. Figure 20⁷⁹ illustrates the extent of marine and coastal sacred sites in the Northern Territory.

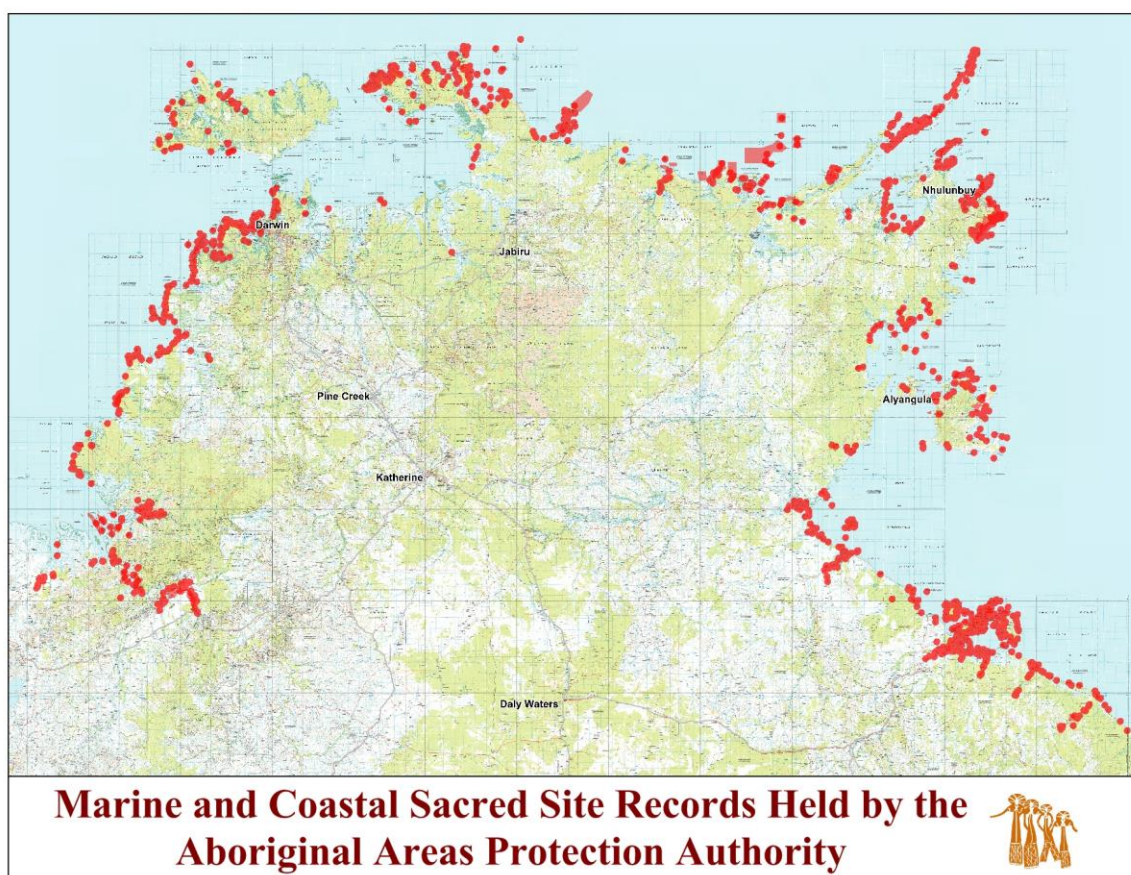


FIGURE 20 – MARINE AND COASTAL SACRED SITE RECORDS HELD BY THE ABORIGINAL AREAS PROTECTION AUTHORITY

The Northern Territory marine and coastal environment is of high cultural significance to Aboriginal people. Many dreaming narratives originate and transect the marine environment. There is no doubt that marine sacred sites are substantially underrepresented in the AAPA database. The key factor in this is the high cost of identifying and assessing marine-based sacred sites.

⁷⁹ Aboriginal Areas Protection Authority (2017)

5.4.6. Commonwealth Department of the Environment and Energy

The Department of Environment and Energy (DoEE), among other things, designs and implements Commonwealth Government policies and programmes designed to protect and conserve the environment, water and heritage and to promote climate action.

Included within this portfolio is the governance of the Commonwealth marine reserves in waters extending from three nautical miles (the limit of State waters) to the edge of the EEZ (the limit of Commonwealth Waters) from shore (see Section 4.1).

The DoEE aims to provide for the protection of matters of national environmental significance; namely the ecological character of internationally important wetlands, nationally listed threatened species and ecological communities, listed migratory species, the value of world and national heritage places and Commonwealth marine waters. Management plans for Commonwealth marine reserves, which provide the framework for management of the matters described above, are developed by the DoEE.

The DoEE is also responsible for the referral, assessment and approval process for any actions that are likely to have a significant impact on matters of national environmental significance (irrespective of whether it is in State or Commonwealth waters). This includes periodic assessments of the ecological sustainability of State and Commonwealth managed fisheries.

The Commonwealth Government has committed to delegating this power to the States to provide for a 'one stop shop' approval process under bilateral agreements between each State (including the Northern Territory) and the Commonwealth.

5.5. Other Regulators

5.5.1. National Offshore Petroleum Safety and Environmental Management Authority

The National Offshore Petroleum Safety and Environment Management Authority (NOPSEMA) regulates the structural integrity and environmental management of all offshore petroleum facilities in Commonwealth waters, as well as the health and safety matters on those facilities.

NOPSEMA's environmental management authorisation process has been endorsed by the Federal Minister for the Environment as a programme that meets the requirements of Part 10 of the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC).

This arrangement, along with a class of actions approved by the Minister, allows titleholders to seek environmental approval for their offshore petroleum activities in Commonwealth waters from NOPSEMA, without the need to make a referral under the EPBC.

NOPSEMA monitors compliance through inspections and investigates accidents, occurrences and circumstances relating to well integrity, safety of workers and environmental management. NOPSEMA also advises on matters relating to safety, well integrity and environmental management, and makes reports, including recommendations, to the responsible Ministers at State and Commonwealth levels

5.6. Key Issues and Marine Science Knowledge Needs

The marine science knowledge needs of regulators of the Northern Territory marine environment are summarised in the following subsections and described in detail in Table 9.

5.6.1. Species and Habitat Baselines, Pressures and Management Frameworks

Apart from some localised areas of development activity, habitat, biodiversity, ecosystem connectivity and water quality mapping and baselines are sparse across the entire Northern Territory marine environment. This baseline information is required to inform a wide range of regulatory decisions including:

- Allocation of fishery resource and setting of quotas, legal catch criteria and allowable fishing areas;
- Determining suitable siting and management requirements for aquaculture projects;
- Determining the adequacy of the marine conservation estate with respect to protecting important marine environmental values;
- Determining activities that are allowable in the marine conservation estate such that important values are not compromised;
- Determining controls around marine tourism such that the marine resource is sustainable;
- Urban and land-use planning that affects the marine environment;
- Agricultural and terrestrial mining activity that has potential to affect the marine environment; and
- Determining controls that may be needed for vessels and ecologically sustainable offshore oil and gas developments and operations.

Baseline information that is required to inform such decisions variably include regional and local physical oceanography; hydrology; bathymetry; water quality, chemistry and sedimentation; benthic biota; habitats; biodiversity and ecosystem connectivity.

This absence of fundamental baseline data places a fundamental limit on the effectiveness and/or productivity of regulation that applies to the Northern Territory marine environment. This flows onto protracted and uncertain project approvals processes that detract from the Northern Territory's attractiveness as an investment destination.

However, for the following reasons, baseline investments need to be prioritised and/or alternative, more cost-effective means of developing 'baseline' information developed:

- Existing baseline coverage is limited and the area that needs to be covered to provide a comprehensive baseline of the Northern Territory marine environment is extensive;
- The high level of natural variability associated with the Northern Territory marine environment implies a need for baselines to be recorded over extended periods of time;
- Technical challenges associated with high turbidity, strong currents and tides and high density of dangerous marine life add both cost and occupational health and safety (OHS) risk; and
- Undertaking baseline surveys in remote areas implies a naturally higher cost structure.

In terms of prioritisation, there is consensus that the short-to-medium term focus should be on Darwin Harbour and the Gulf of Carpentaria. Darwin Harbour is a priority because it is the focus of the vast majority and greatest intensity of contemporary marine oriented industry, urban development and recreational activity. The Gulf of Carpentaria is also considered a priority because it is a major regional oceanographic influence (Carpentaria Gyre), a relatively unique marine system (tropical, almost enclosed epicontinental sea), is generally considered to be one of the most pristine marine environments in the world, there are multiple users of its marine environment (tourism, recreational fishing, commercial fishing, minerals production and export, Aboriginal communities and potential terrestrial water diversion for agriculture) and this activity is increasing.

The Top End (Coburg Peninsula to Wessel Islands) and Bonaparte Basin regions are generally considered lower priority for different reasons. Industrial development in the Top End is relatively limited and the region is managed relatively intensely by Aboriginal Ranger Groups. While the Northern Territory marine environment west of Darwin Harbour and into the Bonaparte Gulf is quite different to the rest of the Northern Territory from a zoogeographical perspective and therefore requires baseline assessment as the basis for effective regulation, with the exception of the Ord River Irrigation Area (see Section 13.3.1 and Project Sea Dragon (see Section 9.3.2), development is limited.

5.6.2. Immediate Environmental Pressures and Management Priorities

There are a number of pressures on the Northern Territory marine environment and marine resource management issues that, by virtue of their relative immediacy and multi-stakeholder impact, require focused investment in marine science. These include understanding pressures on estuarine and coastal ecosystems that impact many users of the Northern Territory marine estate, as well as the impact of increased marine noise, particularly seismic noise, on key species and ecosystems from an environmental conservation, customary economy and commercial perspective.

5.6.3. Knowledge to Inform an Evolving Regulatory Framework

As discussed in Sections 2.7 and 2.8, the regulatory framework that pertains to the Northern Territory marine environment is multi-jurisdictional in nature and evolving. Initiatives to evolve the regulatory framework pertain to the framework for overall management of the marine estate and the framework for managing the fishery resource particularly. The fact that most offshore petroleum infrastructure and activity is located in Commonwealth waters means that regulation pertaining to the activities of the offshore petroleum industry is largely implemented at the national level.

With respect to the overall framework that regulates the marine natural environment, there is a view that the process of modernising Northern Territory legislation can learn from the experiences of other jurisdictions to produce a 'state-of-the-art' environmental regulatory framework. It will likely involve increased devolution of powers from the Commonwealth, a change of regulatory focus from individual species to the protection of important seascapes and ecosystems and management of threats to those ecosystems, and establishing an environmental offsets policy. The development of each of these initiatives will be required to be informed by marine science.

The regulation regarding fisheries management is also evolving with pressure to re-examine the allocation of the fishery resource among the commercial, charter, recreational and customary sectors; to facilitate greater participation of Aboriginal communities in commercial fishing and to increase the allowable commercial catch of some species. The key challenges to regulatory decisions in this regard are limited information on stock structure in some species and, outside of the commercial and charter sectors, very limited information on the total catch of some species.

5.6.4. Knowledge to Inform Commercial Fisheries Development

There is some eagerness on the part of the commercial fishing industry, Aboriginal communities and the Northern Territory Government to explore the development of new commercial fisheries and to increase the commercial catch of some species. However, there are both

practical commercial challenges, as well as public policy challenges associated with achieving this, the resolution of which requires new marine science knowledge.

5.6.5. Knowledge to Inform Safety and Environmental Impact of Vessels and Offshore Infrastructure

Expansion of the offshore oil and gas sector in the Timor and Arafura Seas, Darwin Port's expanding role in supporting offshore oil and gas infrastructure in these locations, as well as the Browse Basin off Western Australia and regional marine logistics connectivity more generally and increased marine tourism and recreational boating exacerbates the potential for vessel and infrastructure incidents that present risk to human safety and the environment. Furthermore, increased vessel traffic between other regions and the Northern Territory marine environment presents potential biosecurity risk that needs to be managed.

Increased marine science knowledge is required to inform responses to hydrocarbon spills, improve pilotage and enhance small vessel safety in the Northern Territory marine environment, as well as establish systems for monitoring and responding to biosecurity threats.

Key Issue	Description	Specific Marine Science Needs
SPECIES AND HABITAT BASELINES, PRESSURES AND MANAGEMENT FRAMEWORKS		
Baseline Prioritisation	<p>The consensus among regulators is that the priorities for baseline investments should be where there is existing or immediate future development pressures. This defines Darwin Harbour and the Gulf of Carpentaria as the priorities. However, these are large and diverse areas in themselves and, increasingly, there are project proposals elsewhere in the Northern Territory marine environment that require assessment and regulation.</p>	<p>Determine an agreed, reasonable and practical ecosystem unit of assessment for baselines in the Northern Territory marine environment (i.e. the standard of 50 square kilometres may not be adequate given the significant variability in parts of the Northern Territory marine environment and, on this basis, there will be many units where there are no anthropogenic pressures whatsoever).</p> <p>Develop a clear understanding of existing development pressures and likely future projects that will impact on the Northern Territory marine environment.</p> <p>An inventory of the existing marine science baseline knowledge in the areas where existing and likely future development will take place, as well as a publicly accessible database for that knowledge that is updated on an ongoing basis.</p> <p>An assessment of the likely pressures that development will place on the local marine environment.</p> <p>Establish a risk-based prioritisation of baseline investment.</p>

Key Issue			Description	Specific Marine Science Needs
Fundamental Surveys	Marine	Baseline	In areas of Darwin Harbour and the Gulf of Carpentaria where there is existing development or imminent development, investment in fundamental baseline data is required. This includes habitat mapping, biodiversity, ecosystem connectivity and water quality. Given the significant natural variation in these factors that is characteristic of much of the Northern Territory marine environment, and in the case of Darwin Harbour, the fact that it is already an altered environment, defining a realistic range for baselines is a challenge.	<p>Develop an inventory of all existing baseline data pertaining to Darwin Harbour and the Gulf of Carpentaria and identify key gaps.</p> <p>Investigation into the establishment and adoption of standardised methods and frameworks for acquiring and interpreting baseline data in the Northern Territory marine environment.</p> <p>Undertake biodiversity and habitat scale mapping to address gaps in key areas.</p> <p>Undertake water quality assessments to address gaps and identify sources of contaminants.</p> <p>Considering natural variability, determination of a defined range of baselines on key environmental variables, including an appropriate duration over which baselines should be taken to define that range (i.e. the standard is two years, but this is unlikely to provide adequate measure of natural variability in the case of the Northern Territory marine environment, where a single natural event can cause significant change that may persist long after the original event).</p> <p>Assessment of climate change pressures on habitats such as mangroves, seagrasses and corals.</p>

Key Issue	Description	Specific Marine Science Needs
Terrestrial Surface and Aquifer Hydrology Baselines	The health of key habitats and ecosystems in Northern Territory coastal and estuarine marine environments are impacted by perennial or seasonal inflows of fresh water from the many rivers that feed into the Northern Territory marine environment and, most likely, aquifers that are connected to the marine environment. Very little is understood about the connectivity between terrestrial surface and groundwater resources, connectivity of aquifers to the Northern Territory marine environment and the resilience of coastal	<p>Identification and quantification of key anthropogenic pressures on the localised marine environment.</p> <p>Determine the likely impact of very large water movements on dispersion and, therefore, localised versus regional impacts.</p> <p>Determination of marine ecosystem connectivity within the localised environment and on a regional scale.</p> <p>Determine location, adequacy and health of localised refugia habitats.</p> <p>Assessment of overall resilience of the marine environment and design of ongoing monitoring programmes for key areas of Darwin Harbour and the Gulf of Carpentaria.</p>
		<p>Detailed mapping of surface water and aquifer connectivity and aquifer and marine environment connectivity using tools such as water aging and microbe relationship analysis.</p> <p>Identification of key coastal and estuarine ecosystems that may be affected by changes in freshwater ingress.</p> <p>Assessment of natural ranges in baseline freshwater ingress into key estuarine and coastal environments and resilience of ecosystems in</p>

Key Issue	Description	Specific Marine Science Needs
Adequacy of and Certainty Associated with the Marine Conservation Estate	<p>and estuarine ecosystems to changes in freshwater ingress.</p> <p>The Commonwealth marine conservation estate covers relatively large areas of the Northern Territory marine environment. The current absence of Management Plans covering the vast majority of this estate means that the environmental values that the reserves were intended to protect are not currently being managed and there is considerable uncertainty being created for industry and other users of the marine estate that intersect with the marine conservation estate.</p>	<p>those environments to changes to freshwater ingress.</p> <p>Baseline surveys of the Commonwealth marine estate to inform the activity zoning of Management Plans, and assessment and decision making for activities that may affect values of the Commonwealth marine conservation estate.</p> <p>Basis for prioritisation of finalising Management Plans for Commonwealth Reserves</p>
Key Habitats for EPBC Protected Species and Megafauna	<p>Sea grass meadows, mangroves and the benthic environment are habitats for a number of species specifically protected under the EPBC. Understanding the health of these habitats is critical for the Northern Territory Government to fulfil its obligations under bilateral agreements with the Commonwealth pertaining to the EPBC.</p>	<p>Baseline surveys of key seagrass meadows, mangroves and benthic environments that are important habitat for EPBC listed species in the Northern Territory marine environment.</p>
Alternatives to Baseline Surveys	<p>Given the enormity of the task and investment required to undertake conventional marine baseline studies, alternatives to survey data as the basis for baselines should be considered. These include modelling from limited local or regional baseline data and examining impacts of pressures well understood in similar ecosystems elsewhere. The optimal use of remote technologies for baseline</p>	<p>Review of the use of existing datasets pertaining to the Northern Territory marine environment and similar marine ecosystems and advanced ecological modelling techniques as an alternative to surveying as a basis for establishing baseline information.</p> <p>Determine areas and aspects of the Northern Territory marine environment where modelling</p>

Key Issue	Description	Specific Marine Science Needs
	<p>data gathering in the Northern Territory marine environment should also be explored.</p>	<p>might prove an acceptable alternative to surveys for the purposes of generating baseline information.</p> <p>Examination of an optimal strategy for investment in remote technology solutions for gathering baseline data in the Northern Territory marine environment, including the identification of appropriate technologies, such as Remotely Operated Vehicles, Unmanned Aerial Vehicles and gliders, as well as vessel independent systems such as drifters and animal attached systems.</p>
<p>Management of the Aboriginal Heritage Cultural Estate</p>	<p>There are at least 500 marine oriented sacred sites registered with the AAPA. It is highly likely that there are many more to be identified, assessed and recorded. Furthermore, managing the protection of these marine-based sacred sites is challenging.</p>	<p>Development of technology that supports more efficient assessment of sacred sites.</p> <p>Developing improved systems for defining and protecting some of the more esoteric marine sacred sites.</p> <p>Development of communication and monitoring systems that assist in preventing unauthorised access to marine sacred sites</p> <p>Understanding the impact of various anthropogenic pressures (e.g. marine noise, dredging and seabed mining) on marine sacred sites.</p>

Key Issue	Description	Specific Marine Science Needs
IMMEDIATE CONSERVATION AND MANAGEMENT PRIORITIES		
Health and Viability of Estuarine Ecosystems	<p>Healthy estuarine environments are critically important to the productivity of Northern Territory fisheries, customary economy and livelihoods of Aboriginal communities and broader environmental issues such as carbon storage. These important estuarine environments and the ecosystems they support are experiencing increasing pressure from climate change, potential diversion of freshwater ingress and contaminants from industry and urban development, which are manifesting in issues such as anecdotal observations of reduced fish stocks and mangrove dieback. Given the critical importance of these ecosystems, their management is a key priority for environmental and fisheries regulators.</p>	<p>Understanding the main physical characteristics of estuarine environments including whether they are wave or tide dominated and their dependency on specific volumes and timing of freshwater ingress.</p> <p>Understanding the impact and resilience of the fishery to mangrove dieback and reduced freshwater ingress into estuarine environments</p> <p>Understanding of which fish stocks are being affected by changing estuarine environments, and which by over-fishing.</p> <p>Understanding as to whether current Northern Territory Government policy to limit development impact to five percent of Northern Territory mangroves is adequate to protect important estuarine and coastal marine ecosystems</p>
Impact of Marine Noise	<p>Because of increased offshore petroleum exploration and development activity and increased commercial and recreational marine traffic generally in the Northern Territory marine environment, marine noise is increasing. There is a need to enhance understanding of the effects of seismic noise from offshore petroleum exploration, particularly with respect to species that are</p>	<p>Inventory of work that has been undertaken in other regions on the impact of seismic noise on the behaviour of marine mammals and specific species of commercial, recreational and customary value.</p> <p>Assessment of the applicability of work undertaken on the impacts of marine noise of marine mammals and specific fish species in other</p>

Key Issue	Description	Specific Marine Science Needs
	<p>important from a fishery productivity and marine conservation perspective.</p>	<p>jurisdictions to the Northern Territory marine environment, as well as relevant environmental impact and regulatory frameworks that apply in those jurisdictions.</p> <p>Consultation and determination of what form research outputs should be delivered to be most applicable to regulatory frameworks.</p> <p>Identification of specific scientific investigation that need to be undertaken to determine the impacts of seismic noise of marine mammal behaviour and species of fish targeted by the commercial, recreational and customary sectors in the Northern Territory marine environment.</p> <p>Integration of this knowledge into regulatory and, if appropriate, any potential future compensation assessment frameworks.</p>

KNOWLEDGE TO INFORM AN EVOLVING REGULATORY FRAMEWORK

<p>Bases for a Northern Territory Environmental Offsets Policy</p>	<p>Currently, the only environmental offset investments in the Northern Territory are those that are associated with projects that have triggered provisions of the EPBC. Modernisation of Northern Territory environmental legislation will almost certainly include introducing provisions that require projects to offset residual environmental impacts through offset investments. The successful implementation of such policy will require marine</p>	<p>Review of marine environmental offsets policy and regulatory frameworks in other jurisdictions determine best options suitable for the Northern Territory.</p> <p>Draw from baseline and environmental pressure studies to determine possible cumulative impacts on key environmental values as a basis for assessing residual impacts from projects.</p>
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Key Issue	Description	Specific Marine Science Needs
	<p>science that accurately informs the true nature of residual impacts, including cumulative impacts, and assists in determining appropriate offset investments for specific projects.</p>	<p>Because there may be limited opportunity for determining 'like-for-like' with marine environmental offsets policy in the Northern Territory, determine the next best option from a conservation of the Northern Territory marine environment perspective.</p>
<p>Shift from a Species Focus of Conservation Management to a Broad-scale Management Approach</p>	<p>Modernisation of Northern Territory environmental management legislation will require a change in species focused conservation management to a more effective and efficient approach that focuses on managing the health of landscapes, seascapes and ecosystems that support species and address large-scale threats to species and the ecosystems that support them. This requires an adequate understanding of the resilience of key species to changes in the ecosystems that support them, definition of a healthy ecosystem range, cumulative impacts on the health of those ecosystems, ecosystem connectivity and methods for managing risks to those ecosystems.</p>	<p>Drawing on baseline and threats research, determine the health of key ecosystems and seascapes.</p> <p>Determine the major large-scale threats to those ecosystems such as climate change, marine debris, etc.</p> <p>Identify threat mitigation measures.</p>
<p>Basis for Equitable and Transparent Allocation of the Fishery Resource</p>	<p>There is currently very little reliable data that can be used to accurately measure the impact of recreational or customary fishing on sustainable fish stocks across the Northern Territory fishery, with the commercial and fishing charter sectors bearing the majority of measurement and monitoring obligation and the regulatory burden. Paradoxically, both the recreational and customary sectors advocate for</p>	<p>Exploration of efficient methods for measuring the recreational and customary takes of key species.</p>

Key Issue	Description	Specific Marine Science Needs
Basis for Confidence in Devolution of Commonwealth Powers	<p>increased allocation of the fishery resources based on social, livelihood and customary economy values. Any significant change to allocation policy must be informed by an objective understanding of social and customary values associated with the fishery and the current take from the recreational and customary sectors.</p> <p>It is the desire of both the Northern Territory and Commonwealth Governments to increasingly devolve regulatory responsibility in certain areas such as the management of certain fisheries and conservation reserves to the Northern Territory Government. For both governments to have confidence in the devolution of powers pertaining to the management of marine resources, they must be confident that the Northern Territory Government has access to adequate scientific knowledge and capability to support the management of those resources.</p>	<p>Identification of key areas in which the Commonwealth and Northern Territory Government have or are likely to agree to increased devolution of regulatory powers pertaining to the Northern Territory marine environment.</p> <p>Assessment of the adequacy of existing marine science knowledge pertaining to those areas with respect to supporting management responsibilities and a gap analysis.</p> <p>Prioritisation of marine science investments necessary to support devolution of powers pertaining to the management of the Northern Territory marine environment from the Commonwealth to the Northern Territory Government.</p>
Framework for Improved Management of Joint Jurisdictional Fisheries	<p>Some fisheries in the Northern Territory marine environment, such as the Northern Prawn Fishery (NPF) span multiple state jurisdictions, as well as the Commonwealth jurisdiction. Furthermore, by high</p>	<p>Assessment of options for a marine science governance framework that coordinates investment in marine science across Western Australian, Queensland and Northern Territory that</p>

Key Issue	Description	Specific Marine Science Needs
	degrees of ecosystem connectivity, the lifecycle of the species targeted by many fisheries operating in the Northern Territory marine environment are affected by regulation and enforcement of regulation in other State jurisdictions, the Commonwealth jurisdiction and the jurisdictions of Indonesia, Timor-Leste and Papua New Guinea.	supports the management of marine resources common to the three jurisdictions.
Framework for Equitable Management of Fisheries in Aboriginal Controlled Waters	Increasing influence and control over commercial and recreational fishery resource by Traditional Owners mandates increased participation of Traditional Owners in fisheries management decision making.	Review of international frameworks for the meaningful inclusion of Indigenous peoples in fisheries management frameworks and assessment of the most suitable options for the Northern Territory context.
COMMERCIAL FISHERIES DEVELOPMENT		
Risk-based Assessment for Fisheries Management	There have been calls from some stakeholders to increase the Total Allowable Catch (TAC) in some species, including species identified as globally endangered, but otherwise in apparent abundance in the Northern Territory marine environment. Understanding baseline stocks and stock structure, as well as the importance of the Northern Territory marine environment as refugia for these species must be achieved before any increase in catch can be considered.	For species that have been identified as potential candidates for increased commercial take, a detailed assessment of stock structure and regional genetic connectivity, as the basis for risk-based assessment of the potential for increased commercial catch.
Framework for Prioritising Investment in the Establishment of New Fisheries	Commercial fishing operators and Aboriginal communities have identified potential new commercial fisheries that could operate in the	Identification of all new potential commercial fisheries and detailed analysis of commercial

Key Issue	Description	Specific Marine Science Needs
Facilitation of Aboriginal Communities in Commercial Fishing	Northern Territory marine environment. However, environmental regulation places significant burden on regulators with respect to undertaking environmental impact assessments that are necessary to establish a new fishery. Therefore, a cost benefit framework that allows investments in new fisheries to be prioritised is desirable.	<p>potential as the basis for prioritisation of investment.</p> <p>Desktop assessment of the likely environmental, social and customary impacts of a commercial fishery targeting species that are <i>prima facie</i>, commercially viable.</p> <p>Using a cost-benefit analysis based on this assessment prioritisation of species that could be the focus of new commercial fisheries as the basis for investment.</p>
	Absence of infrastructure and distance to market are significant challenges for remote communities to develop commercial fishing operations. A new licencing regime is required that mitigates the impact of these disadvantages and facilitates business models that allow the development of sustainable remote and typically small commercial fishing enterprises.	<p>Review of fisheries regulations that apply to commercial and customary fishing to identify unnecessary regulatory hurdles to the development of commercial fishing enterprise in Aboriginal communities.</p> <p>Review and assessment of innovative business models and structures that could render small-scale commercial fishing in remote communities economically viable.</p>

KNOWLEDGE TO INFORM SAFETY AND ENVIRONMENTAL PROTECTION ASSOCIATED WITH VESSELS AND OFFSHORE INFRASTRUCTURE

Management of Vessel-borne Risk	Increased vessel traffic between particularly the eastern States of Australia and South East Asia and the Northern Territory marine environment heightens the risk of introduction of exotic pests and pathogens from vessel hulls or ballast water that can have	Review of methods and technologies for identifying vessels that present risk and inspecting hulls for potential exotic species, particularly with respect to recreational cruising vessels visiting remote parts of the Northern Territory marine
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Key Issue	Description	Specific Marine Science Needs
	<p>significant negative impact on the range of ecosystem services provided by the Northern Territory marine environment.</p>	<p>environment and with a focus on developing inspection functions for Aboriginal Ranger Groups.</p> <p>Review of existing methods and technologies implemented to meet already identified active management needs, including ease and cost of application in remote areas or by Aboriginal Ranger Groups.</p>
<p>Knowledge to Support Improved Pilotage</p>	<p>While pilotage in Darwin Harbour is supported by strong knowledge pertaining to the hydrography, bathymetry and hydrology of key traffic areas of Darwin Harbour and navigation lane leading directly to other regional port facilities, such data for most of the Northern Territory coastline is limited. This presents a significant challenge to pilotage models across the region.</p>	<p>Study to priorities areas of the Northern Territory marine environment with respect to current and future vessel traffic intensity as a basis for prioritising investment in hydrography, bathymetry and hydrology studies.</p>
<p>Improved Regulation of Small Vessels</p>	<p>Because the impact of an incident involving large commercial vessels is typically greater, marine safety regulation focus in the Northern Territory has been primarily on the commercial sector. However, there are approximately 50,000 unregistered, unlicensed, recreational vessels in the Northern Territory with no formal system for vessel or skipper quality control or data-driven system that allows a regulator to link a vessel to an owner or operator.</p>	<p>Review of systems for improved quality control of recreational vessels and vessel operators used in other jurisdictions, including the Torres Strait Marine Safety Program.</p> <p>Assessment of the likely efficacy of different systems with respect to improving small boat safety from a vessel and operator perspective, administrative efficiency and flow-on benefits such as potential improved ability to measure and monitor the take from the recreational fishing sector.</p>

Key Issue	Description	Specific Marine Science Needs
Hydrocarbon Spill Response	<p>To inform and immediately respond, operators of offshore petroleum infrastructure have detailed oceanographic data pertaining to the immediate vicinity of infrastructure that informs how a hydrocarbon spill will disburse. However, there is limited detailed regional oceanographic data that informs how a spill that is not immediately contained will disburse across the Northern Territory marine environment. There is also limited information on the various ecosystems a spill that is not immediately contained might affect.</p>	<p>Development of more sub-regional scale oceanographic modelling near major oil and gas fields and pipeline infrastructure, as well as shipping lanes to enhance predictive capacity for spill risks, thereby informing preparedness and allowing implementation of appropriate response measures in the event of an incident.</p> <p>Based on the more regional scale oceanographic modelling, identification of ecosystems and its constituent components that might be first impacted by a hydrocarbon spill that is not immediately contained, aiming to prioritise preparedness, ensure control measures deliver optimal benefit and to inform research priorities.</p> <p>Design of response strategies for hydrocarbon spills that are not immediately contained.</p>
EFFECTIVE COMMUNICATION OF SCIENTIFIC BASIS FOR REGULATORY DECISIONS		
Ensuring the Public Understand the Scientific Basis for Regulatory Decisions	<p>Some regulatory decisions pertaining to the marine environment can be controversial and not necessarily accepted as reasonable by all stakeholders. Being able to effectively communicate the scientific evidence and rationale on which a decision is made can assist in garnering wider stakeholder acceptance and support of regulatory decisions.</p>	<p>Social science that leads to better communication of the scientific evidence of and rational for specific regulatory decisions to a wide cross section of often diverse stakeholders.</p>

TABLE 9 – MARINE SCIENCE NEEDS OF REGULATORS OF THE NORTHERN TERRITORY MARINE ENVIRONMENT

6. Australian Defence Force

The most recent Australian Defence White Paper⁸⁰ describes several drivers that will shape Australia's security environment over the next two decades. These are summarised in Figure 21 below.



FIGURE 21 – FACTORS THAT WILL SHAPE AUSTRALIA'S SECURITY ENVIRONMENT OVER THE NEXT 20 YEARS

As discussed in Section 2.4, Australia's key strategic defence interests are now clearly oriented toward the north of the Nation. Areas of most immediate importance to Australia are its borders and offshore territories, its strategic intersection with the interests of Indonesia, Timor-Leste, Papua New Guinea and various Pacific Island countries, as well as its maritime interests in South East Asia more generally. This is reflected in Australia's three key Strategic Defence Interest and associated Strategic Defence Objectives, which are articulated in the 2016 Defence White Paper. These are summarised in Figure 22 below.

⁸⁰ Department of Defence (2016), Defence White Paper 2016, Australian Government, Canberra

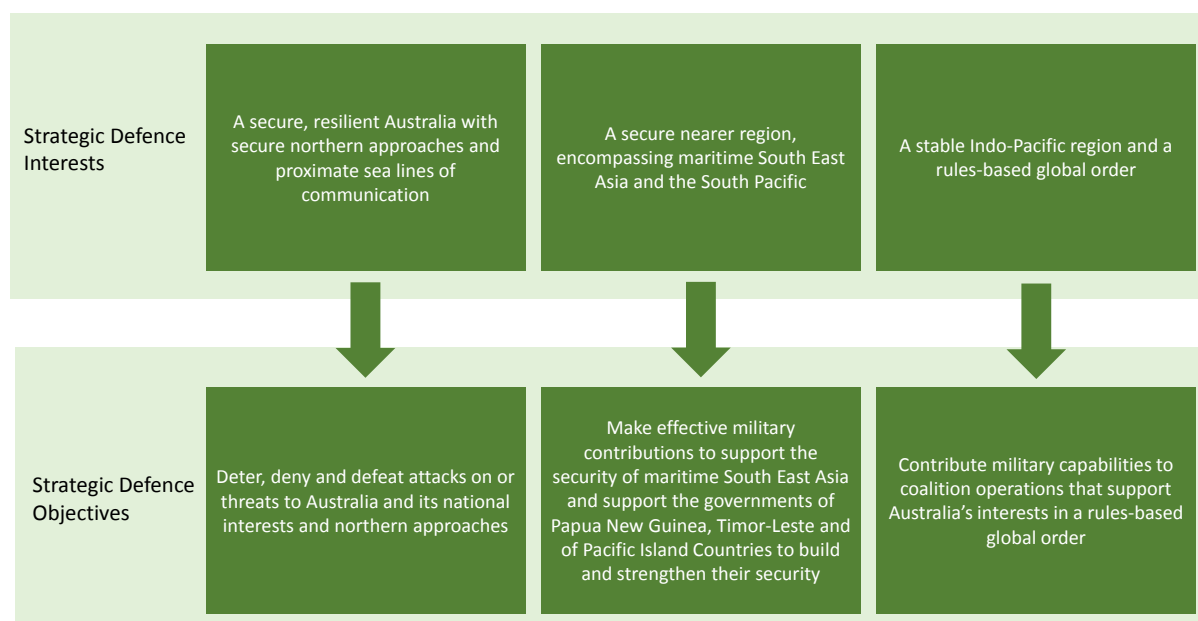


FIGURE 22 – AUSTRALIA’S STRATEGIC DEFENCE INTERESTS AND OBJECTIVES

The economic importance of northern Australia and its offshore resources plays a significant role in current and future defence planning. An effective, visible force posture in northern Australia and the northern and western approaches is necessary to demonstrate the capacity and will to defend sovereign territory, including offshore resources and extensive maritime areas.⁸¹

This is a major aspect of ADF doctrine that has been further promoted in the most recent Defence White Paper that articulates ADF doctrine out to 2035.⁸² To be able to achieve the Strategic Defence Objectives (see Figure 22), the ADF will need to be more agile and adaptable with a broader set of capabilities from which to draw on so that it is able to conduct the full range of tasks that might be required. The ADF will also need to maintain a high degree of interoperability with the sophisticated capabilities of its strategic partners, particularly the United States military, but also ASEAN nations and the United Nations.

The ADF's operations in the Northern Territory will become increasingly important with respect to force posture in northern Australia and maintaining interoperability with the capabilities of its strategic partners in the region.

6.1. Northern Territory Marine Environment and Australian Defence Force Doctrine

In this contemporary defence landscape, the Northern Territory is playing an increasingly important role in supporting the operations of the ADF from a posture and power projection, as well as training and exercise perspective.

⁸¹ Australian Government, Department of Defence, Defence White Paper 2013, Canberra 2013, page 10

⁸² Department of Defence (2016), Defence White Paper 2016, Australian Government, Canberra

6.1.1. The Northern Territory and ADF Posture and Projection

Since European settlement, the population and industrial base of Australia has resided primarily on the eastern coast of the continent and, as such, Australia's political, social and economic orientation has also been focused on the east coast. These circumstances have resulted in ADF posture and power projection capabilities also being east coast oriented. Over the course of the past two centuries, investment in major base infrastructure has revolved around this orientation, as well as ADF capability sustainment requirements that can only be serviced by the larger eastern state's population and industrial centres. While there has been some investment in major basing elsewhere such as RAAF Tindal near the town of Katherine in the Northern Territory and HMAS Stirling (Fleet Base West) in Fremantle, Western Australia, the critical mass of major ADF base infrastructure remains east coast oriented.

In the context of the eastern concentration of major ADF base infrastructure, ADF doctrine remains focused on maintaining high-end capabilities, as well as a highly mobile modern defence force that can deter security threats and increase regional influence over relatively significant distances. The ability to deploy troops, equipment and supplies across a wide theatre of operation is an important aspect of this doctrine and is supported by a number of relatively smaller, forward support bases in northern Australia. The main concentration of these forward support bases is in the Northern Territory.

ADF presence and investment in Northern Australia will gradually increase over the next decade to support the needs of the more capable, high technology future force that the ADF will bring into service, as well as a more active defence posture. This will be supported by the existing ADF bases in the Northern Territory (as well as others across northern Australia) that are summarised in Table 10 below.

Base	Operations
Larrakeya Barracks	<p>Larrakeyah Barracks was established in 1934 as one of the first major commitments to national defence in the north of Australia. It is a tri-service base hosting ten units, including:</p> <ul style="list-style-type: none"> ▪ Head Quarters of Northern Command (NORCOM); ▪ HMAS Coonawarra; ▪ Patrol Boat Group; ▪ North West Mobile Force (NORFORCE); ▪ 36 Water Transport Troop; ▪ Army Cadets; ▪ Defence Support and Reform Group; ▪ Patrol Boat Systems and Program Office; ▪ Larrakeyah Health Centre; and ▪ Several commercial contractors providing support to the ADF. <p>Of most relevance to the NTMSEUNA is HMAS Coonawarra, which is discussed in detail in Section 6.1.2 below.</p>
Robertson Barracks	<p>Robertson Barracks is located 15 kilometres east of the Darwin CBD on an area of approximately 7,000 hectares. It is the home base for the Australian Army 1st Brigade, the operator of the Australian Army's mechanised and army aviation force.</p> <p>Robertson Barracks is also the base for United States Marine Corp Darwin Rotational Force. Under the Force Posture Agreement, Australia and the United States will continue to work toward the full United States Marine Air-Ground Task Force of approximately 2,500 personnel and equipment rotating through Australia by 2020 during the six-month dry season, while at the same time expanding Air Force cooperation.</p>
RAAF Tindal	<p>RAAF Tindal is located 15 kilometres outside of the town of Katherine and is one of Australia's most important defence installations. It is home to:</p> <ul style="list-style-type: none"> ▪ No 17 Squadron (including Delamere Air Weapons Range) – Combat Support; ▪ No 2 Security Force Detachment Tindal – Combat Support; ▪ No 2 Squadron Detachment Tindal; ▪ No 28 Squadron Detachment Tindal; ▪ No 3 Control and Reporting Unit Detachment Tindal – Surveillance and Response; ▪ No 452 Squadron Tindal Flight – Surveillance and Response; ▪ No 75 Squadron – Air Combat; ▪ Chief Information Officer Group – Communications Security Tindal; ▪ Defence Community Organisation; ▪ Defence Support Reform Group – Base Support Tindal; ▪ Tindal Health Centre; ▪ No 2 Expeditionary Health Squadron Detachment Tindal; ▪ Joint Health Unit – Northern Territory; and ▪ Detachment of NORFORCE.

RAAF Darwin RAAF Darwin is located at Darwin International Airport and shares runway facilities with the airport. It is one of the RAAF's main forward operating bases and covers an area of 1,200 hectares

Live Fire Ranges and Training Areas Delamere Range Facility, Bradshaw Field Training Area, Bunday Training Area and Northern Australian (maritime) Exercise Area.

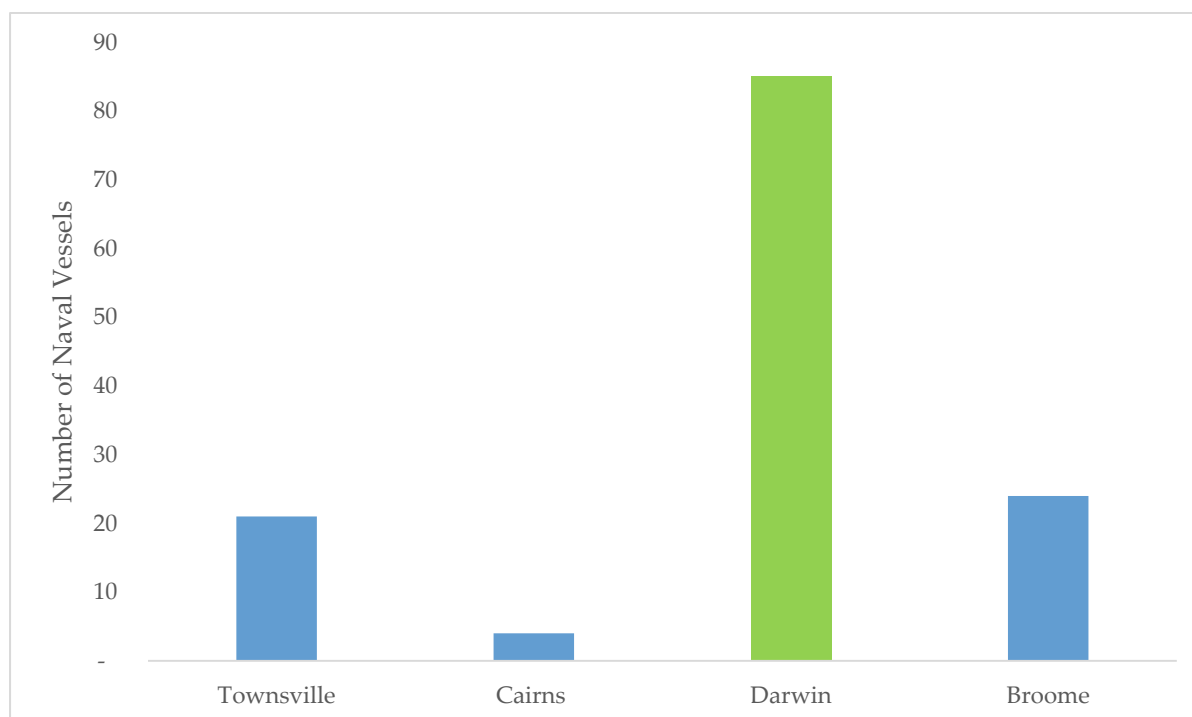
TABLE 10 – MAJOR NORTHERN TERRITORY ADF BASES

6.1.2. HMAS Coonawarra

HMAS Coonawarra is a tenant unit at Larrakeyah Barracks occupying approximately 12 hectares of water-side land on the Larrakeyah site and is the main base by which the ADF interacts directly with the Northern Territory marine environment. The first HMAS Coonawarra facilities were constructed in 1982 to support Fremantle Class patrol boats that were then entering service to replace the former Attack Class patrol boats. A new wharf was constructed in 2001 to accommodate an additional number of Fremantle Class patrol boats. That wharf was then extended in 2006 to its current service profile following a decision to replace the Fremantle Class patrol boats with larger Armidale Class patrol boats.

Current Operations

HMAS Coonawarra is a critically important northern installation for the Royal Australian Navy (RAN). It is the base that supports border integrity operations and major international exercises in Australia's northern waters, with approximately 100 RAN and foreign naval vessels visiting the base and Darwin Harbour more generally each year. As illustrated in Figure 23,⁸³ Darwin is by far the most frequently visited naval port in northern Australia.



⁸³ Ports Australia

FIGURE 23 – NUMBER OF NAVAL VESSEL VISITS – NORTHERN AUSTRALIAN PORT (2014–15)

Importantly, HMAS Coonawarra is currently the home port for the majority of the Armidale Class Patrol Boats with several also supported at HMAS Cairns. These vessels play a continuous and critical role supporting enforcement for the Australian Quarantine and Inspection Service, Australian Border Force and the prevention of illegal fishing.

The existing wharf at HMAS Coonawarra can accommodate six Armidale Class vessels, three abreast with each berthing point delivering fuel, electrical power, compressed air, sewerage management, oily waste suction and defueling services.

HMAS Coonawarra also operates a vertical-lift facility allowing patrol boats to be mechanically removed from the water for maintenance. The facility can dock vessels with a draught of up to 2 metres in any tide and can lift 750 tonnes.

Future Operations

The 2016 Defence White Paper sets out a schedule of new asset acquisitions for the RAN. Prior to these assets being deployed, RAN bases across the north of Australia, including HMAS Coonawarra, will require significant upgrades. HMAS Coonawarra will, in some cases, perform a home base function and, in others, a forward supply and reload function for the operation of those assets in the region. These assets and the likely associated function of HMAS Coonawarra are summarised in Table 11.

New Royal Australian Navy Asset Acquisition	HMAS Coonawarra Function
Twelve new Offshore Patrol Boats to replace the current fleet of Armidale Class Patrol Boats	Home Port
Canberra Class Amphibious vessels HMAS Canberra and HMAS Adelaide	Forward supply and reload support for northern region operations
Fleet of lightly armed small patrol boats to allow mobility in a wide range of riverine environments	Forward supply and reload support for northern region operations
Twelve Shortfin Barracuda Submarines	Forward supply and reload support for northern region operations
Three Hobart Class Air Warfare Destroyers	Forward supply and reload support for northern region operations
Nine Future Frigates	Forward supply and reload support for northern region operations

TABLE 11 – NEW ROYAL AUSTRALIAN NAVY ASSETS AND RELATED FUNCTION OF HMAS COONAWARRA

To perform its function with respect to the assets listed in Table 11, a new 250 metre wharf with mooring dolphins will be constructed to:

- Support home port functions for the new Offshore Patrol Vessels;
- Provide a range of other supply and reload activities for afloat support vessels, minor war vessels and other surface combatants; and
- Importantly, reduce traffic pressure on Darwin Port, particularly with respect to usage of the naval anchorage area and Fort Hill Wharf.

Enhanced fuel facilities that can provide 24 × 7 fuel storage and refuelling services to Australian and foreign vessels will also be developed.

6.2. Australian and International Training Exercises

The Northern Territory and ADF installations listed in Table 10 play a key role in a number of domestic and international defence exercises. These exercises both develop and test the capabilities of the ADF and its strategic partners, and visibly demonstrate capability from a posture perspective. The main exercises are Talisman Sabre, Kakadu and Pitch Black, each of which interact with the Northern Territory marine environment to varying degrees.

To the extent that these exercises involve a maritime component, they typically result in a surge of naval activity in the area, including in Darwin Port, and often involve international naval vessels.

Talisman Sabre

The United States will continue to be Australia's most important strategic partner. It is the ADF's intent to broaden and deepen its alliance with the United States, including sponsoring its critical role in underpinning security in the region via the continued rebalance of the United States military.⁸⁴ Exercise Talisman Sabre is a biennial training exercise involving Australian and United States armed forces that is designed to develop joint capabilities in planning and conducting combined task force operations, particularly with respect to ADF and United States combat readiness and interoperability across the spectrum of military operations.

Exercises are conducted across Queensland and the Northern Territory and in adjacent maritime areas. In the Northern Territory specifically, the Delamere Range Facility, Bradshaw Field Training Area, airspace over the northern part of the Northern Territory and the Timor and Arafura Seas are used extensively in exercises. HMAS Coonawarra plays a major role in supporting naval capability used in exercise Talisman Sabre.

Kakadu

Exercise Kakadu is a maritime exercise that is designed to strengthen ADF ties with international counterparts and improve maritime interoperability. The exercise typically involves naval and aviation assets from Australia, New Zealand, Singapore, Thailand, Japan and Malaysia.

The exercise is conducted in the Northern Australia Exercise Area located off the coast of Darwin and in adjacent airspace and is supported significantly by HMAS Coonawarra.

Pitch Black

Exercise Pitch Black is the ADF's largest and most complex air combat exercise and takes place across northern Australia, with RAAF Darwin and Tindal performing major roles. It typically involves participation from the RAAF and Australian Army, as well as elements of the Singapore, New Zealand and Thailand air forces.

The purpose of Exercise Pitch Black is to test participants in the tasking, planning and execution of Offensive Counter Air and Offensive Air Support operations in a coalition operating

⁸⁴ Department of Defence (2016), Defence White Paper 2016, Australian Government, Canberra

environment. Exercise Pitch Black's interaction with the Northern Territory marine environment is limited to the extent that the exercise involves a sea-air warfare interface.

6.3. Key Issues and Marine Science Knowledge Needs

The Northern Territory marine science knowledge needs of the ADF are summarised in the following subsections and described in detail in Table 12.

6.3.1. Marine Science that Demonstrates the Royal Australian Navy's Marine Stewardship

As an agency of the Australian Government, the RAN allocates significant resources to ensuring that it observes the highest standards of marine stewardship. These include:

- Investment in pre-exercise consultation to ensure conflicts over usage of the marine estate are minimised and other users are given adequate advanced notice of naval activity;
- Minimised use of special naval rights of access to areas of water; and
- Strict adherence to environmental standards.

By its nature, the RAN is an 'evidence-based' organisation and can only respond to accusations based on evidence. Its main marine science knowledge needs revolve around the ability to demonstrate the standard of its marine stewardship whenever this is called into question. A specific contemporary issue that demonstrates the need for evidence-based response is the impact of sonar on marine mammals.

6.3.2. HydroScheme Industry Partnership Program

The Commonwealth Department of Defence has a long history of hydrographic survey and has an ongoing obligation to conduct hydrographic surveys under various international conventions and Australian legislation. Furthermore, demand is growing for a whole-of-nation hydrographic and oceanographic survey programme.

As illustrated in Figure 24,⁸⁵ a significant area of Australian coastal waters is considered inadequately surveyed, with significant inadequately surveyed areas located in the Northern Territory marine environment. This task involves significant investment and Defence will increasingly look for opportunities to collaborate with industry and academia to fulfil its hydrographic and oceanographic survey obligations under the HydroScheme Industry Partnership Program.

⁸⁵ Parker, B. (CMDR) (2017), *HydroScheme Industry Partnership Program*, Department of Defence, Australian Government, Canberra

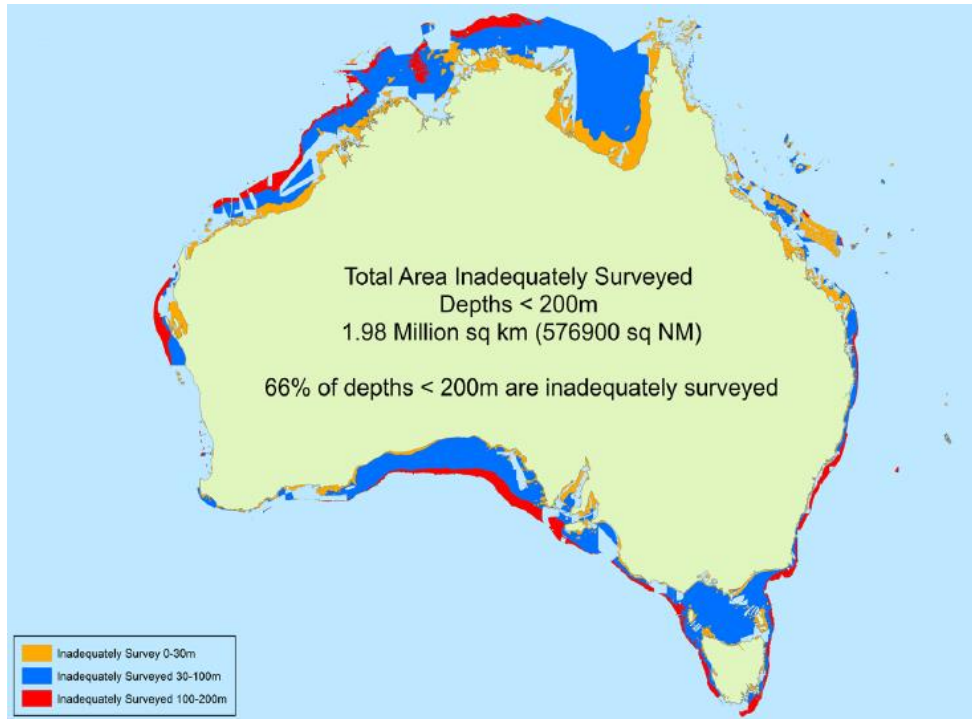


FIGURE 24 – THE AUSTRALIAN SURVEY TASK

Key Issue	Description	Specific Marine Science Needs
MARINE SCIENCE EVIDENCE THAT DEMONSTRATES HIGH STANDARDS OF MARINE STEWARDSHIP		
Effective Communication of RAN Marine Stewardship Standards and Outcomes to the Community	The RAN invests significantly in maintaining high levels of marine stewardship. It is important for the social licence to operate facilities such as HMAS Coonawarra, as well as the large-scale exercises that are conducted in the Northern Territory marine environment, so that the community understands the high standards set by the RAN and that, because of adherence to these standards, the impact of the RAN's activities on the marine environment and other users of the marine estate is minimised.	Social science research that ensures that communication of the RAN's marine stewardship standards achieve optimal reach, understanding and appreciation by major interest groups and the community more widely and that this translates into an ongoing social licence to operate for HMAS Coonawarra, military exercises in the region and the RAN more generally.
Impacts of Sonar on Marine Megafauna	Sonar is a critical target identification and ranging technology that is used extensively by submarine and surface combatant vessels worldwide. Marine megafauna such as whales and dolphins (but not Dugong) use natural sonar capability for communication, object identification and ranging. There is some community concern that extensive use of naval sonar, particularly during intensive naval activity associated with exercises, may disrupt migration paths, breeding and nursery activity and/or result in 'beaching' of these species.	Research that provides an evidence base demonstrating the impact, or otherwise, of sonar on marine megafauna in the Northern Territory marine environment.

Key Issue	Description	Specific Marine Science Needs
HYDROSCHEME INDUSTRY PARTNERSHIP		
Leveraging the Hydrographic and Oceanographic Survey Capabilities of Industry and Academia	Under the HydroScheme Industry Partnership, Defence will seek to utilise the hydrographic and oceanographic survey capabilities of industry and academia to efficiently fulfil its survey obligations and large areas of the Northern Territory marine environment are classified as inadequately surveyed.	Hydrographic and oceanographic survey data at adequate standards in inadequately surveyed areas.

TABLE 12 – MARINE SCIENCE NEEDS OF THE AUSTRALIAN DEFENCE FORCE

7. Darwin Port

As a place of trade, the general area around Darwin Port pre-dates European settlement, with the Larrakia people having conducted trade with South East Asia, particularly with Makassan Trepang fisherman from the southwest corner of Sulawesi, for thousands of years. The embayment was named Port Darwin in 1839 by the commanding officer of HMS Beagle, Lieutenant John Stokes, and was quickly developed into a commercial port servicing the then only local settlement of Palmerston. Figure 25⁸⁶ summarises a timeline of key events leading up to the development of the modern-day Darwin Port.

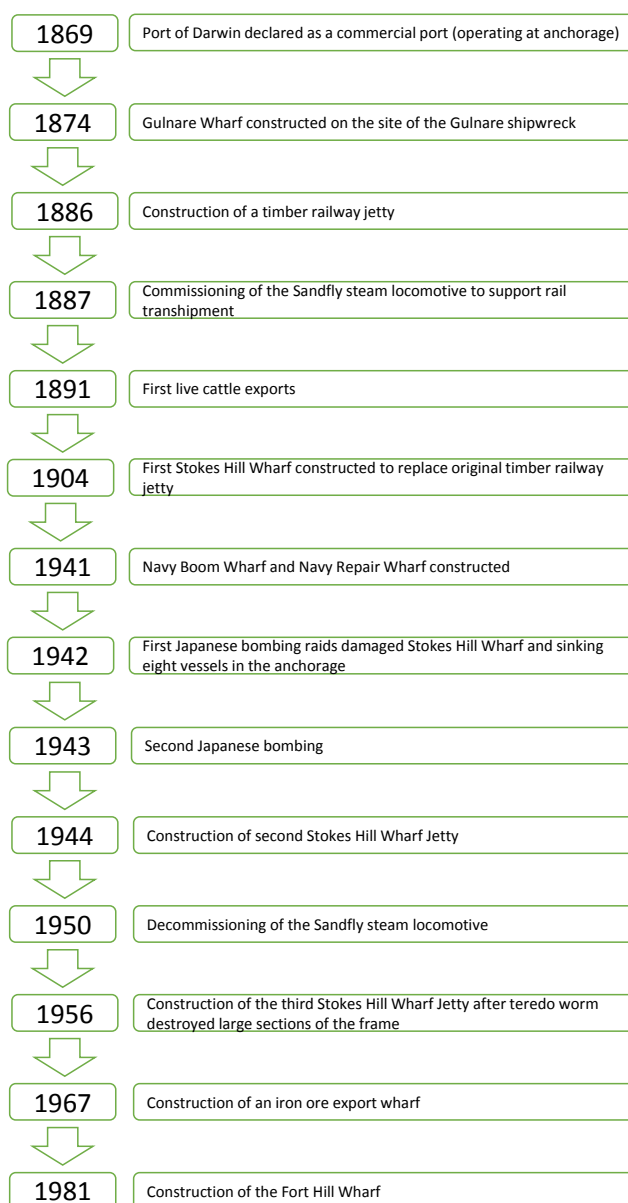


FIGURE 25 – EARLIER INFRASTRUCTURE DEVELOPMENT AT DARWIN PORT

⁸⁶ ADAPTED FROM: Darwin Port Corporation, *Port of Darwin History: Fact Sheet 7*

Today, commodity ore exports, livestock exports, petroleum imports and bulk liquids, containerised import and export cargoes and specialised cargo are all handled through the multi-modal facility at East Arm Wharf, with the City Wharf area dedicated to cruise ship and limited defence needs.

In 2015, the Northern Territory Government provided the PRC domiciled company, Landbridge Holdings, with a 99-year lease to operate Darwin Port, retaining a 20 percent interest. Landbridge Holdings operates seaport facilities in the PRC and Panama.

7.1. Darwin Port and the Northern Territory Economy

In 2015–16, the Northern Territory had merchandise exports of approximately \$5.1 billion, equivalent to 22 percent of GSP. A significant portion of these exports were transported through Darwin Port including \$444 million of live animal and \$317 million of crude petroleum product. Major export destinations included Japan, the PRC, Thailand, Indonesia and the United States.⁸⁷ In the same year, the Northern Territory had merchandise imports of approximately \$2.1 billion, equivalent to approximately 9 percent of GSP. Again, a significant portion of these imports were transported through the Darwin Port, with major source countries for goods being Thailand, Japan, Singapore, the PRC and the United States.⁸⁸

As discussed throughout this section, Darwin Port plays a critical role in the Northern Territory's export-oriented economy and will play an increasingly important role in supporting the economy of northern Australia more generally, particularly central and western northern Australia. Darwin Port is the only true multi-modal port in northern Australia, with direct rail connectivity through central Australia, to the southern, eastern and western regions of the Nation.

7.2. Darwin Harbour and Regional Maritime Logistics

7.2.1. Darwin Port and Northern Australia

Excluding the large mineral and petroleum bulk commodity ports in the Pilbara Region of Western Australia and in Queensland (which accommodate substantially greater vessel traffic and throughput), Darwin Port is the busiest commercial port in northern Australia. This is illustrated in Figure 26⁸⁹ that compares recent commercial vessel calls at the ports of Darwin, Broome, Cairns and Townsville.

⁸⁷ Department of Foreign Affairs and Trade (2017), Northern Territory Economy, Australian Government, Canberra

⁸⁸ Ibid

⁸⁹ Ports Australia

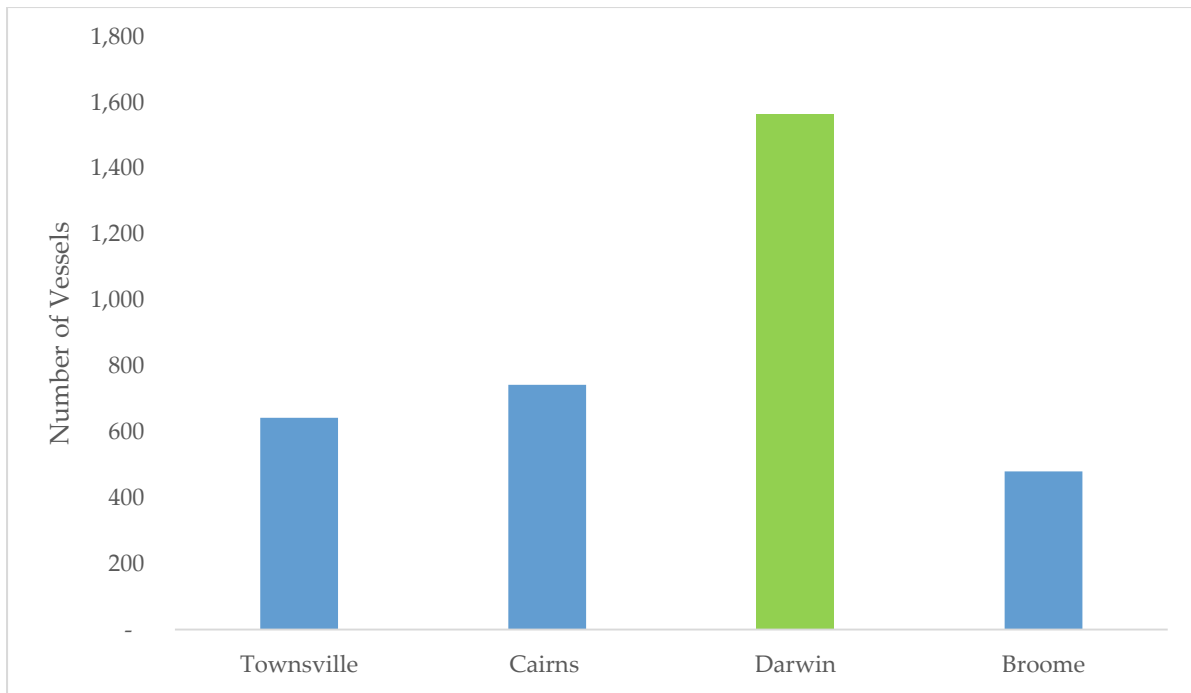


FIGURE 26 – COMMERCIAL VESSEL CALLS – NORTHERN AUSTRALIAN PORTS (2014–15)

In terms of throughput across these important northern Australian ports, Darwin is second only to Townsville, as illustrated in Figure 27.⁹⁰

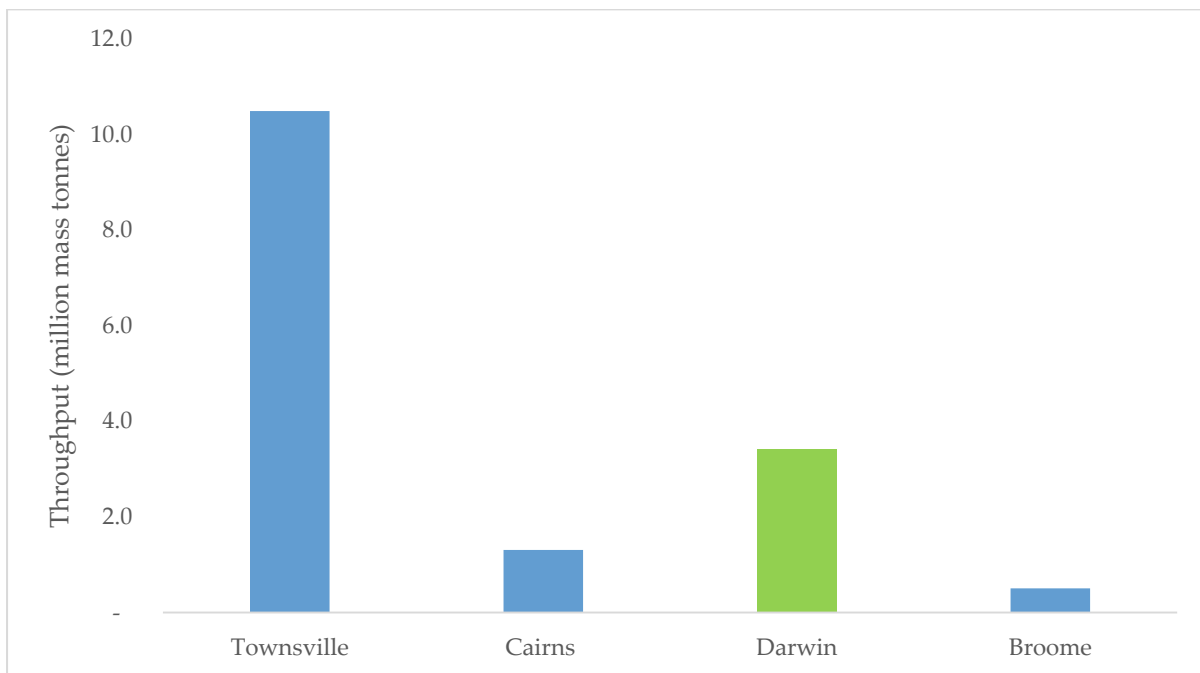


FIGURE 27 – TOTAL THROUGHPUT – NORTHERN AUSTRALIAN PORTS (2014–15)

⁹⁰ Ports Australia

The significantly higher throughput at Townsville is primarily a function of its container cargo capacity. As illustrated in Figure 28,⁹¹ almost twice as much container cargo is transported through Townsville compared to Darwin.

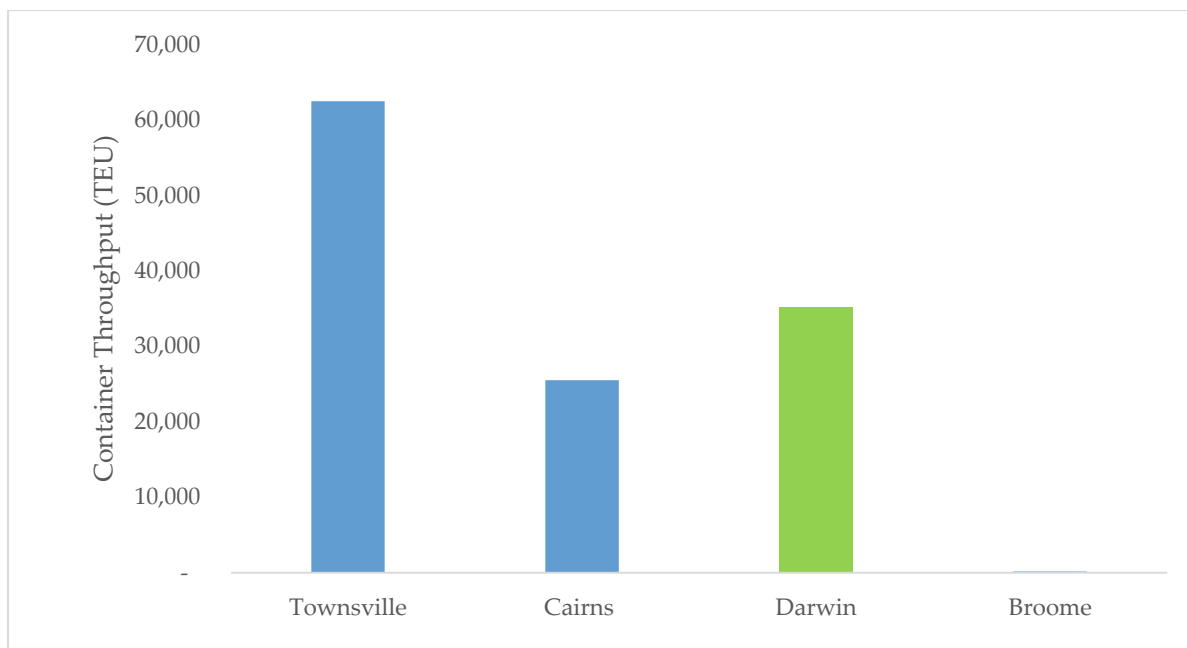


FIGURE 28 – CONTAINER THROUGHPUT – NORTHERN AUSTRALIAN PORTS (2014–15)

7.2.2. Darwin Port Trade and Vessel Activity Profile

While activity at Darwin Port has been gradually increasing over the past decade, the Port has only been operating at approximate current levels of activity for the past five years, as illustrated in Figure 29.⁹²

⁹¹ Ports Australia

⁹² Ports Australia

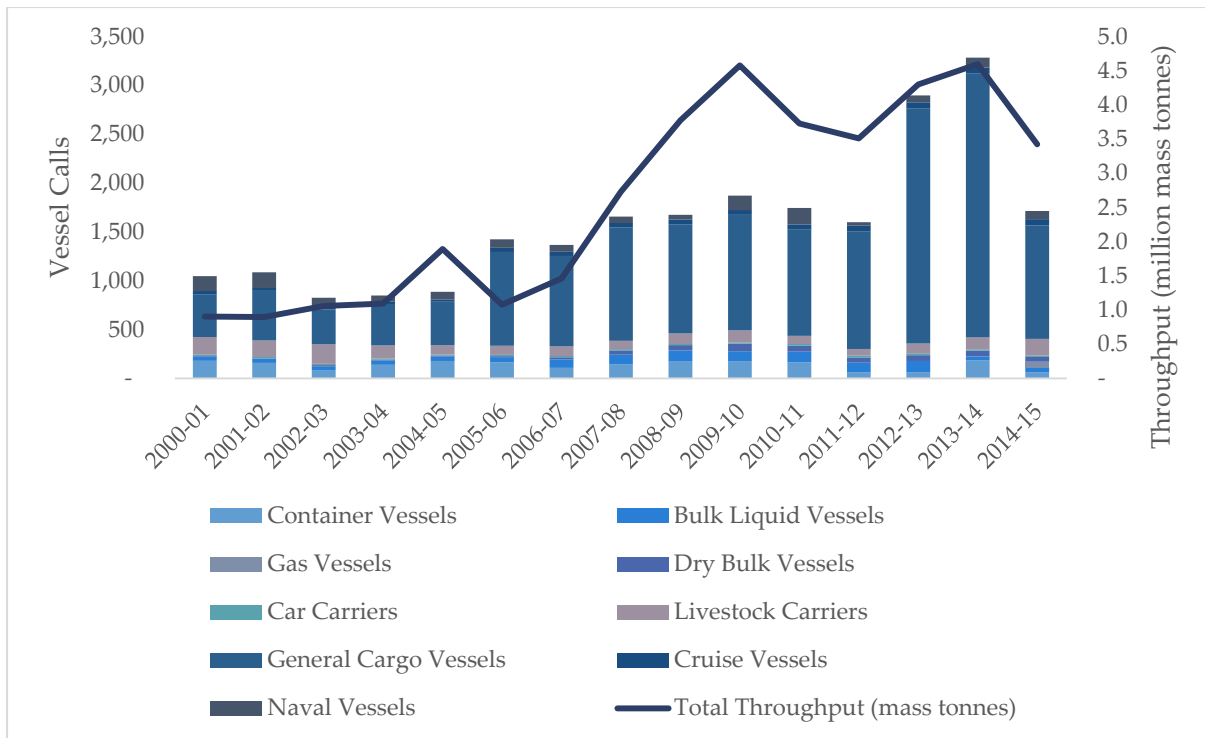


FIGURE 29 – DARWIN PORT – VESSEL CALLS AND THROUGHPUT (2000-01 TO 2014-15)

While the growth in vessel calls at Darwin Port has been driven primarily by increased general cargo traffic, the increase in throughput is primarily the result of bulk mineral commodity throughput, mainly manganese and iron ore as shown in Figure 30.⁹³

⁹³ Ports Australia

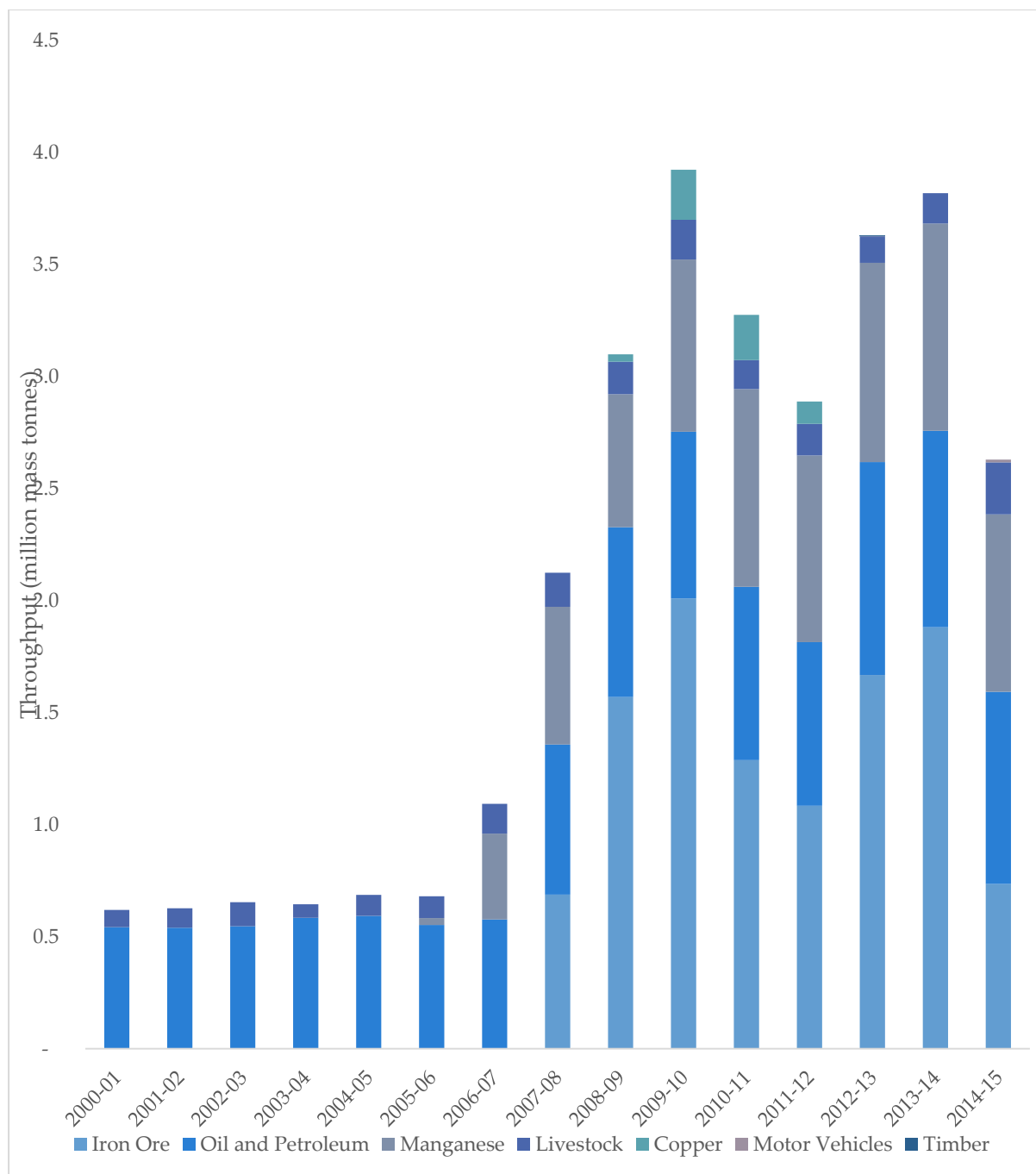


FIGURE 30 – DARWIN PORT THROUGHPUT BY COMMODITY (2000-01 TO 2014-15)

7.2.3. Darwin Port and Future International Trade

Darwin Port's strategic location with respect to key Asian markets for Australian exports, proximity to northern Australian primary production areas, multi-modal connectivity to the wider Nation and expansion potentially renders it one of the most important pieces of economic infrastructure in northern Australia. Furthermore, private ownership of Darwin Port operations provides it with efficient access to the investment that will be necessary to facilitate this expansion.

Underpinning the future importance of Darwin Port is its potential role in connecting northern Australia to the PRC's One-Belt-One-Road trade corridor. One-Belt-One-Road is a major

international logistics capital investment programme being undertaken by the PRC, which is designed to create an efficiently connected trading block that expands Asia-European landmass and east Africa. It will involve approximately 65 countries, a total population reach of 4.4 billion and a 30 percent share of the global economy. To date, US\$1 trillion of projects have been initiated including major infrastructure works in Africa and Central Asia.

As illustrated in Figure 31,⁹⁴ the southern terminus of the One-Belt-One-Road infrastructure is Indonesia. Capacity at Darwin Port, together with the PRC's ownership of Darwin Port operations, provides the foundations for an opportunity for Australia to participate in this revitalised trading block.

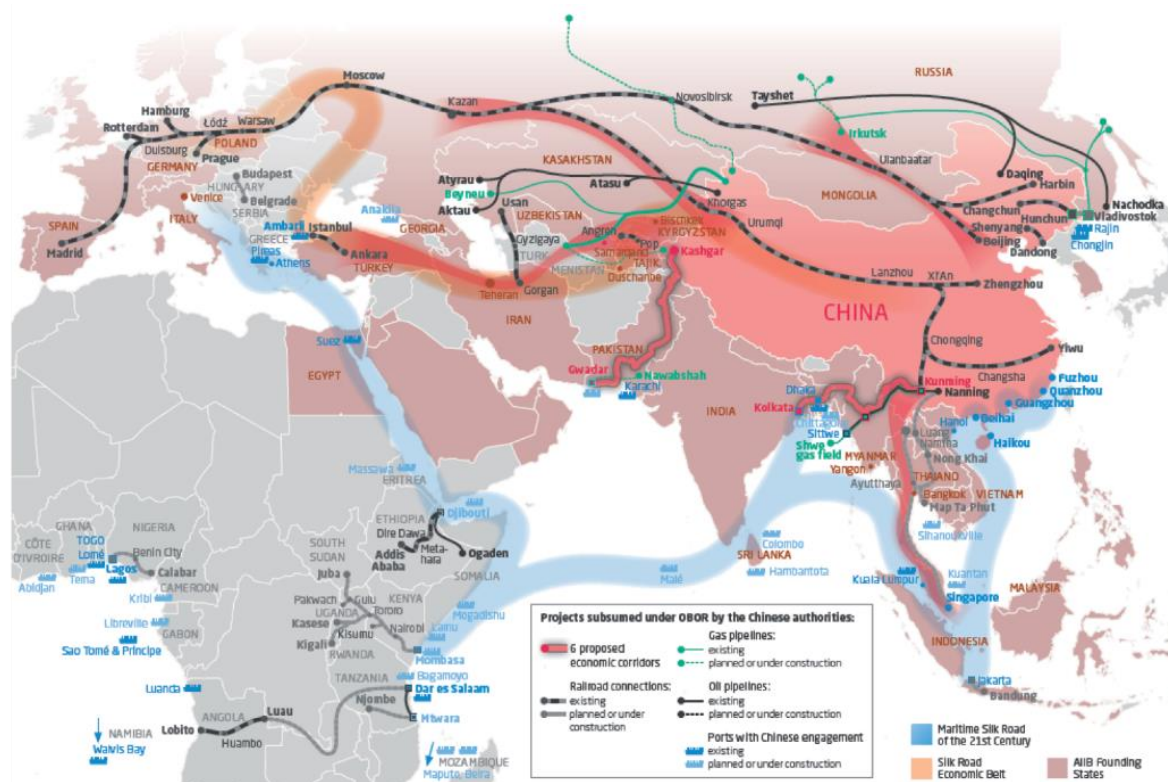


FIGURE 31 – ONE-BELT-ONE-ROAD LOGISTICS NETWORK

7.3. Current Operational Footprint

As illustrated in Figure 32,⁹⁵ Darwin Port tenure covers extensive maritime areas within Darwin Harbour and its nexus with Beagle Gulf, as well as significant areas of the Darwin Harbour shoreline.

⁹⁴ Wang, B. (2017), 'Philippines will attend China's One Belt One Road conference in May where there will be the announcement of many new deals', *Next Big Future*, 20 January

⁹⁵ Northern Territory Government Gazette No. G19, 17 May 2000



FIGURE 32 – BOUNDARIES OF DARWIN PORT

The operating facilities of Darwin Port are dispersed within this larger footprint and are described in the following subsections.

7.3.1. East Arm Wharf and Logistics Precinct

East Arm Wharf was commissioned in 2000 and is the main commercial cargo facility of Darwin Port. It is a multi-user facility supporting commodity ore exports, livestock exports, petroleum imports and bulk liquids, containerised import and export cargoes and specialised cargoes for particularly the offshore oil and gas industry. It also hosts quarantine and customs services including quarantine waste collection and disposal.

East Arm Wharf has a total quay-line length of 754 metres, apron width of 25.3 metres and berthing draught of 13 metres (Chart Datum), with the ability to handle vessels of up to 80,000 tonnes. Its operating facilities are summarised in the following subsections. It has a direct rail service as the terminus of the AustralAsia rail line that connects the Port to Alice Springs and Adelaide and into the eastern and western national rail networks. The East Arm Logistics Precinct, including wharf facilities is illustrated in Figure 33.⁹⁶

⁹⁶ Northern Territory Land Development Corporation

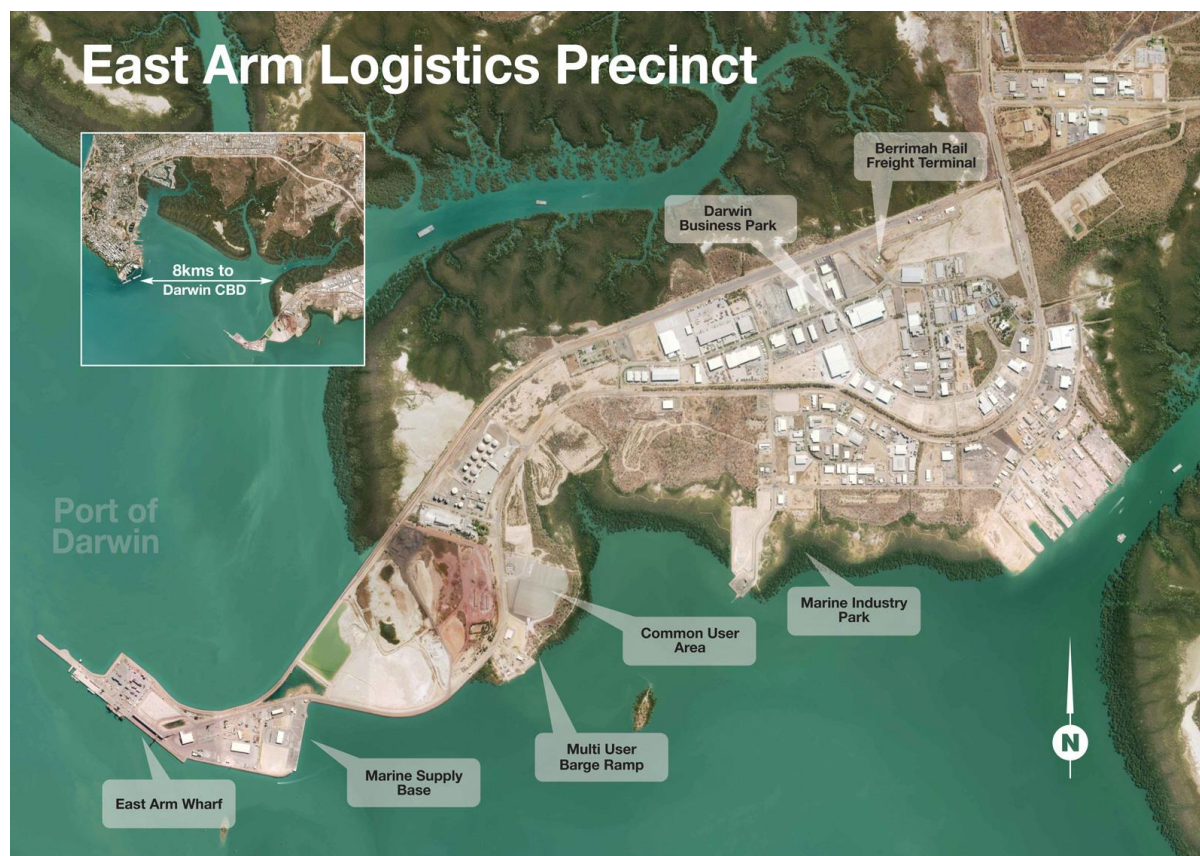


FIGURE 33 – EAST ARM LOGISTICS PRECINCT

The key facilities that comprise the East Arm Logistics Precinct are summarised in the following subsections.

Bulk Liquids Facility

A 157 metre bulk liquids berth is connected via a pipeline to a fuel oil facility and bio-diesel refinery. Additional piping allows the facility to handle other chemicals such as sulfuric acid stored at adjoining acid handling facilities.

Container and Common User Supply-Base Facility

Container capacity at East Arm Wharf is supported by 18 hectares of sealed hardstand (supply-base) connected to the Darwin-Adelaide rail-line by a 16-metre-wide, 2.5-kilometre railway access causeway and a container berth serviced by a portainer crane. It also hosts an onsite dry-bulk transit shed and reefer storage facility.

This berth also serves as a common user berth to discharge or load break-bulk cargo, including live cattle exports and offshore oil and gas tender vessels. The supply-base has the capacity to handle up to 1,000 offshore support vessels per annum.

Bulk Handling Facility

The bulk materials handling facility currently supports iron ore and manganese exports. It is comprised of a dedicated berth, a 1,500 tonne per hour rail dump facility, a road dump facility with the capacity of one truck every 3 minutes and a 2,000 tonne per hour ship-loader.

Multi-user Barge Ramp and Common User Area

A multi-user barge ramp that was co-funded with the Department of Defence is adjoined to another hardstand common-user area. This facility is used by various merchant barge operators, as well as periodically by the Australian and United States armed forces to support exercises, particularly amphibious operations associated with those exercises. The Department of Defence contributed \$16 million to this \$28 million investment and has 60 days of access to the facility per annum, and priority access in the event of an incident. This facility is near several registered sacred sites, and thus requires careful and sustained management of important heritage values in the area.

Recreational Boat Ramps

There are five heavily used recreational boat ramps located around the general Darwin Harbour Area.

Darwin Business Park and Berrimah Freight Terminal

Landside of East Arm Wharf is a light industrial area, with warehousing and office lots contained within the Darwin Business Park and freight facilities associated with the Berrimah Freight Terminal located on the railway line.

7.3.2. Hudson Creek Barge Facility

Located on the east side of the East Arm Wharf landside facilities are a number of service areas with forelands onto Hudson Creek (see Figure 33). These facilities are operated by a number of commercial coastal barge operations that service a large number of remote coastal communities in the Northern Territory, as well as Western Australia and Queensland (see Section 14.2).

7.3.3. Darwin Wharf Precinct

Located on the Darwin CBD waterfront, the Darwin Wharf Precinct includes the Stokes Hill and City (Fort Hill) Wharf sites. As discussed, prior to 2000, these wharfs were the main commercial operations of Darwin Port. Since the construction of the East Arm Wharf precinct, the Stokes Hill Wharf has been transformed into a restaurant and tourism precinct associated with the Darwin Convention Centre and Darwin Waterfront Precinct, which includes hotels, restaurants, retail, high density residential, office space and a wave park.

Shipping operations at the City (Fort Hill) Wharf are largely restricted to cruise ships and naval vessels visiting Darwin for rest and recreational purposes. A refuelling facility is also located adjacent to the City (Fort Hill) Wharf site.

The Darwin Wharf Precinct is illustrated in Figure 34.⁹⁷

⁹⁷ Northern Territory Land Development Corporation



FIGURE 34 – DARWIN WHARF PRECINCT⁹⁸

7.3.4. Fisherman's Wharf

Located northeast of the Darwin Wharf Area, Fisherman's Wharf is the home port for a number of local fishing and pearling operations and some coastal barge operations. The facility is comprised of a concrete wharf that can berth up to eighteen 30 metre vessels with power supply and bunkering, sliprails and maintenance facilities including machine, fabrication and electrical workshops. Repair berths for vessels up to 80 metres in length are also available.

Adjacent to the wharf is a marina with 85 berths that is used by the commercial fishing industry. A number of commercial operations have their offices and retail seafood outlets at the site.

7.3.5. Cullen Bay and Other Marina Facilities

The Cullen Bay Marina is located approximately two kilometres north of the Darwin CBD. It is a 140 berth, sea-locked, recreational marina, residential and restaurant precinct. Depicted in Figure 35 below⁹⁹, Cullen Bay Marina offers a range of services including water and power services berths for vessels of up to 25 metres length overall and refuelling.

⁹⁸ Note that some development has occurred since this photograph

⁹⁹ Tourism NT



FIGURE 35 – CULLEN BAY MARINA

Other marina facilities in Darwin Harbour include Bayview Marina and Tipperary Marina.

7.3.6. HMAS Coonawarra

HMAS Coonawarra is a naval base located on Larrakeyah Barracks and operating within Darwin Port. HMAS Coonawarra is discussed in detail in Section 6.

7.3.7. Wickham Point

Wickham Point is located on Middle Arm, immediately opposite East Arm Wharf and is the location of the ConocoPhillips operated Darwin LNG plant. Natural gas is piped to the facility from the Bayu Undan field in the Timor Sea and is processed at the Wickham Point facility, converted to LNG and exported via LNG carriers from a wharf at the facility.

Darwin LNG and ConocoPhillips operations are discussed in more detail in Section 10.

7.3.8. Bladin Point

West of Wickham Point, is Bladin Point, the location of Inpex's Ichthys LNG plant. This facility sources natural gas from a 900-kilometre pipeline connecting the plant to a production facility in the Browse Basin in Western Australia. The plant converts the raw natural gas to LNG and exports it via LNG carriers at a wharf located at the facility.

The Ichthys Project is discussed in greater detail in Section 10.

7.3.9. Channel Island Power Station

The Channel Island Power Station is located off Middle Arm and is the largest power station in the Northern Territory and the main source of electricity for the Darwin-Katherine Interconnected System. Commissioned in 1986, it is an open and combined cycle gas-fired plant with a capacity of 310 MW, with diesel back-up.

7.4. Expansion Plans

With significant maritime forelands, land-maritime interface and areas of shore-side land, Darwin Port lends itself to significant expansion potential. Current and planned expansion projects are discussed in the following subsections.

7.4.1. East Arm Wharf Precinct

Table 13 summarises sanctioned and proposed future expansion projects associated with East Arm Wharf.

Project	Description
Sanctioned Projects	
Refrigerated Container Park	Development of a powered container park with 50 to 200 reefer points.
Strategic Hardstand	Additional area of hardstand adjacent to the main East Arm Wharf quay-line.
Harbour Support Vessel Facility	Support vessel berths and associated facility.
Proposed Future Projects	
Quay-line Container Park Expansion	Expansion of the East Arm quay-line by 1,000 metres and land reclamation to support an ultimate container capacity at East Arm Wharf of 500,000 TEUs. This will require further reclamation.
Increased Bulk Mineral Commodity Capacity	Cross-land conveyor from stockpiles to bulk loading system, enclosed storage sheds, additional bulk loading systems and additional rail-loading systems.
Marine Supply-base Expansion	Expansion of existing supply-base area and quay-line to support new offshore projects in the region.

TABLE 13 – EAST ARM WHARF EXPANSION PROJECTS

7.4.2. Middle Arm Industrial Precinct

Middle Arm currently hosts the Darwin LNG and Ichthys subsea pipeline receivable, LNG processing and LNG export facilities at two separate sites, as well as the Channel Island Power Station. Middle Arm has been identified as the site for a 1,000-hectare industrial precinct that

will focus on downstream gas processing and gas related industries. The planned development for the Middle Arm Industrial precinct is illustrated in Figure 36.¹⁰⁰

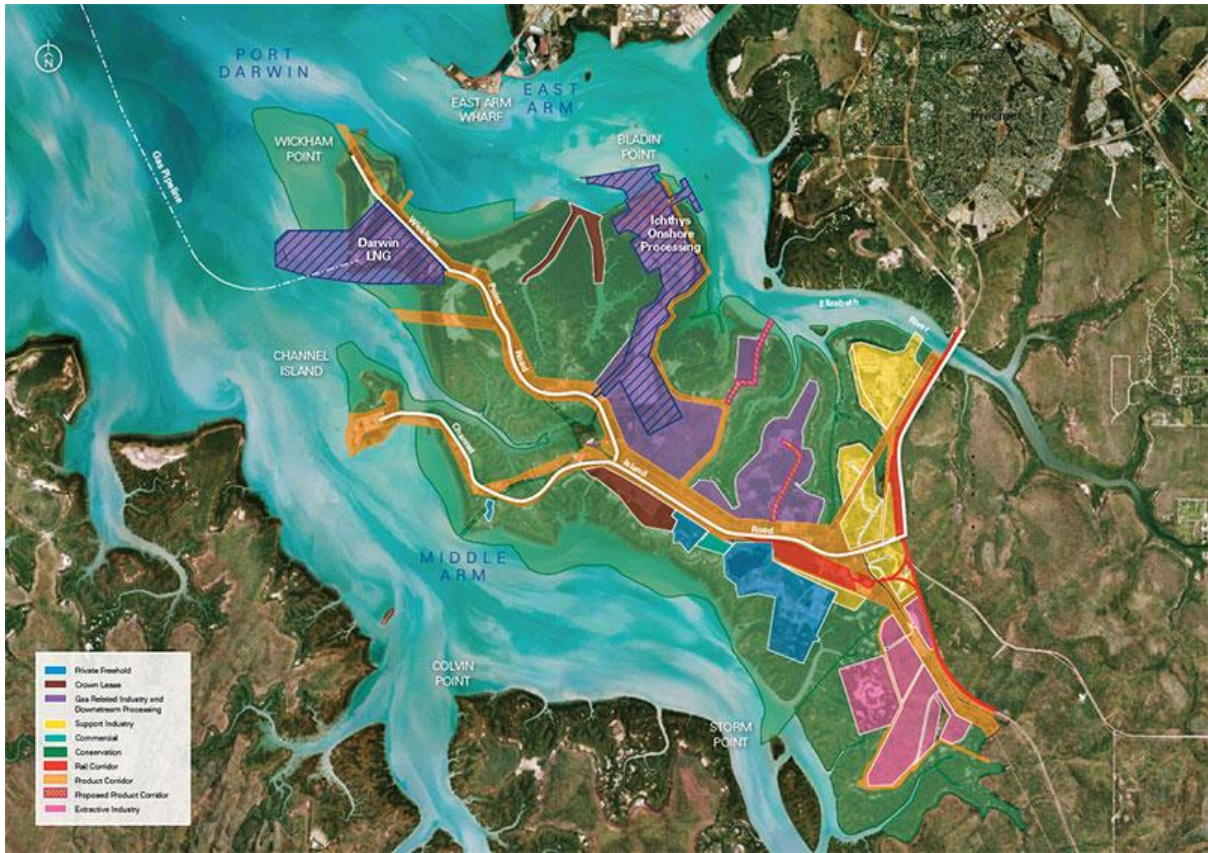


FIGURE 36 – PROPOSED MIDDLE ARM INDUSTRIAL PRECINCT

¹⁰⁰ Northern Territory Land Development Corporation

7.4.3. Other Expansion Projects

Table 14 summarises a number of other sanctioned and proposed projects at Darwin Port or closely associated with Darwin Port.

Project	Description
Sanctioned Projects	
Marine Industry Park	A total of 100 hectares of waterside land immediately south of the existing Darwin Business Park on East Arm Wharf, with potential for up to 2 kilometres of quay-line supporting marine related industries such as marine maintenance, marine services, marine logistics and a potential common-user ship-lifting facility. This facility may also support coastal shipping, replacing the tidally constrained Hudson Creek Facility. This facility will likely include a 2,500-tonne ship-lifting facility.
Defence Industry Hub	A 53-hectare site located near Robertson Barracks and approximately 13 kilometres from East Arm Wharf. Designed to attract private industry servicing the ADF.
Proposed Future Projects	
Transport Industry Precinct	A 70-hectare onshore site northwest of the existing Berrimah Freight Terminal. Development will include a large trailer park, assembly area, fuel outlet and vehicle maintenance services, as well as warehousing.
Cruiseline Facility	Additional quay-line and passenger handling facilities at the City Wharf Precinct to support larger cruiseliners and the potential home-basing of cruiseliners.
New Fishing Fleet Marina	The development of a new marina to host the commercial fishing and pearling industry.

TABLE 14 – OTHER DARWIN PORT EXPANSION PLANS

7.5. Key Issues and Marine Science Knowledge Needs

The main marine science knowledge needs of Darwin Port are summarised in the following subsections and detailed in Table 15.

7.5.1. Harbour Water Quality

In addition to hosting Darwin Port, the wider Darwin Harbour Area has important recreational and customary values for Northern Territorians and supports other industries such as pearling and tourism.

Public perceptions of the health of Darwin Harbour range from a 'pristine marine environment' to a 'rubbish tip'. In fact, the Darwin Harbour marine environment is likely one that has been moderately altered as the result of increased urbanisation and industrialisation over the course of the past 150 years. There is evidence of some water contamination, however, because of the long history of activity in the port, the source of this contamination is unclear.

Furthermore, because like much of the Northern Territory marine environment there is significant natural variation in the Darwin Harbour marine environment, determining water quality baselines are also challenging. Finally, because of significant daily water exchange through tidal action and significant seasonal flushing, the extent to which any contamination is localised or adequately dispersed such that it is relatively innocuous is also unknown.

7.5.2. Dredging

The 24 X 7 quay-line access to East Arm Wharf for Panamax and Handymax Class vessels requires a 14-metre channel depth. There are currently two choke points in Darwin Port's navigation channel network, Charles Point Patch (current depth of 13 metres) and the approach to East Arm Wharf (current depth of 12 metres). While it is unlikely there will be demand for Darwin Port to accommodate Cape Class Vessels in the foreseeable future, there may be demand for larger container vessels requiring wider channels with 20 metre depth. Addressing the choke points and accommodating larger vessels will require additional dredging.

Furthermore, because there is limited operating experience at the current levels of activity, the current maintenance dredging cycle requirements are not extensively understood. Initially, it was thought that berthing pockets would require dredging every six to seven years and channels every five years. However, the channels are starting to fill earlier than expected, the cause of which is not understood. The likely impact of a major storm event on the integrity of channels is also not well understood.

Both new dredging and maintenance dredging raises the question of how future dredge spoil is best handled and the cumulative impact of dredging activity within the Darwin Harbour Area.

7.5.3. Other Issues

The wider Darwin Harbour Area has a number of users. It is the main focus of the recreational fishing sector, hosts numerous sacred sites and is the focus of many customary practices. It also supports other industry and defence operations. Darwin Port has at times been very busy. For example, during recent peak activity (see Figure 29), berth occupancy reached 69 percent. Coming off that peak activity, berth occupancy is currently at approximately 40 percent. Port traffic levels can be quite sensitive to intermittent activities and when traffic levels increase, user conflict can occur. Understanding predictors of this and suitable responses assists with improved port management.

Because commercial vessels are continuously moving and operators are motivated to keep hulls free of biofouling to improve efficiency, commercial vessels are not considered a major biosecurity threat. However, an increasing number of smaller recreational cruising vessels visiting the Darwin Harbour Area increases the risk of the introduction of exotic species from other parts of Australia and Asia.

As both the port and suburban Darwin expands, it is likely that conflicts around the port-residential interface will increase.

There is increasing recognition of Aboriginal interests in the wider Darwin Harbour Area, including areas managed by the Darwin Port. Integrating these interests in Port management decisions is of critical concern.

Key Issue	Description	Specific Marine Science Needs
WATER QUALITY		
Harbour Baselines	There is currently a good understanding of Darwin Harbour water quality in the areas of industrial activity and their immediate surrounds such as the Darwin Wharf Area, East Arm Wharf, Wickham Point, Blaydin Point, Channel Island and Larrakeyah Barracks and HMAS Coonawarra. However, there is limited toxicology data pertaining to other areas of Darwin Harbour.	Study to prioritise water quality measurement and monitoring sites beyond those which are well understood. Undertaking of additional water quality baseline measurements
Definition of the Harbour Baseline Benchmark	Because of a long history of albeit relatively limited industrial activity and periods of heightened defence activity (i.e. Japanese raids on Darwin during the Second World War), Darwin Harbour is an altered marine environment. Furthermore, because it is such a dynamic environment, there is considerable natural variation in its condition. As such, determining an appropriate baseline range for key environmental variables is both important and challenging.	Study to determine an appropriate range of water quality baseline for Darwin Harbour.
Identification of Contemporary Sources of Contamination	There are several contemporary potential sources of identified contamination in the wider Darwin Harbour Area including run-off from Darwin City, contamination from live-export activities and minerals exports, and brine and saltwater discharge from LNG facilities. There are	Toxicology and oceanographic studies around known sources of potential contamination determine attribution of known contamination in Darwin Harbour.

Key Issue	Description	Specific Marine Science Needs
	<p>also significant potential historical sources of contamination including the former sewerage drain near HMAS Coonawarra, shipwrecks from WWII, rubbish disposed in the Harbour, lead exports from Fort Hill Wharf, tributyltin (TBT) from vessel cleaning at the former slip-way and the old power station site. Understanding the source of contamination is important for determining baselines and designing and prioritising remediation efforts.</p>	
DREDGING		
<p>Data and Modelling to Understand and Plan for Maintenance Dredging Cycle</p>	<p>Possible causes of what appears to be a shorter than anticipated dredging cycle include sandbar drift, long-waves moving sand across the Harbour seabed (particularly at Charles Patch Point) or dredge spoil being transported by tidal movements back into the Harbour.</p> <p>Understanding the cause of what appears to be a shorter than expected maintenance dredging cycle, as well as the possible impact of major storm events on channel integrity, requires detailed modelling of the oceanographic processes within Darwin Harbour and the regional oceanographic processes that affect it.</p>	<p>Detailed oceanographic and bathymetry surveys and modelling of Darwin Harbour and the immediate regional ocean environment to determine processes that are leading to seabed transport into existing channels as the basis for scheduling and optimising maintenance and design of channel expansion or new channels.</p>

Key Issue	Description	Specific Marine Science Needs
Future Dredge Spoil Management	<p>Ongoing maintenance dredging and future dredging to address bottlenecks and facilitate port expansion will likely place pressure on the current dredge spoil dumping site, which is approximately 30 kilometres from Darwin Harbour. Determining the effectiveness and capacity of this site, as well as other potential sites will be important in facilitating future dredging.</p> <p>Furthermore, there is some community pressure to bring dredge spoil onto land. Based on current technology and usage potential, this would likely render port expansions sub-economic. To mitigate this risk, cost-effective ways of transferring dredge spoil land-side and economic terrestrial uses of dredge spoil should be determined.</p>	<p>Assessment of the integrity of the current offshore dredge spoil dumping site and determination of its capacity.</p> <p>Identification of other potential future offshore dredge spoil dumping sites.</p> <p>Examination of potential economic onshore applications of dredge spoil.</p>
Understanding Impacts of Dredging	<p>Cumulative While the large water movements in Darwin Harbour suggest that the cumulative impacts of dredging are most likely limited, understanding potential cumulative impacts on the Darwin Harbour marine environment should be definitively determined.</p>	<p>Oceanographic studies and modelling to determine destination of dredge plumes and transported soil, and the ecosystems they affect.</p> <p>Assessment of the health of ecosystems reached by dredge plumes and spoil.</p>

OTHER ISSUES

Key Issue	Description	Specific Marine Science Needs
Biosecurity on Small Cruising Vessels	Biosecurity risk associated with larger vessels is considered limited due to ballast discharge taking place outside of territorial waters, and hulls remaining relatively clean because of constant movement and commercial motivation to keep hulls clean. However, private cruising vessels present a greater risk.	<p>Detailed assessment of the origination of private cruising vessels entering Darwin Harbour and a corresponding exotic pest transport risk assessment.</p> <p>Identification of specific ports of origination and specific exotic pests that present the greatest risk to the biosecurity of Darwin Harbour.</p> <p>Design of an efficient vessel inspection protocol and invasive species monitoring programme for private cruising vessels visiting Darwin Harbour.</p>
Harbour Usage Trends and Conflict Triggers	The wider Darwin Harbour Area can be subject to congestion and user conflict at times of heightened activity. Understanding triggers to congestion and user conflict and areas where congestion occurs can assist in the management of these issues. Additionally, understanding longer term trends in the usage of specific interest groups.	<p>Longitudinal study of historical harbour traffic identifying types of vessel and intensity of use of specific navigation channels, anchorages, wharf facilities and recreational boat ramps to determine triggers for heightened activity of particular port users.</p> <p>Assessment of likely future trends in Darwin Harbour usage by main users such as offshore oil and gas, defence, recreational fishing sector, live export and containership lines. As well as drivers of these trends such as the impact of increased crocodile numbers on increased leisure alternatives for recreational use in Darwin Harbour.</p>
Port-Residential Interface	As the boundary of residential areas, particularly the suburb of Berrimah, approach port operational areas, particularly around East Arm Point, understanding the potential impact of port operation externalities on residential areas	Dust and noise studies in areas surrounding the port that have been identified as imminent or future residential areas.

Key Issue	Description	Specific Marine Science Needs
	and means of mitigating the impact of those externalities will become increasingly important.	Identification of port infrastructure investments that will be required to minimise noise and dust externalities in suburban areas.
Role of Traditional Owners in Management	Better mechanisms are required for Traditional Owners to influence management to maintain customary interests in natural and cultural heritage	Review of relevant laws to better access Aboriginal views and recognise rights in the management of Darwin Harbour and port affairs.
Understanding and Ongoing Monitoring of Change and Impacts of Particular Relevance to Aboriginal Interests	Incorporation of Aboriginal views and perspectives in the design of research and monitoring programmes, including the application of Aboriginal knowledge	Principles and criteria for design of research and monitoring programmes capable of meeting multiple needs and applying IEK.

TABLE 15 – MARINE SCIENCE KNOWLEDGE NEEDS OF DARWIN PORT

8. Commercial Fishing Industry

8.1. Commercial Fishing Industry and the Northern Territory Economy

The Australian wild-catch and aquaculture industry produces a GVP of over \$1.4 billion. As illustrated in Figure 37,¹⁰¹ the Northern Territory wild-catch and aquaculture industries account for approximately 4.3 percent of national production.

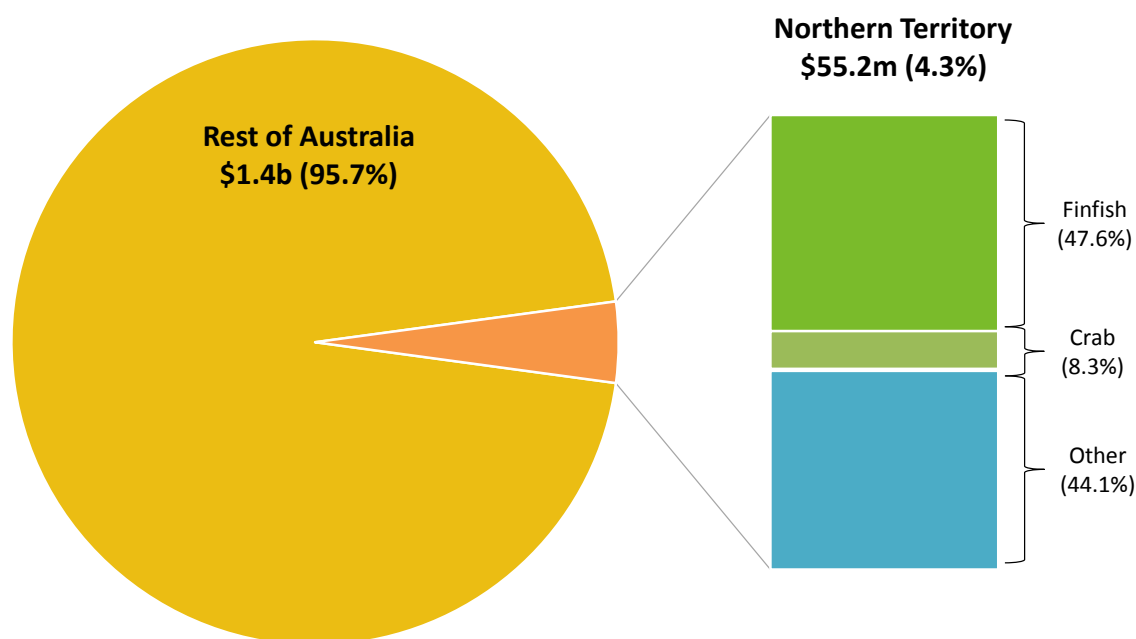


FIGURE 37 – NORTHERN TERRITORY WILD-CATCH AND AQUACULTURE PRODUCTION IN THE NATIONAL CONTEXT

The Northern Territory wild-catch fishery is comprised of several fisheries that are managed:

- Under the exclusive jurisdiction of the Northern Territory Government;
- Jointly between the Northern Territory and Commonwealth Government; or
- Under the exclusive jurisdiction of the Commonwealth Government.

The Northern Territory aquaculture and pearling industry is discussed in Section 9.

¹⁰¹ Fisheries Research and Development Corporation (2016), *Australian Fisheries and Aquaculture Statistics*, Australian Government, Canberra

As illustrated in Figure 38,¹⁰² the GVP from Northern Territory and jointly managed fisheries has ranged between \$25 and \$35 million over the past decade, with various finfish species collectively accounting for the majority of this GVP, followed by Mud Crabs.

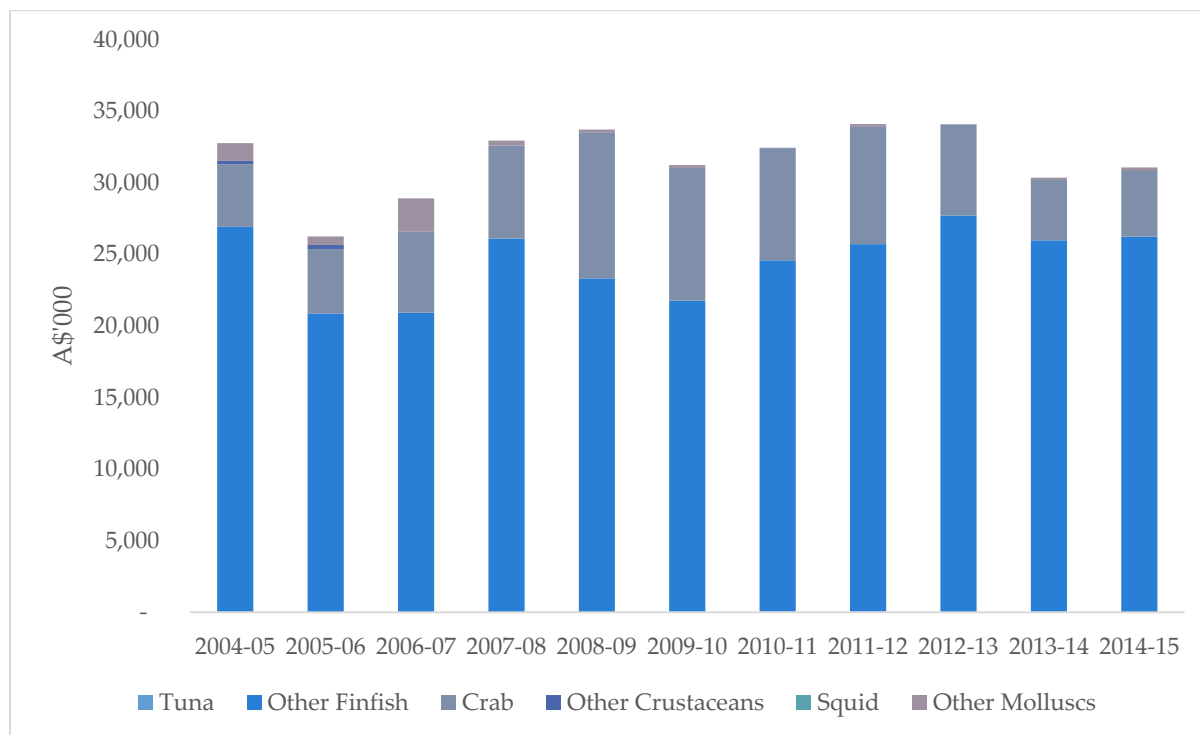


FIGURE 38 – GROSS VALUE OF PRODUCT – MAJOR SECTORS OF NORTHERN TERRITORY FISHERIES

Of the two fisheries located in the Northern Territory marine environment that are managed exclusively by the Commonwealth, the NPF accounts for the majority of GVP. This is illustrated in Figure 39.¹⁰³ The NPF includes areas outside the Northern Territory marine environment. In 2015, operations in the NPF inside the boundaries of the Northern Territory marine environment accounted for approximately 58 percent of the catch by tonnage. However, the Northern Territory Government estimates that NPF operations based out of the Northern Territory account for approximately 21 percent of the fishery's GVP.¹⁰⁴ This implies that the Northern Territory component of the NPF adds between approximately \$20 and \$60 million to the value of the Northern Territory commercial fishery, valuing production from the total Northern Territory wild-catch fishing industry at between approximately \$50 and \$90 million per annum.

¹⁰² Fisheries Research and Development Corporation (2016), *Australian Fisheries and Aquaculture Statistics*, Australian Government, Canberra

¹⁰³ Ibid

¹⁰⁴ *Economic Outlook 2015* (2015), published NT Department of Primary Industry and Fisheries, available <http://dpif.nt.gov.au>

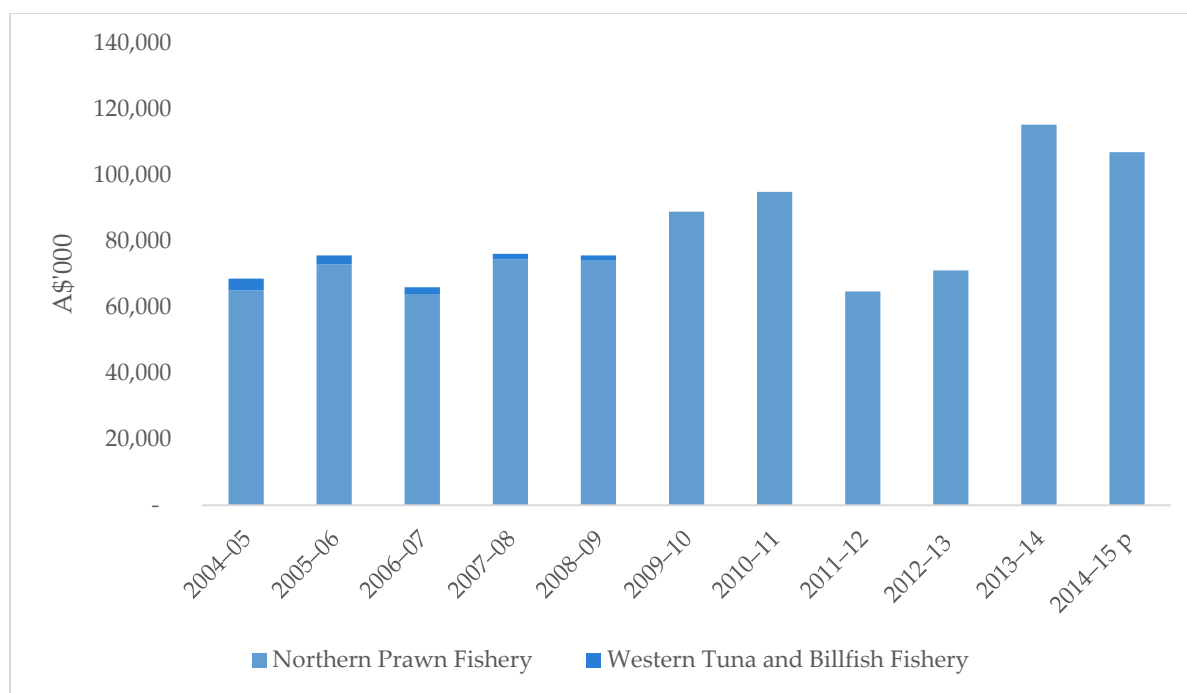


FIGURE 39 – COMMONWEALTH NORTHERN PRAWN FISHERY AND WESTERN TUNA AND BILLFISH FISHERY

While GVP from the commercial fishing industry is smaller than some other sectors of the Northern Territory economy such as oil and gas and minerals, it remains an important sector of the economy. The vast majority of fishing operations in the Northern Territory are Small to Medium Enterprise style businesses, employing fewer than 20 staff.¹⁰⁵

8.2. Northern Territory Managed Fisheries

The fisheries that are managed exclusively by the Northern Territory Government through the Fisheries Group at the Department of Primary Industry and Resources (see Section 5.2.1) are those fisheries that operate exclusively in Northern Territory waters, meaning they are coastal and estuarine oriented. These include the Barramundi Fishery, Coastal Line Fishery, Mud Crab Fishery, Trepang Fishery and several small fisheries consisting of relatively few licences that have been granted to a number of other coastal operations.

Figure 40¹⁰⁶ summarises production from the Northern Territory managed fisheries of greatest economic significance in 2014.

¹⁰⁵ *Economic Outlook 2015* (2015), published NT Department of Primary Industry and Fisheries, available <http://dpif.nt.gov.au>

¹⁰⁶ *Status of Key Northern Territory Fish Stocks Report 2014* (2016), Fisheries Report no. 115, Northern Territory Department of Primary Industry and Resources, available www.dpir.nt.gov.au

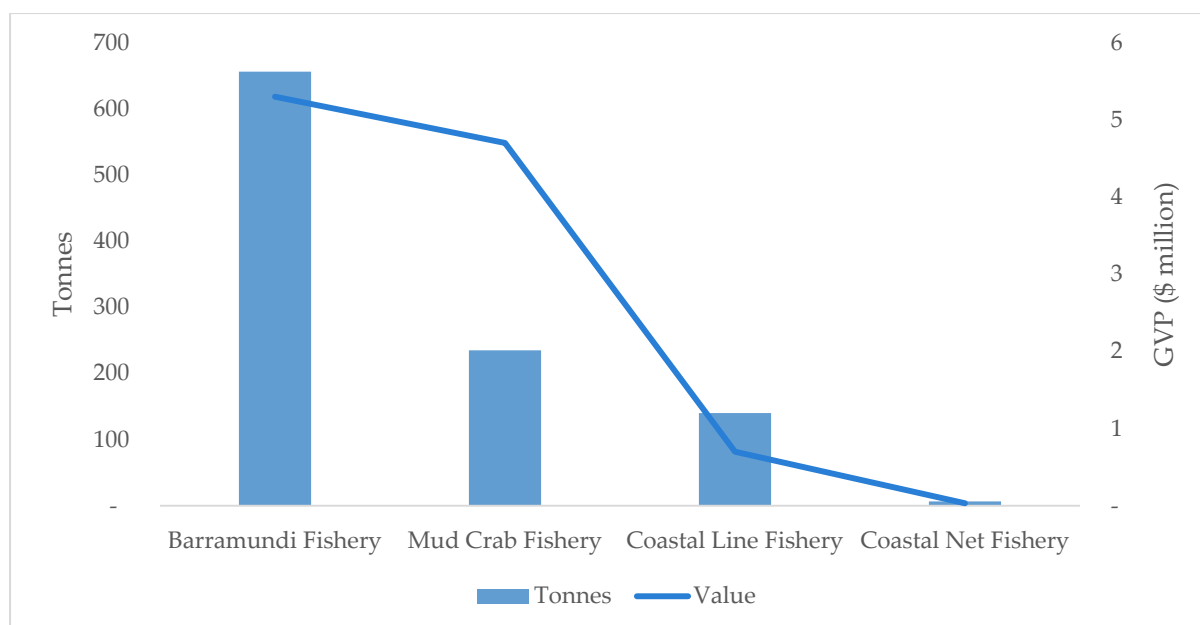


FIGURE 40 – PRODUCTION FROM THE NORTHERN TERRITORY MANAGED FISHERIES

8.2.1. Barramundi Fishery

There is currently a total of 14 licences in the Northern Territory Barramundi Fishery, held by several operators that collectively operate nine vessels. These operations use gillnets to target Barramundi in the size range of 60 to 80 centimetres, as well as King Threadfin and Blue Salmon.¹⁰⁷ In 2014, this fishery demonstrated a total catch of 656 tonnes of fish comprised of 62 percent Barramundi, 32 percent King Threadfin and 2 percent Blue Salmon. The majority of the fishing effort was focused on Anson Bay, Van Diemen Gulf, East Arnhem, Central Arnhem and Limmen Bight.¹⁰⁸

Significant areas of the coastal line fishery have been closed because of a decision by the Northern Territory Government to reallocate resource to the recreational sector. These areas include most river systems in the Northern Territory from the Little Finniss River to the Wildman River.

Much commercial barramundi fishing occurs in or adjacent to Aboriginal controlled waters.

As illustrated in Figure 41,¹⁰⁹ the commercial Barramundi Fishery extends along much of the Northern Territory coastline seaward of the shore (with most rivers and creeks closed to commercial operators) but it is periodically interrupted by significant areas of fishery closure.

¹⁰⁷ Northern Territory Seafood Council (2016), *NT Professional Seafood Industry Fact Sheet – Barramundi Wildcatch Fishery*

¹⁰⁸ *Status of Key Northern Territory Fish Stocks Report 2014* (2016), Fisheries Report no. 115, Northern Territory Department of Primary Industry and Resources, available www.dpir.nt.gov.au

¹⁰⁹ Northern Territory Seafood Council (2016), *NT Professional Seafood Industry Fact Sheet – Barramundi Wildcatch Fishery*



FIGURE 41 – NORTHERN TERRITORY BARRAMUNDI FISHERY

8.2.2. Mud Crab Fishery

The Mud Crab Fishery is comprised of 49 licences operated by 35 fishing operations. These operators exclusively target Mud Crabs using pots. Historically, the Mud Crab fishing effort has been concentrated in the Gulf of Carpentaria¹¹⁰; however, in more recent years the catch has been distributed approximately equally between the southern Gulf of Carpentaria and the Greater Darwin Area.

Much of the commercial Mud Crab catch is taken from waters owned by Aboriginal people. However, Aboriginal participation in the management of the Mud Crab Fishery is limited to singular representation on the Mud Crab Fishery Advisory Committee. Many stakeholders agree that a more regional management framework involving appropriate representation from regional Aboriginal interests is required.

The location of the Mud Crab Fishery is illustrated in Figure 42.¹¹¹

¹¹⁰ Northern Territory Seafood Council (2016), *NT Professional Seafood Industry Fact Sheet –Mud Crab Fishery*

¹¹¹ Ibid



FIGURE 42 – NORTHERN TERRITORY MUD CRAB FISHERY

8.2.3. Coastal Line Fishery

The Northern Territory Coastal Line Fishery is comprised of a Western Zone, under which access is controlled through quota holdings, and an Eastern Zone that is open to all fishers. There is a total of 52 licences issued across the fishery, of which 17 are currently active across both zones. The licences allow the taking of most species apart from Barramundi, Spanish Mackerel, Threadfin, Mud Crab, various sharks and Trepang.¹¹² Industry currently targets various snapper, cod and emperor species using hook and line methods. However, there are some differences between the two zones, whereby traps may be used in the Eastern Zone and Black Jewfish are also targeted in the Western Zone.

In 2014, the total catch from the Coastal Line Fishery was 140 tonnes, of which the vast majority (94 percent) was Black Jewfish, distantly followed by Golden Snapper (2.8 percent). The fishing effort is concentrated on rock reefs less than 150 kilometres from Darwin.¹¹³

¹¹² Northern Territory Seafood Council (2016), *NT Professional Seafood Industry Fact Sheet – Coastal Line Fishery*

¹¹³ *Status of Key Northern Territory Fish Stocks Report 2014* (2016), Fisheries Report no. 115, Northern Territory Department of Primary Industry and Resources, available www.dpir.nt.gov.au

As illustrated in Figure 43,¹¹⁴ the Coastal Line Fishery spans the entirety of the Northern Territory coastline, with some areas temporarily closed for management purposes.



FIGURE 43 – NORTHERN TERRITORY COASTAL LINE FISHERY¹¹⁵

8.2.4. Trepang Fishery

A single operator owns all six Northern Territory Trepang licences that were acquired on the open market (including from Aboriginal groups that previously owned licences) and dive for Trepang from operating vessels that are supported by dories. The extent of the Trepang Fishery is illustrated in Figure 44.¹¹⁶ Aboriginal people have a long history of Trepang fishing, but while much of the present commercial Trepang fishing activity occurs in or adjacent to Aboriginal-owned waters and lands, Aboriginal people do not have a role in the management of the Trepang fishery.

¹¹⁴ Northern Territory Seafood Council (2016), *NT Professional Seafood Industry Fact Sheet – Coastal Line Fishery*

¹¹⁵ Note that this map is for indicative purposes only. The Western Zone of the Fishery does not follow the territorial sea baseline and it omits some areas of the Van Diemen Gulf.

¹¹⁶ Northern Territory Seafood Council (2016), *NT Professional Seafood Industry Fact Sheet – Trepang Fishery*



FIGURE 44 – NORTHERN TERRITORY TREPANG FISHERY

8.2.5. Coastal Net and Other Northern Territory Fisheries

There is a total of seven other Northern Territory commercial fishing licences. While important to livelihoods, they collectively make minimal contribution to total Northern Territory wild-catch fishery GVP. There are five licences to use nets to target coastal Mullet and baitfish and one mollusc licence.¹¹⁷

In 2014, the Coastal Net Fishery took 6.5 tonnes of Mullet, Blue Threadfin, Queenfish and shark Species, with Mullet accounting for 76 percent of this catch. Because of specific area controls attached to each licence, this effort is concentrated in the Darwin Harbour Area, Gove and Borroloola.¹¹⁸

8.2.6. Aboriginal Coastal Licence

The Northern Territory DENR also grants what might be described as 'quasi-commercial' licences to individual operators in coastal communities. The Aboriginal Coastal Licence framework was implemented to provide for seafood supply into communities.

These licences allow individuals to take various species using recreational fishing gear (spears, dab nets, hook and line, traditional fish traps, as well as more recently up to 100 metres of gill netting with mesh size smaller than 65 millimetres) to either supply fresh fish to a local community or to sell fresh fish into a third-party supply chain.

¹¹⁷ Northern Territory Seafood Council (2016), *NT Professional Seafood Industry Fact Sheet – Coastal Net Fishery*

¹¹⁸ *Status of Key Northern Territory Fish Stocks Report 2014* (2016), Fisheries Report no. 115, Northern Territory Department of Primary Industry and Resources, available www.dpir.nt.gov.au

While holders of these licences are allowed to retain and sell small volumes of commercially managed species that are taken as by-catch under the conditions of these licences, they are not permitted to directly target those species or retain and sell commercial volumes of those species. Holders of Aboriginal Coastal Licences are also subject to several other limitations that do not apply to other commercial fishing licences.

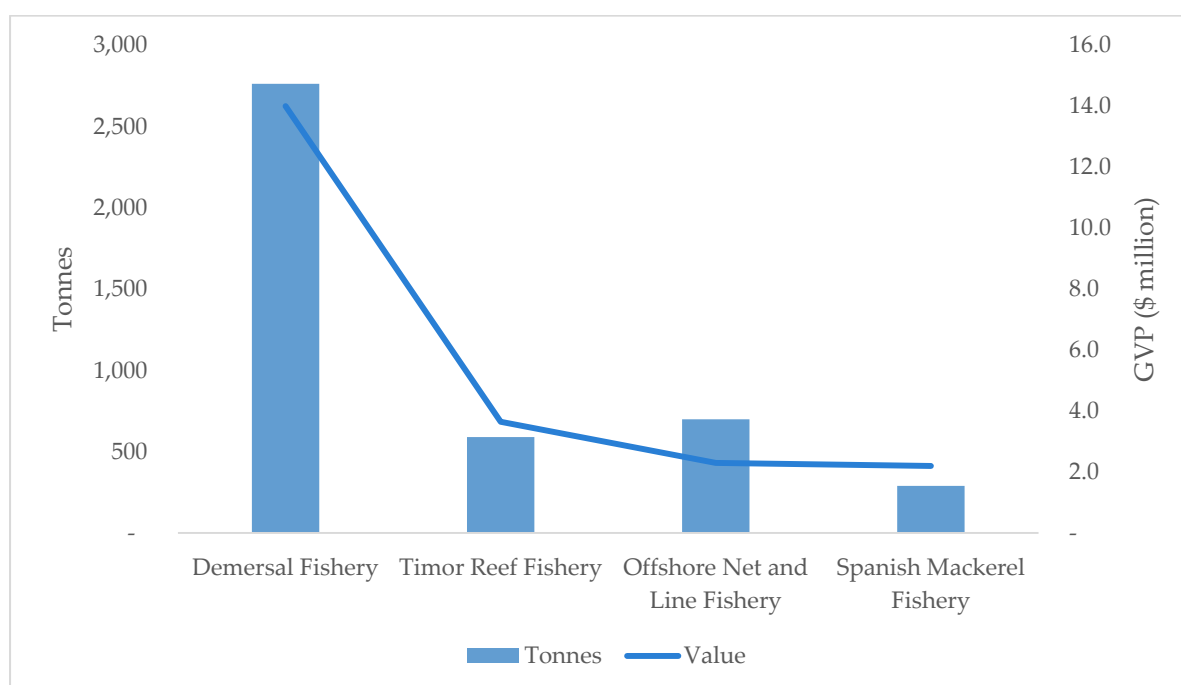
One of the secondary policy intentions of these licences is to provide Aboriginal communities with the ability to establish small fishing enterprises operating in their waters for the purposes of supporting livelihoods in those communities, develop local economies and to develop experience and skills that may result in the transition of those enterprises or people working in those enterprises into the existing commercial fishery licencing framework.

As discussed previously, several commercial fisheries including the Barramundi, Mud Crab and Trepang fisheries take stock from Aboriginal waters or waters adjacent to Aboriginal waters. In this context, the current commercial fishery framework and the limitations of Aboriginal Coastal Fishing Licences is of considerable concern to Aboriginal custodians of and stakeholders in the Northern Territory marine environment.

8.3. Jointly Managed Fisheries

There are five fisheries that are managed under the joint jurisdiction of the Northern Territory and Commonwealth Government. From a day-to-day management perspective, the responsibility resides primarily with the Northern Territory Government. However, because the fisheries extend into Commonwealth Waters and the EEZ, the Commonwealth retains some jurisdiction.

The 2014 production from the Northern Territory and Commonwealth jointly managed fisheries (excluding the aquarium fishery) is summarised in Figure 45¹¹⁹ below.



¹¹⁹ *Status of Key Northern Territory Fish Stocks Report 2014 (2016)*, Fisheries Report no. 115, Northern Territory Department of Primary Industry and Resources, available www.dpir.nt.gov.au

FIGURE 45 – 2014 PRODUCTION FOR NORTHERN TERRITORY AND COMMONWEALTH JOINTLY MANAGED FISHERIES

8.3.1. Demersal Fishery

The Northern Territory Demersal Fishery is comprised of 13 licences, of which 7 are currently active and is managed under a quota regime whereby the current TAC is 2,500 tonnes for Red Snapper, 400 tonnes Goldband Snapper and 915 tonnes of other retained species.¹²⁰ Operators of this fishery use hook and line, traps and trawling equipment to target Red Snapper, as well as various cod and emperor species.¹²¹ In 2014, approximately 2,750 tonnes of primarily Red Snapper (44 percent), Goldband Snapper (11 percent) and Sweetlip Snapper (5 percent) was landed from the fishery. The fishing effort associated with the Demersal Fishery is widely dispersed but is more concentrated west of Palmerston Island and East of the Goulburn Islands.¹²²

As illustrated in Figure 46¹²³, the fishery covers the entire Northern Territory coastline, out to the AFZ boundary.

¹²⁰ Australian Fisheries Management Authority (2012), *Management Arrangements for the Northern Territory's Demersal Fishery*, Australian Government, Canberra

¹²¹ Northern Territory Seafood Council (2016), *NT Professional Seafood Industry Fact Sheet – Demersal Fishery*

¹²² *Status of Key Northern Territory Fish Stocks Report 2014* (2016), Fisheries Report no. 115, Northern Territory Department of Primary Industry and Resources, available www.dpir.nt.gov.au

¹²³ Northern Territory Seafood Council (2016), *NT Professional Seafood Industry Fact Sheet – Demersal Fishery*

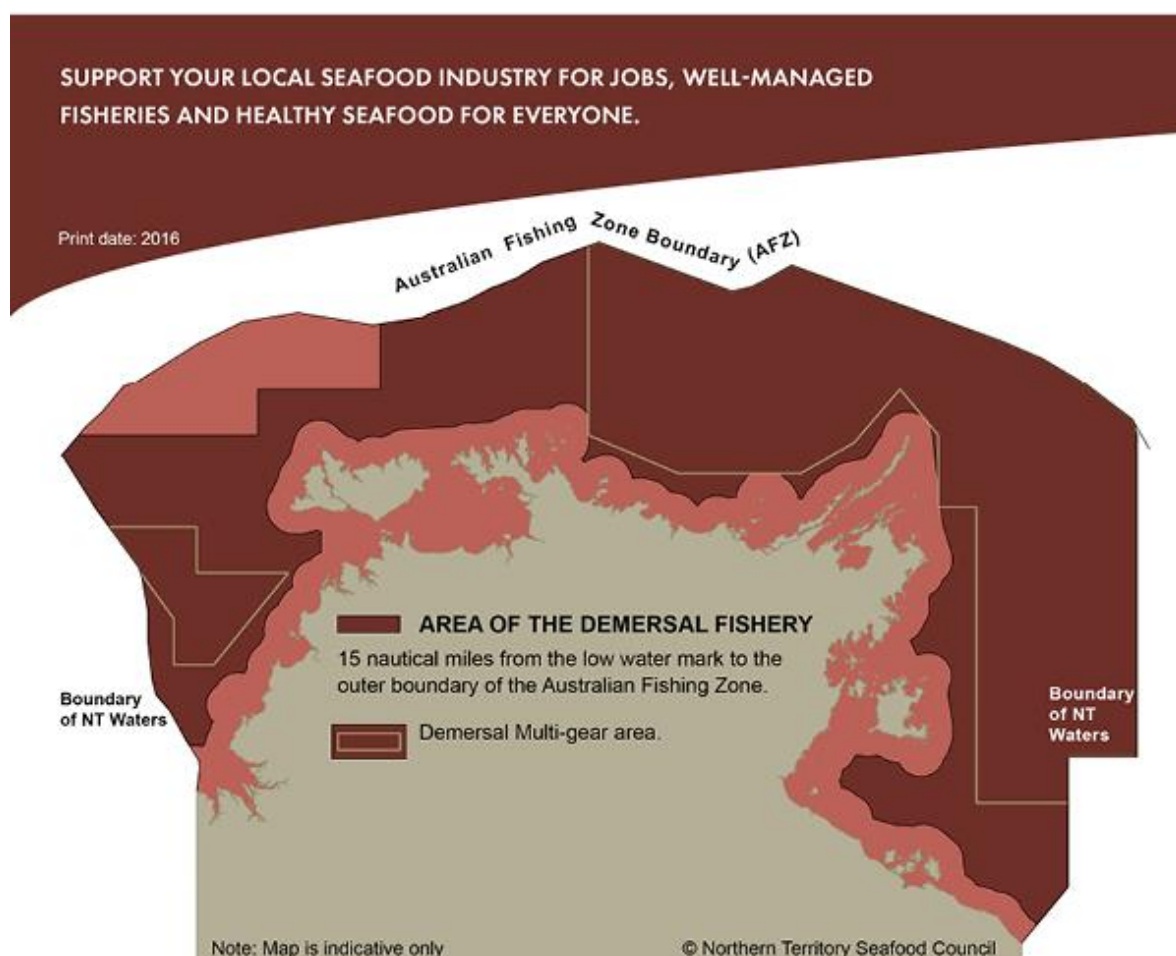


FIGURE 46 – NORTHERN TERRITORY DEMERSAL FISHERY¹²⁴

8.3.2. Offshore Net and Line Fishery

The Northern Territory Offshore Net and Line Fishery is comprised of 17 licences that are currently fished by between three and five vessels. These operators are targeting Black-tip Sharks and Grey Mackerel using long-line systems.¹²⁵ In 2014, the primary catch from this fishery was Grey Mackerel, which accounted for 72 percent of the total 699 tonnes caught, followed by Black-tip Sharks (10 percent), Hammerhead Sharks (3 percent) and Spot-tailed Sharks (3 percent).

As illustrated in Figure 47¹²⁶, the fishery covers the entire Northern Territory coastline out to the boundary of the AFZ.

¹²⁴ Note that this map does not illustrate recent changes to the boundary.

¹²⁵ Northern Territory Seafood Council (2016), *NT Professional Seafood Industry Fact Sheet – Offshore Net and Line Fishery*

¹²⁶ Ibid

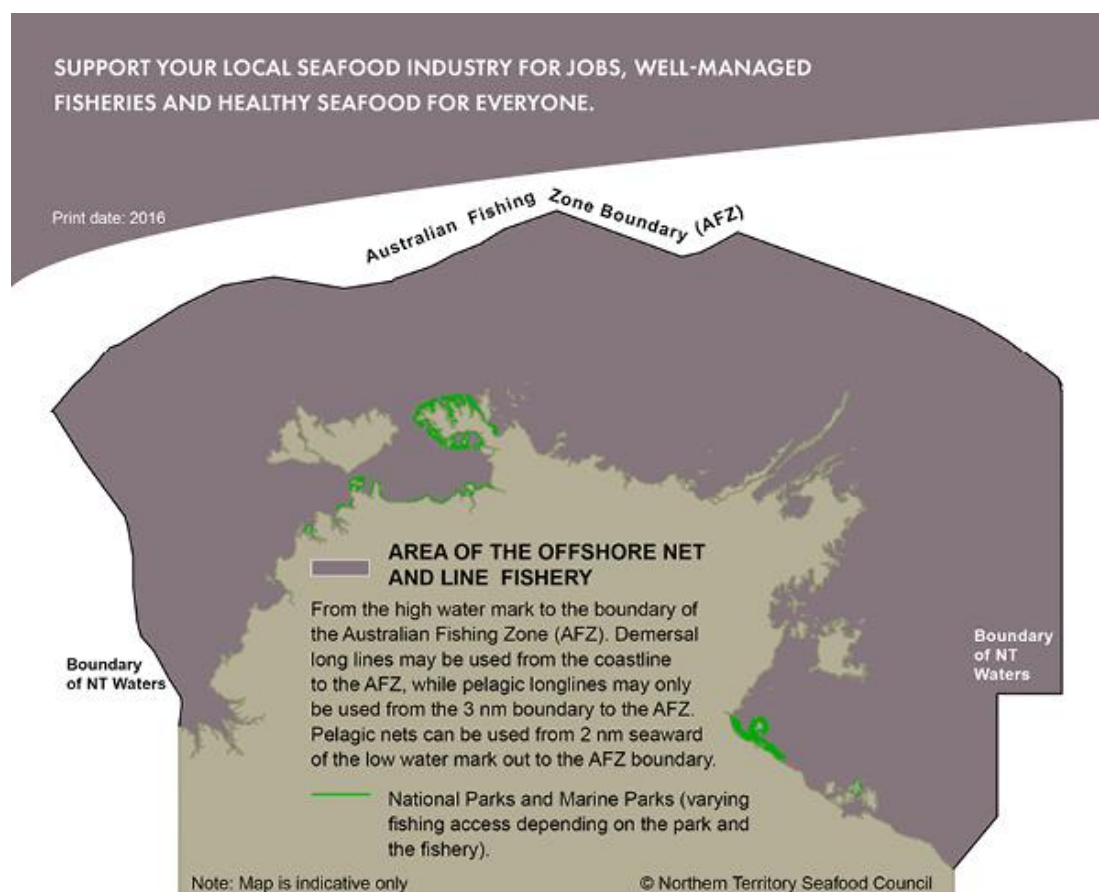


FIGURE 47 – NORTHERN TERRITORY OFFSHORE NET AND LINE FISHERY

8.3.3. Spanish Mackerel Fishery

The Spanish Mackerel Fishery is the only Northern Territory fishery that is currently managed according to a TAC, with a total of 342 tonnes across 15 licences that are currently operated by 11 boats.¹²⁷ Operators use troll gear to exclusively target Spanish Mackerel, with a very small amount (less than 1 percent of the total catch) of Grey Mackerel and Trevally also taken as by-catch. The fishing effort is concentrated around Bathurst Island, New Year Island, Sir Edward Pellew Group and Wessel Islands and Groote Eylandt.¹²⁸

As illustrated in Figure 48¹²⁹, the fishery can fish the entire Northern Territory coastline out to the boundary of the AFZ.

¹²⁷ Northern Territory Seafood Council (2016), *NT Professional Seafood Industry Fact Sheet – Spanish Mackerel Fishery*

¹²⁸ *Status of Key Northern Territory Fish Stocks Report 2014* (2016), Fisheries Report no. 115, Northern Territory Department of Primary Industry and Resources, available www.dpir.nt.gov.au

¹²⁹ Northern Territory Seafood Council (2016), *NT Professional Seafood Industry Fact Sheet – Spanish Mackerel Fishery*

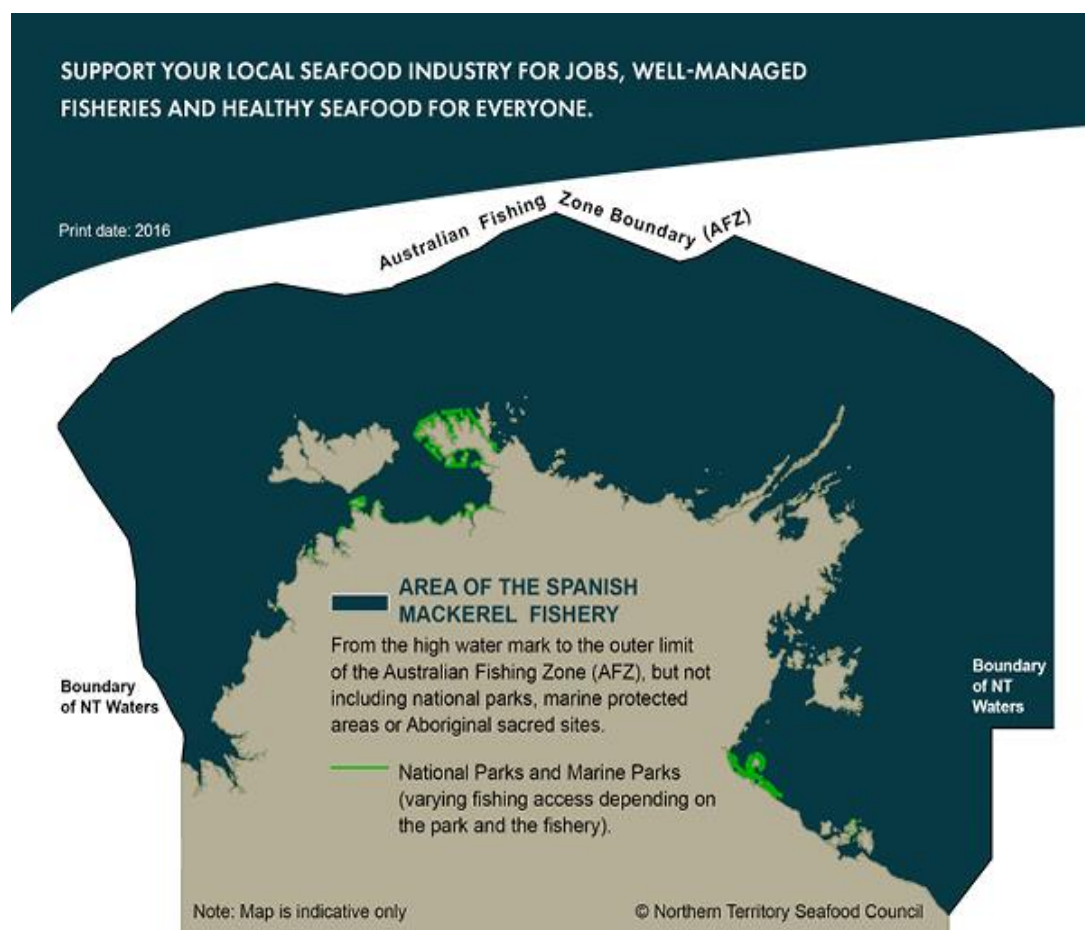


FIGURE 48 – NORTHERN TERRITORY SPANISH MACKEREL FISHERY

8.3.4. Timor Reef Fishery

The Timor Reef Fishery is comprised of 12 licences to fish in the 'Timor Box', an area of approximately 8,400 square nautical miles, extending to the outer boundary of the AFZ, which is currently worked by eight vessels. The fishery is managed under a quota regime, with a TAC of 900 tonnes for Goldband Snapper species, 1,300 tonnes for Red Snapper species and 415 tonnes for all other retained group species.¹³⁰

Operators use predominately fish traps as well as hook and line to target Goldband, Red and other Snapper species, as well as various species of cod and emperor.¹³¹ Of the 590 tonnes of total catch in 2014, Goldband Snapper accounted for 44 percent and Red Snapper for 35 percent.¹³²

¹³⁰ Australian Fisheries Management Authority (2015), *Policy Guidelines for Management of the Northern Territory Timor Reef Fishery*, Australian Government, Canberra

¹³¹ Northern Territory Seafood Council (2016), *NT Professional Seafood Industry Fact Sheet – Timor Reef Fishery*

¹³² *Status of Key Northern Territory Fish Stocks Report 2014* (2016), Fisheries Report no. 115, Northern Territory Department of Primary Industry and Resources, available www.dpir.nt.gov.au

The location of the Timor Reef fishery is illustrated in Figure 49.¹³³

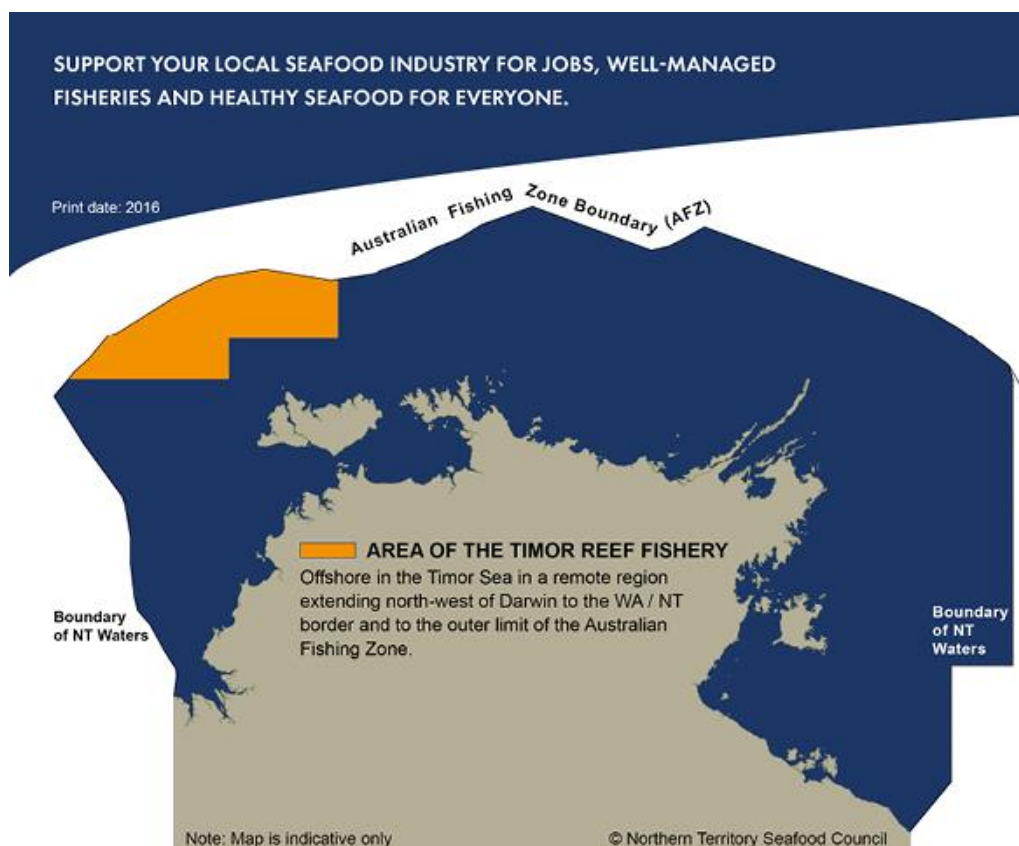


FIGURE 49 – NORTHERN TERRITORY TIMOR REEF FISHERY

8.3.5. Aquarium Fishery

The Northern Territory Aquarium Fishery is comprised of 11 licences and is currently operated by three boats. Operators use a range of methods to collect a wide range of fish, coral and other invertebrate species, as well as marine plants and 'live rock'. The Aquarium Fishery also operates in fresh waterways in the Northern Territory.

The location of the Northern Territory Aquarium Fishery is illustrated in Figure 50.¹³⁴

¹³³ Northern Territory Seafood Council (2016), *NT Professional Seafood Industry Fact Sheet – Spanish Mackerel Fishery*

¹³⁴ Northern Territory Seafood Council (2016), *NT Professional Seafood Industry Fact Sheet – Aquarium Fishery*

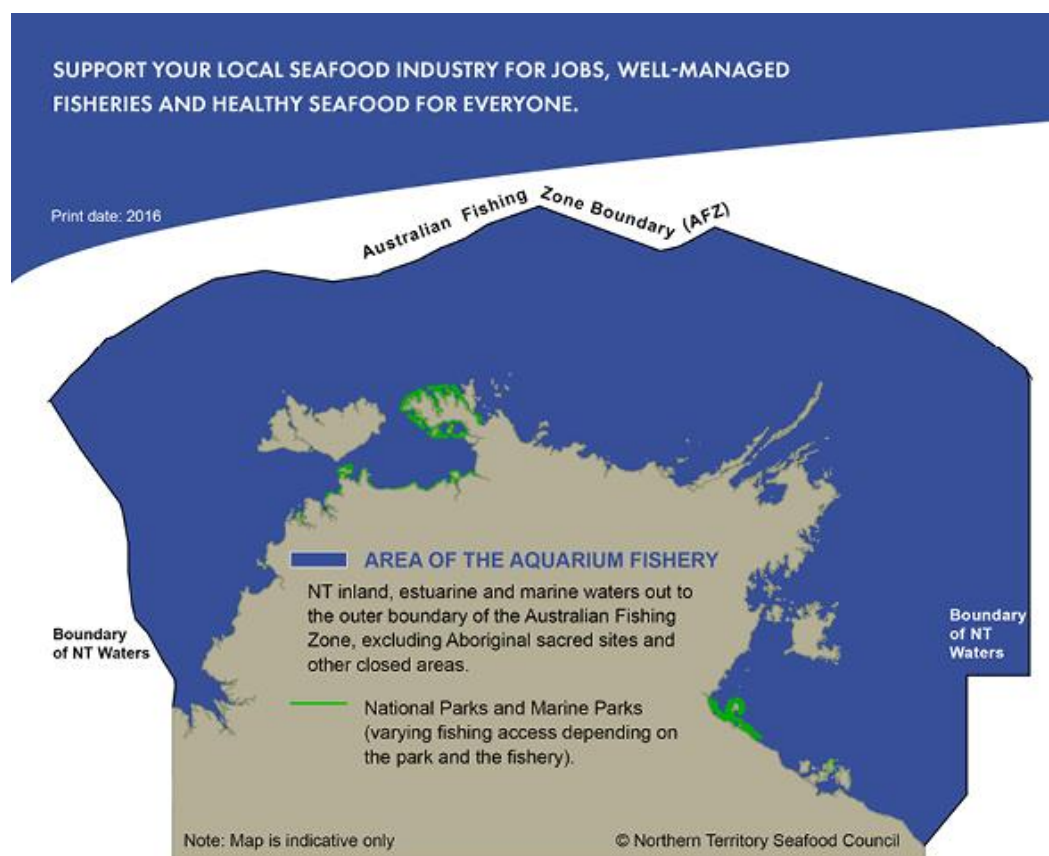


FIGURE 50 – NORTHERN TERRITORY AQUARIUM FISHERY

8.3.6. Squid Jigging

A very small squid jigging fishery operates in both coastal waters and to the extent of the AFZ. With only a single licence, the economic contribution of the fishery is minimal.

8.4. Commonwealth Managed Fisheries

There are two Commonwealth fisheries within the Northern Territory marine environment that are managed exclusively by the Commonwealth Government, the NPF and the Western Tuna and Billfish Fishery.

8.4.1. Northern Prawn Fishery

The NPF is managed under the jurisdiction of the AFMA (see Section 5.2.2). As illustrated in Figure 51¹³⁵, it covers an expansive body of water from Cape Londonderry in Western Australia to Cape York in Queensland. Currently, a total of 52 boats use trawling nets to target Banana and Tiger Prawns, with a small number of Endeavour Prawns taken primarily as by-catch. Over the course of the past decade, the NPF has produced a GVP of between \$60 and \$100 million, accounting for as much as 7 percent of the GVP of the total Australian commercial fishing and aquaculture industry.

¹³⁵ Northern Prawn Fishery Data Summary 2015 (2016), Laird, A, for NPF Industry Pty Ltd, available www.afma.gov.au

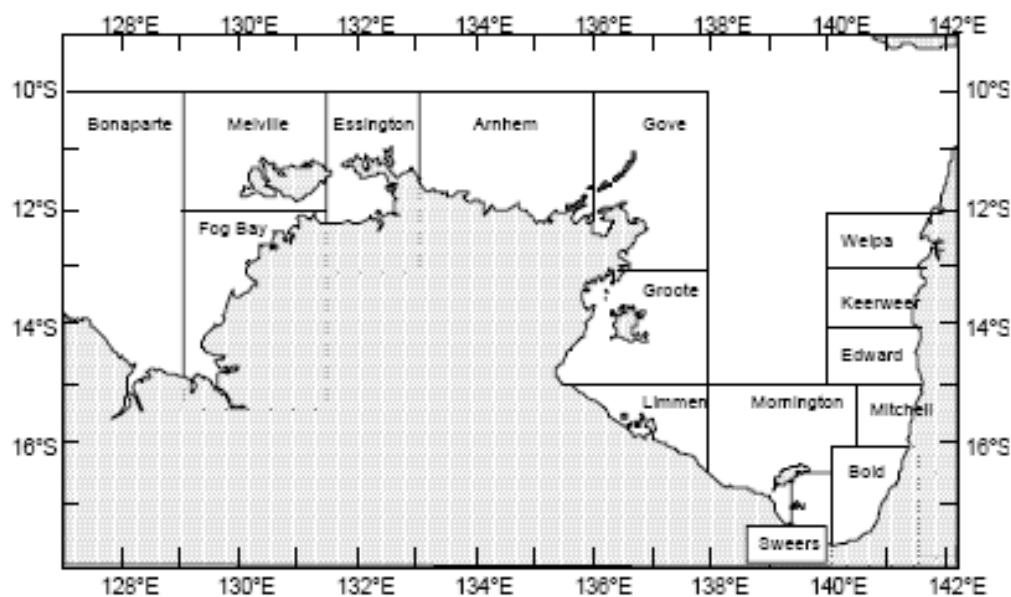


FIGURE 51 – NORTHERN PRAWN FISHERY

As illustrated in Figure 51, the NPF is divided into 15 distinct operating areas, seven of which (Fog Bay, Melville, Essington, Arnhem, Gove, Groote and Limmen) are within the boundaries of the Northern Territory marine environment. Much of the fishing effort in the NPF occurs in waters abutting Aboriginal lands and seas and impacts on environments such as seagrasses that are important to marine resources in the Aboriginal customary economy. However, Aboriginal people do not have any direct involvement in the management of the NPF.

During the period April to June, operators in the NPF target Banana Prawns. In 2015, a total of 3,916 tonnes of Banana Prawns were taken from the NPF. As illustrated in Figure 52¹³⁶, approximately 40 percent of this catch was sourced from NPF areas within the Northern Territory marine environment.

¹³⁶ Northern Prawn Fishery Data Summary 2015 (2016), Laird, A, for NPF Industry Pty Ltd, available www.afma.gov.au

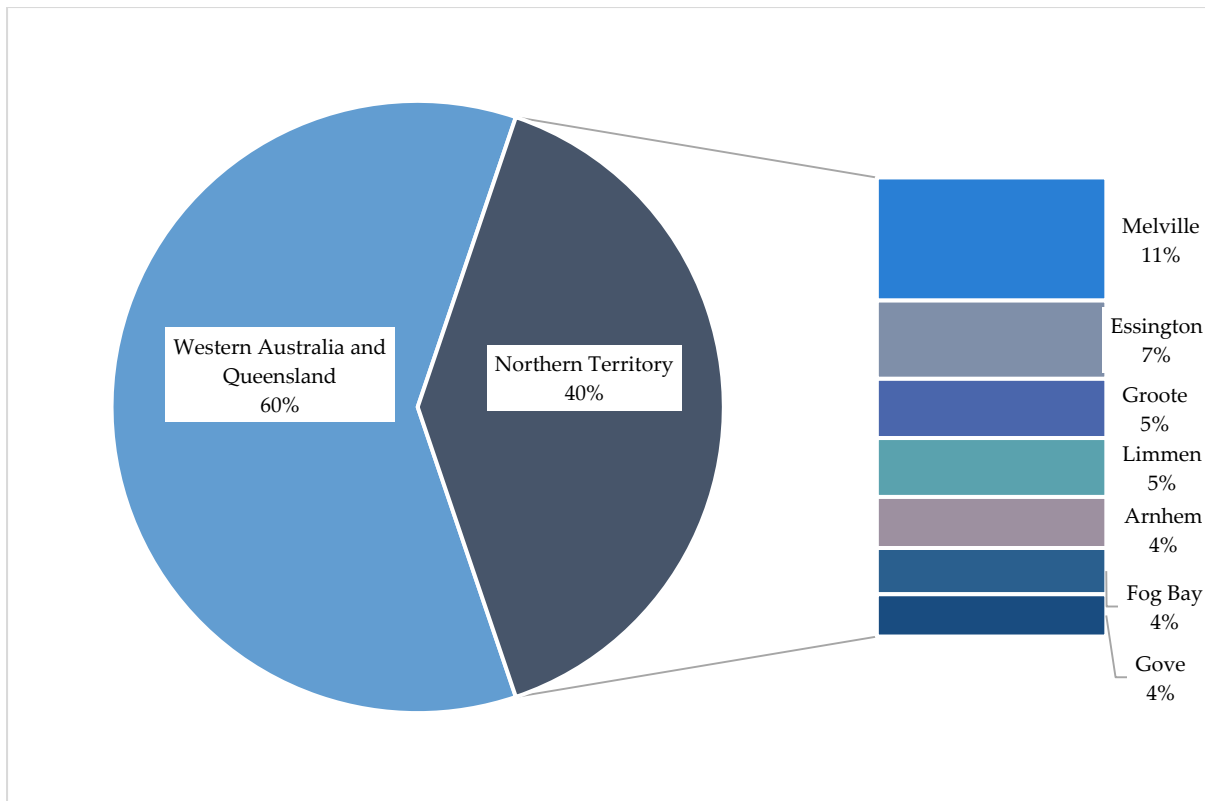


FIGURE 52 – GEOGRAPHICAL DISTRIBUTION OF THE NORTHERN PRAWN FISHERY BANANA PRAWN CATCH IN 2015

During the period August to November, operators in the NPF target Tiger Prawns. In 2015, a total of 3,181 tonnes of Tiger Prawns were taken from the NPF. As illustrated in Figure 53¹³⁷, the vast majority of this catch was taken from areas of the NPF that are located in the Northern Territory marine environment.

¹³⁷ Northern Prawn Fishery Data Summary 2015 (2016), Laird, A, for NPF Industry Pty Ltd, available www.afma.gov.au

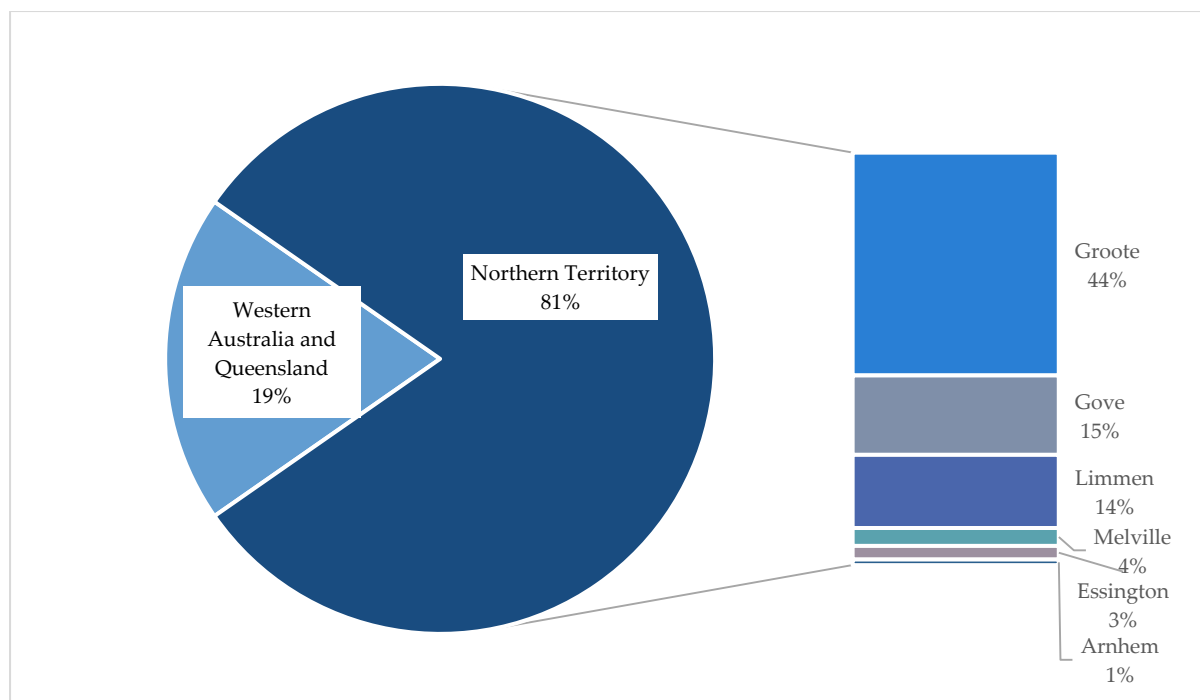


FIGURE 53 - GEOGRAPHICAL DISTRIBUTION OF THE NORTHERN PRAWN FISHERY TIGER PRAWN CATCH IN 2015

In addition to the Banana Prawn and Tiger Prawn take in 2015, 558 tonnes of Endeavour Prawns were also taken as by-catch.

As is apparent, the vast majority of Tiger Prawns are sourced from the Northern Territory marine environment, in particular from the western edge of the Gulf of Carpentaria, whereas the Banana Prawn catch is spread over a larger area, with the highest concentrations found beyond the Queensland border in the Gulf. While these catch levels differ year by year, sometimes by large margins, it is apparent that the Tiger Prawn fishery is of greater economic importance to the Northern Territory but is concentrated in a much smaller area. By contrast, the Northern Territory share of the Banana Prawn fishery is much lower, but sees this effort distributed more equally around the Northern Territory coastline, with implications for local communities, regional planning and marine science knowledge needs.

8.4.2. Western Tuna and Billfish Fishery

As illustrated in Figure 54,¹³⁸ the Western Tuna and Billfish Fishery expands from the South Australian–Victorian border around the western two thirds of the Nation to Cape York.

¹³⁸ Australian Fisheries Management Authority (2011)

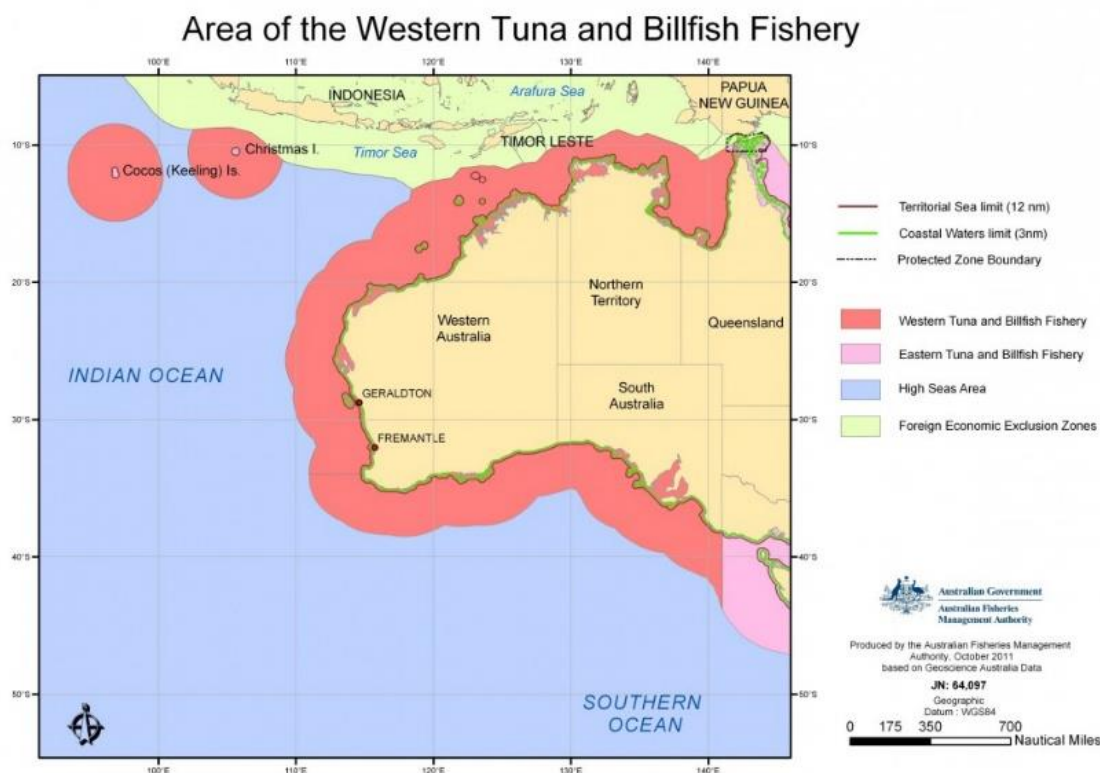


FIGURE 54 – WESTERN TUNA AND BILLFISH FISHERY

As illustrated in Figure 39, this fishery has not produced since 2008-09.

8.5. Key Issues and Marine Science Knowledge Needs

The following subsections summarise the key marine science knowledge needs of the commercial fishing industry, with these needs detailed in Table 16.

8.5.1. Continued Access to the Fishery

Various sectors of the Northern Territory commercial fishing industry are facing increasing threats with respect to future access to fishing areas from primarily the following circumstances:

- Commonwealth marine reserves cover large areas of the Northern Territory marine environment and with management plans yet to be finalised, there is a significant lack of certainty with respect to the extent to which commercial fishing will be allowed in areas of those reserves, if at all;
- The evolving legal framework with respect to Traditional Owner rights with respect to commercial fishing within waters controlled by Traditional Owners is exacerbating this uncertainty; and
- Significant political pressure from the recreational fishing sector is placing pressure on the areas to which the commercial sector has access. Collectively, these issues are serving as a barrier to private investment in fisheries development and innovation.

8.5.2. Equitable Allocation of the Fishery Resource

The commercial fishing sector (and now the fishing charter sector) bear most of the catch recording obligations of the fishery as a whole and are subject to a number of regulations imposed by both Territory and Commonwealth regulators. In many cases, fishery resource

allocation decisions are made based on very limited information with respect to the take of various species by the recreational and customary sectors. The resulting absence of empirical evidence renders fishery resource allocation decisions exposed to political influence, with a perception on the part of the commercial sector that allocation decisions are increasingly being made at their expense. The implementation of the Resource Sharing Framework by NT Fisheries¹³⁹ requires management decisions in allocating fisheries resources to take into account a variety of factors apart from total catch level and weight these appropriately, including community views and pressures, multiplier effects and social licence to operate. The absence of reliable catch level data on the part of non-commercial operators reduces the ability of management decisions to take into account all relevant factors. The absence of a transparent, data informed basis for allocation potentially puts at risk ongoing investment by the commercial industry.

8.5.3. Productivity of the Fishery

A number of factors such as mangrove dieback, inland waterway diversion and seismic surveys have the potential to impact on the productivity of various Northern Territory fisheries. Understanding the precise impact of these factors on the productivity of specific fisheries is necessary for a cost-benefit analysis of the activity that is impacting fishery productivity, developing reactive and proactive methods to mitigate or avoid impact and, where determined appropriate, establish the case for reasonable compensation for lost productivity.

8.5.4. Fishery Development

A number of opportunities to expand existing fisheries by increasing the TAC, as well as the development of new fisheries have been identified by the commercial sector. Before private sector investment can be made in these opportunities, a clear framework for the regulatory pathway for developing new fisheries needs to be transparent and resourced.

In some cases, there are structural obstacles to developing markets for otherwise discarded by-catch or low value species. The development of new technology to reduce by-catch or business models to capitalise on these products are required.

Importantly, the Northern Territory commercial fishing industry must ensure that it is able to continue to meet community expectations with respect to demonstrating sustainable practices and meeting animal welfare standards.

8.5.5. National Fishing and Aquaculture Research, Development and Extension Strategy

Led by the Fisheries Research and Development Corporation (FRDC), the National Fishing and Aquaculture Research, Development and Extension Strategy¹⁴⁰ aims to coordinate stakeholders across industry and all levels of government to deliver progress towards agreed research priorities. The FRDC plan identifies the following objectives to be achieved by 2020:

- Fishing and aquaculture will continue to have improved performance in environmental sustainability;

¹³⁹ Northern Territory Fisheries Resource Sharing Framework (2015), NT Fisheries, available <https://dpir.nt.gov.au>

¹⁴⁰ Fisheries Research and Development Corporation (2015), *Research Development and Extension Plan*, Australian Government, Canberra

- Fishing and aquaculture will be more resilient to social, environmental and economic change;
- Fishing and aquaculture businesses will be more productive and profitable;
- Recreational fishers will have improved opportunities for better fishing experience and will play a greater role in the stewardship of fisheries resources;
- More Indigenous people will derive benefit from fishing and aquaculture activities and will play a greater role in the stewardship of fisheries resources; and
- Information about the science and management of sustainability of fishing and aquaculture will be more accessible to the consumer and meet consumer's needs.

These objectives are aligned with the key issues and specific marine science knowledge needs identified in Table 16, as well as the issues and marine science knowledge needs of the Northern Territory aquaculture industry that are discussed in Section 9 and detailed in Table 17, as well as those of the recreational fishing sector that are discussed in Section 15 and detailed in Table 24.

Key Issue	Description	Specific Marine Science Needs
ACCESS TO THE FISHERY		
Certainty of Access to Fishing Grounds	Owing to the Blue Mud Bay Case, political pressure from the recreational fishing sector and unclear zoning in marine conservation reserves, the commercial fishing industry is facing increasing uncertainty with respect to future access to fishing grounds. This uncertainty is stifling investment in innovation designed to grow the industry and improve industry productivity. Similarly, Traditional Owners of the marine estate are eager to equitably exercise their rights.	<p>Research into systems to effectively measure the recreational sector usage of the fishery resources that are adopted in the context of the Northern Territory and produce reliable data.</p> <p>Research that informs the expedited development and implementation of clear management plans for Commonwealth marine reserves and that adequately take into account the needs of the commercial fishing sector.</p> <p>Research into frameworks to adequately, equitably and expediently resolve resource sharing issues within the emerging legal framework presiding over interests in commercial fisheries that transect and impact on Traditional Owner controlled and owned waters.</p>
ALLOCATION OF THE FISHERY RESOURCE		
Science to Assist Transition to a More Equitable Sharing of the Fishery Resource	Compared to the commercial industry, the take from the customary and particularly the recreational sector is poorly understood. While not the primary focus of these sectors, any level of fishing effort will impact on all parties. This means that decisions pertaining to resource allocation between the three main users of the fisheries resource is not based on scientific evidence and is subject to political pressure, with the commercial and now fishing	<p>Abundance, stock structure, distribution and resilience baseline data for key commercially targeted species that allows the management regime to migrate from an area management basis to management of the resource basis.</p> <p>Development of systems and licencing regimes that provide more granular data on the take from the recreational and customary sectors as a basis</p>

Key Issue	Description	Specific Marine Science Needs
	<p>charter sector under stricter obligations than recreational or customary sectors.</p>	<p>for equitable and transparent allocation of the fishery resource.</p> <p>Research into the potential to share resource based on stage of species life-cycle targeted by a sector (i.e. in the Barramundi Fishery, the recreational sector targets larger fish, whereas the commercial sector targets smaller fish).</p>
<p>Allocation Frameworks Capable of Securing More Equitable Resource Allocations</p>	<p>Present frameworks for setting and managing allocations act as barriers to Aboriginal entry to the industry.</p>	<p>Develop science-based methods for setting equitable allocations and resolving competing interests based on scientific evidence of stock structure and take from the commercial, charter, recreational and customary sectors.</p>
<p>Transition to a TAC Method of Management</p>	<p>There is a desire in the commercial sector to see the framework for management of the Northern Territory fishery to shift from one based primarily on the regulation of fishing areas, to one based more on TAC. While some geographical management criteria will necessarily remain to protect conservation values and Aboriginal interests, a TAC-based management framework is a more equitable and efficient means of managing the fishery,</p>	<p>Review of TAC-based management frameworks used in other jurisdictions to determine aspects of demonstrated frameworks that are applicable to managing the Northern Territory fishery.</p> <p>Understanding of the marine science knowledge that will be required to support a decision to transition to a more TAC-based approach to managing the fishery.</p> <p>Develop a proposal and plan to transition the management of the Northern Territory fishery to a TAC-based framework.</p>

Key Issue	Description	Specific Marine Science Needs
Monitoring and Enforcement	There are currently inadequate resources to effectively monitor the activities of commercial and recreational fishers. There is a need to explore the use of remote community resources and technology to improve the efficacy of monitoring.	Development of frameworks and assessment of resources for Aboriginal Rangers to play a greater role in monitoring and enforcement. Assessment of technology options for monitoring compliance.
FISHERY PRODUCTIVITY		
Improved Understanding of the Best Method of Managing the Fishery Across the North.	Understanding the extent to which stocks of key species are linked across the north of Australia is key to understanding if they should be managed as a single fishery or discrete fisheries within jurisdictions.	Stock structure, distribution and resilience data for key species, as well as genetic connectivity between those areas as a basis for better informing the optimal delineation of fisheries in northern waters.
Impact of Water Diversion on Fisheries Productivity	Increasing concern that water diversion for the purposes of irrigated agriculture will have adverse effects on estuarine ecosystems, negatively impacting the productivity of several key species whose life-cycles are critically dependent on those ecosystems.	Science that leads to a better understanding of the impact of reduced freshwater flows to estuaries on the productivity of fisheries.
Impact of Seismic Noise on Fishery Productivity	Increasing concerns that seismic noise is impacting the distribution and productivity of key fisheries, particularly the NPF.	Science that leads to improved understanding of the impact of offshore seismic noise on the distribution of target species and productivity of those fisheries.

Key Issue	Description	Specific Marine Science Needs
Impact of Mangrove Dieback on Fishery Productivity	Extensive mangrove dieback in the Gulf of Carpentaria and Limmen Bight has led to increasing concerns that there will be further mangrove dieback events that will ultimately impact on key species whose life cycles are dependent on mangrove ecosystems.	Science that leads to a better understanding of the impact of reduced mangrove forests on the productivity of fisheries.
Improved Understanding of Local Depletion Issues	Anecdotal reports of depleted stocks of some species in localised areas need to be better understood and, if local stocks have been depleted, an understanding of causation.	Baselines of localised abundance, structure and distribution of species of concern and identification of causes of local depletion.
FISHERY DEVELOPMENT		
Governance Arrangements for all Commercial Fisheries	Developing the marine science necessary to facilitate a more data-driven approach to allocation and management, addressing productivity challenges, and developing the fishery will require some public sector investment. It is likely that efficiencies can be gained within the regulator by rationalising sub-economic activities, releasing at least some additional resource for addressing these issues.	Review of the administrative resource allocated to all fisheries to determine fisheries that represent sub-economic administration (i.e. administrative dis-economies of scale) as the basis for a cost-benefit analysis of the administrative investment in those fisheries. Investigate the viability of a cost-recovery management model for some Northern Territory fisheries.
By-catch Management	Minimisation of un-used by-catch is an issue of paramount concern for the commercial fishing industry globally and systems for reducing or creating utility from by-catch are important ongoing areas of innovation.	Understanding the impact of by-catch on specific key non-target species. Development of technology that reduces by-catch.

Key Issue	Description	Specific Marine Science Needs
	Several fisheries generate by-catch that have potential value, but which are currently discarded (such as Blue Swimmer Crabs that are taken by trawlers targeting prawns in the NPF).	Research that leads to technologies and innovative business models that render the processing and marketing of by-catch commercially viable.
Protection of Aboriginal Interests in Non-target Species	Aboriginal people are concerned about impacts of commercial fishing on fauna that are of particular significance to them for customary, customary economy or livelihood reasons.	Scientific research identifying non-target mortalities that directly engage Aboriginal people. Development of methods for mitigating risk presented to non-target fauna by commercial fishing activities.
Criteria to Create New Fisheries	Environmental approvals processes mean that developing new fisheries is an expensive exercise. However, the commercial industry has identified several new potential fisheries including a Glassy Bombay Duck Prawn Fishery in the Bonaparte Gulf and small pelagic fishery in several areas of the Northern Territory marine environment.	Development of a transparent, data-driven, cost-effective framework for assessing the merits and viability of potential new fisheries. Development of a clear approvals pathway for implementing a new fishery and the regulatory framework that will apply to that fishery.
Basis for Increasing Quotas	There is concern by some sectors of the commercial fishing industry that the precautionary principle has been overapplied to certain fisheries, where species appear to be in relative abundance. This is particularly the case where catch criteria for species in other jurisdictions have been crudely applied to the Northern Territory management framework, or where species considered threatened in other jurisdictions or in a global context appear to be in relative abundance in the Northern Territory marine	Identification of species where there is anecdotal evidence that quotas may be able to be increased while maintaining sustainable harvest. Research into the stock structure of those species to facilitate evidence-based assessment as to whether quotas can be increased.

Key Issue	Description	Specific Marine Science Needs
Remote Operations for Hazardous Harvests	<p>environment. This is resulting in sub-optimal sustainable harvest of the fishery resource.</p> <p>Fisheries that require divers to harvest stock in the Northern Territory marine environment, such as the Trepang Fishery, face significant OHS issues because of dangerous species such as Irukandji and Box Jellyfish, Saltwater Crocodiles and various species of shark. Tides and poor visibility associated with high turbidity can also be challenging. The development of remote harvesting technologies can overcome these problems.</p>	Investigation into the use of Remotely Operated Vehicles to replace divers in relevant fisheries.
Supply-chain Optimisation	Greater productivity can potentially be achieved from the Northern Territory commercial fishing industry by optimising the use of supply chain infrastructure.	Mapping the optimisation of upstream and downstream supply chain infrastructure and development of systems for collaborative use of infrastructure.
Social Licence to Operate	The commercial fishing industry globally is coming increasingly under pressure from environmental and animal welfare activist groups, as well as the mainstream community to demonstrate high standards of sustainability and animal welfare. The Northern Territory industry needs to understand these trends and ensure that its practices are consistent with those required to maintain a social licence to operate.	<p>Understanding of global and national trends in attitudes toward the commercial wild-catch fishing industry.</p> <p>Systems that give the community confidence that the Northern Territory commercial fishing industry is compliant with regulations and is adhering to high standards of marine stewardship.</p>
Industry Contribution to the Economy	The importance of the commercial fishing industry to the Northern Territory economy is not well or widely	Analysis that clearly demonstrates the impact the Northern Territory commercial fishing industry has

Key Issue	Description	Specific Marine Science Needs
	<p>understood. This is important for maintaining a social licence to operate, as well as for making a case for sustaining and growing the industry's share of the fishery resource.</p>	<p>on the local economy across a range of metrics including contribution to GSP, employment, exports, community livelihoods, multiplier effects and so on.</p>

TABLE 16 – MARINE SCIENCE NEEDS OF THE COMMERCIAL FISHING INDUSTRY

9. Pearling, Aquaculture and Crocodile Industries

9.1. Pearling, Aquaculture and the Northern Territory Economy

The aquaculture and pearling industry in the Northern Territory has consistently produced GVP of between approximately \$15 million and \$25 million per annum for the past decade. This is illustrated in Figure 55¹⁴¹.

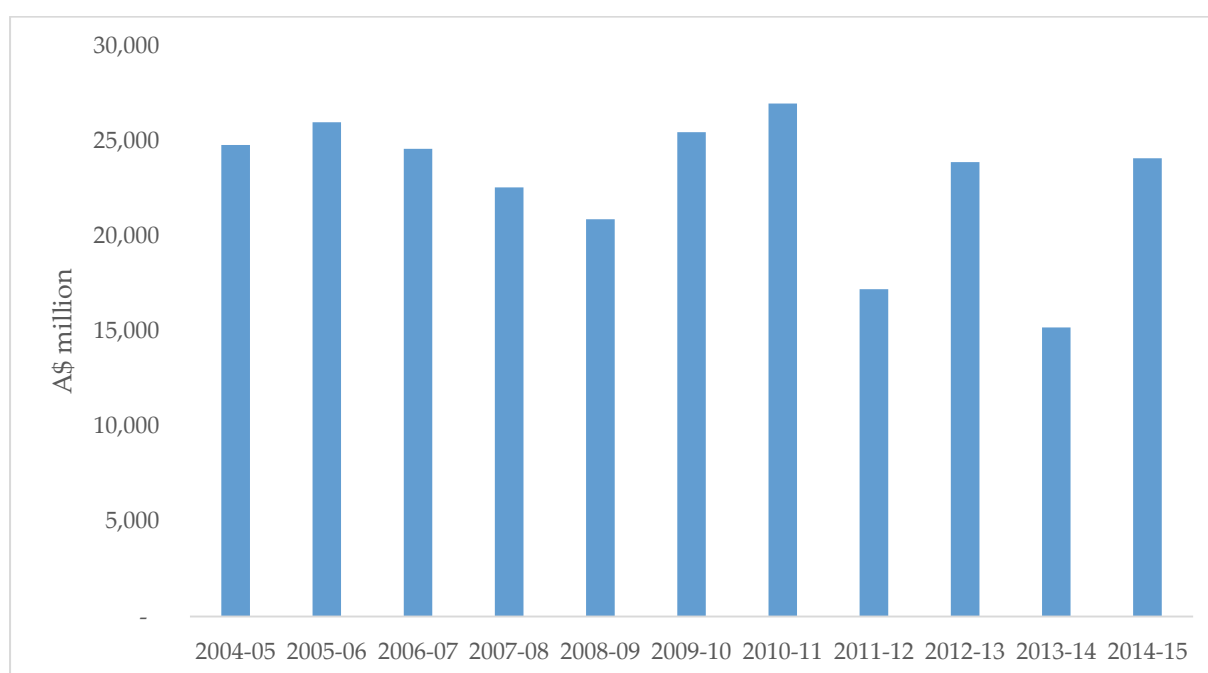


FIGURE 55 – NORTHERN TERRITORY AQUACULTURE AND PEARLING GVP – 2004-05 TO 2014-15

Individual sector composition of Northern Territory aquaculture GVP is only available for the period 2009–10 to 2011–12. Based on this data, it is estimated that on average, the pearling sector accounts for approximately 70 percent of the Northern Territory aquaculture and pearling GVP, Barramundi approximately 27 percent and other species the balance. This data does not include the Northern Territory crocodile farming sector, which is discussed in this report as a separate sector within the Northern Territory aquaculture and pearling industry.

Challenges that face the development of aquaculture in the Northern Territory are similar to those along most of the northern Australian coastline. High costs associated with remoteness and an absence of infrastructure, long project approval lead-times as the result of limited existing baseline data to underpin environmental approvals, land tenure issues and a limited number of biophysically suitable sites collectively render establishing large-scale marine aquaculture in the Northern Territory a difficult exercise. These challenges are compounded

¹⁴¹ Fisheries Research and Development Corporation and Department of Agriculture and Water Resources (2004–05 to 2014–15), *Australian Fisheries and Aquaculture Statistics*, Australian Government, Canberra

by the fact that many species that can be produced by aquaculture methods in northern Australia can be produced in South East Asia and other parts of the world at much lower cost. This means that northern Australian aquaculture production is typically targeted at niche markets that pay premium prices for seafood produced from the 'clean-and-green' and biosecure production environment that northern Australia can offer.

9.2. Pearling Industry

The Northern Territory pearling sector is based on the cultured production of the *Pinctada maxima* pearl oyster which produces high-quality pearls known as South Sea Pearls. Prior to European settlement, the *P. maxima* pearl oyster performed important cultural functions and was traded by Aboriginal people in northern Australia.

While the majority of Australian *P. maxima* production occurs on the Kimberley coast of Western Australia, where cultured pearls are grown out from wild pearl oysters fished from Eighty Mile Beach, production from Northern Territory operations makes a significant contribution to the national production base, accounting for approximately one third of total Australian pearling GVP.

GVP from the Australian pearling industry has declined from approximately \$120 million in 2006–07 to around \$60 million today.¹⁴² This decline in GVP has been driven by several factors including:

- Impact of the Global Financial Crisis on discretionary spending on luxury items; and
- A still largely unresolved oyster shell health issue, whereby since 2006–07 many operations have experienced higher than normal mortalities among juvenile *P. maxima* animals.

The main pearling operator in the Northern Territory is Paspaley, which has grow-out operations on the Coburg Peninsula and juvenile nursery facilities in Bynoe Harbour, as well as along the Kimberley coastline. These operations are supported by a small fleet of dedicated pearling vessels that allows Paspaley to source juveniles from various locations along the northern Australian coast.

9.3. Aquaculture Industry

9.3.1. Barramundi Sector

In recent history, there have been several attempts to establish large-scale aquaculture production of Barramundi in the Northern Territory. The most significant of these was a sea-cage grow-out operation off the coast of the Tiwi Islands operated by Marine Harvest. This operation was closed, following the escape of tens of thousands of fish when some of the cages broke from their moorings in 2006 as the result of cyclone related metocean conditions.

Today, the only significant Barramundi aquaculture operation in the Northern Territory is the Humpty Doo pond-based production operation on the Adelaide River. The Humpty Doo operation has been operating for 20 years and currently produces 2,000 tonnes per annum, with plans to expand to 3,120 tonnes per annum. It sources saline water from the Adelaide River and operates on a recycling system with very limited discharge to the Adelaide River.

¹⁴² Department of Agriculture and Water Resources (2015), *Australian Fisheries and Aquaculture Statistics*, Australian Government, Canberra

9.3.2. Emerging Prawn Sector

The production of prawns has arguably been the most successful aquaculture sector in northern Australia, with the sector producing GVP of \$86.2 million in 2014–15, 94 percent of which is associated with prawn farms in Queensland.¹⁴³ While the Northern Territory does not have a prawn aquaculture production history, the main operating assets of Australia's proposed largest prawn farm, Project Sea Dragon, will be located in the Northern Territory.

Project Sea Dragon is a proposed, large-scale vertically integrated prawn farming operation that has an operational footprint across the Northern Territory and Western Australia. The main assets comprising the core breeding centre and broodstock maturation centre, commercial hatchery and grow-out operations will be in the Northern Territory, with the founder stock centre and processing plant in Western Australia. This is illustrated in Figure 56¹⁴⁴ below.

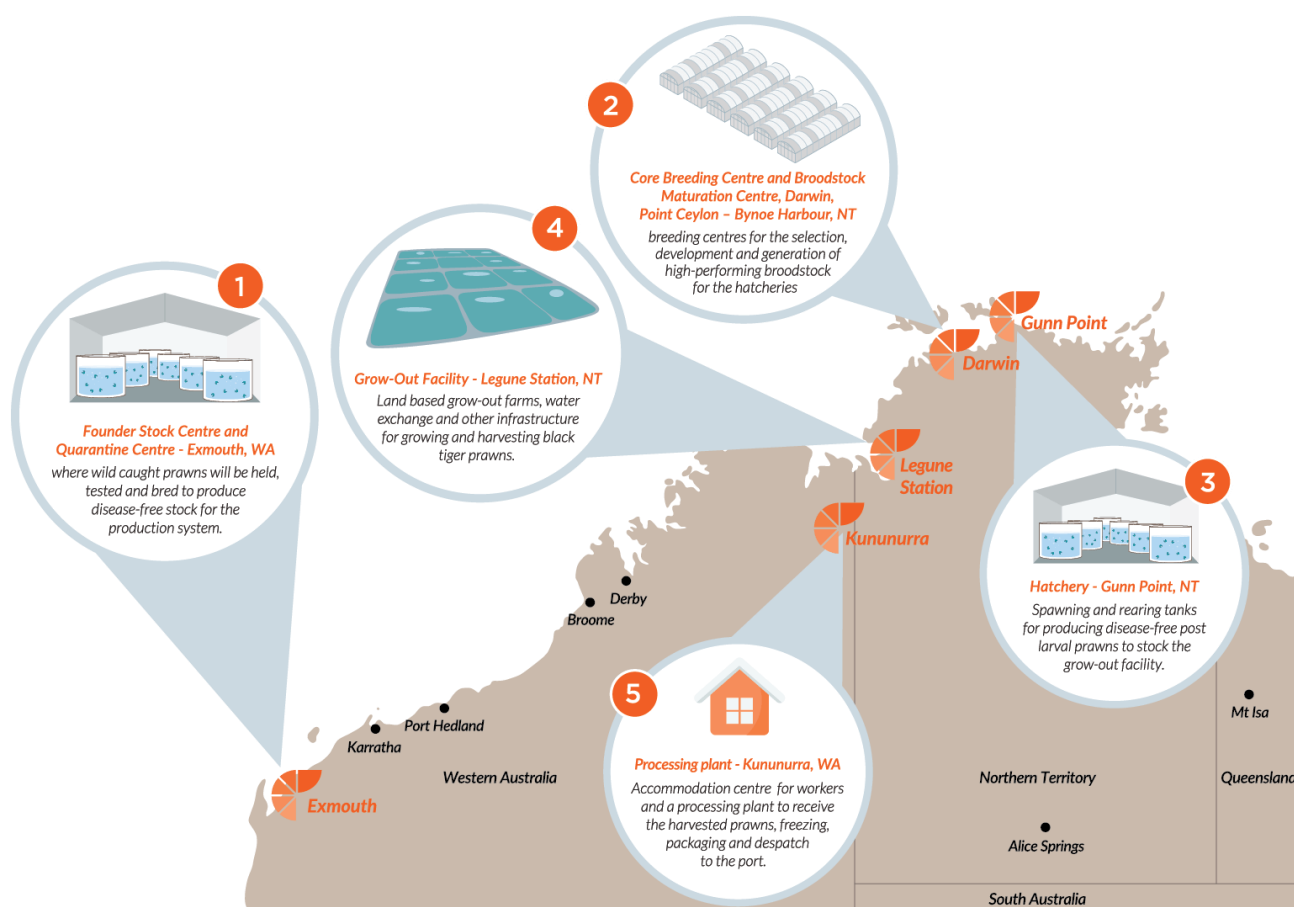


FIGURE 56 - PROJECT SEA DRAGON OPERATIONAL FOOTPRINT

The main operational footprint will be on Legune Station, where at ultimate production scale, the site will be comprised of 10,000 hectares of production ponds. The project will produce Banana Prawns (*Fenneropenaeus merguensis*) and Black Tiger Prawns (*Penaeus monodon*).

¹⁴³ Department of Agriculture and Water Resources (2016), *Australian Fisheries and Aquaculture Statistics*, Australian Government, Canberra

¹⁴⁴ Seafarms Group Limited (2017) (www.seafarms.com.au/about-project-sea-dragon/)

9.3.3. Other Emerging Sectors

The Northern Territory Government and private enterprise have been working with a number of Aboriginal communities along the Northern Territory coast, exploring opportunities to develop aquaculture designed as a commercial enterprise or to support livelihoods within those communities.

Trepang

Tasmanian Seafoods have produced juvenile Trepang that have been released at South Goulburn Island by the Waruwi community. The first trial harvest was conducted in 2015, with plans now to implement site monitoring and increased releases and harvests, ultimately scaling to a viable industry.

Similarly, a joint venture between the Anindilyakwa Land Council, several Pearl Oyster propagators, Masurina, Cross Cultural Consultants and Tasmanian Seafoods, known as Traditional Trepang Traders, is exploring opportunities for Trepang aquaculture on Groote Eylandt.

Giant Clams

The Northern Territory Government is working with communities on Goulburn Island, Nhulunbuy and Groote Eylandt exploring the potential for ranching of aquaculture produced Giant Clams. Trials have been conducted to assess clam grow-out potential in sea-based cages, with initial results indicating technical and commercial viability.

Tropical Blacklip Oysters

The Northern Territory Government is working with communities on Goulburn Island and the Tiwi Islands, exploring opportunity for breeding and grow-out of Tropical Blacklip Oysters (*Striostrea mytiloides*). Several different farming systems have been trialled and hatchery techniques for reliable production of spat are progressing. The current plan involves placement of product within the communities. However, work is continuing towards developing a quality assurance scheme to enable commercial sale of oysters.

9.4. Crocodile Industry

The Northern Territory hosts a significant crocodile farming industry that produces various products from the native Salt Water Crocodile (*Crocodylus porosus*), the GVP from which is not included in the data presented in Figure 55 above.

The first crocodile farm in the Northern Territory was established in 1979. Over the course of the past 40 years, the industry has grown to include eight commercial crocodile farms.¹⁴⁵ Concentrated primarily around the Darwin Area, these farms collectively produced product with a value of approximately \$23 million in 2014–15, making it the largest livestock industry outside of cattle in the Northern Territory.¹⁴⁶ These operations source stock from either captive breeding or regulated sustainable harvest of eggs and a limited number of hatchlings and juveniles from the wild.

¹⁴⁵ Crocodile Farmers Association of the Northern Territory (2016), *Northern Territory Crocodile Farming Industry Strategic Plan 2015-21*

¹⁴⁶ Department of Primary Industry and Fisheries (2016), *Overview and Outlook 2015*, Northern Territory Government, Darwin

As illustrated in Figure 57¹⁴⁷, global trade in crocodile, alligator and caiman skins, the main product produced by the industry, is comprised of a number of species from around the globe.

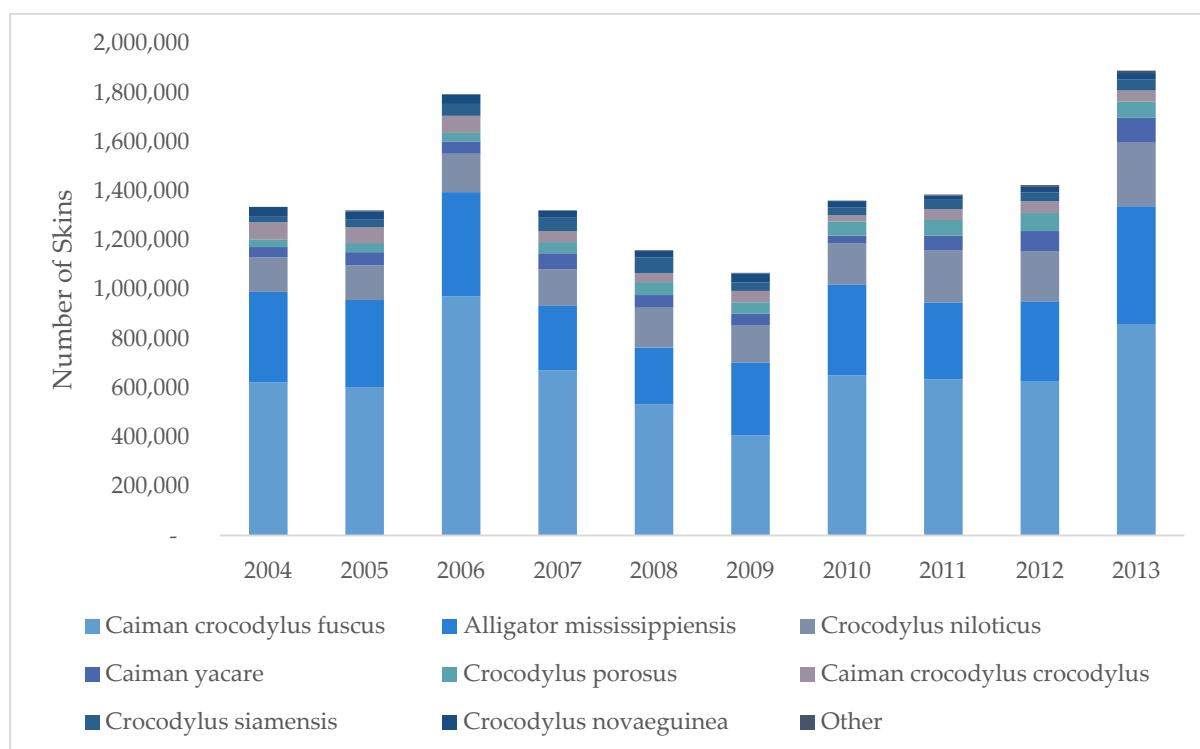


FIGURE 57 – GLOBAL EXPORTS OF ALLIGATOR, CAIMAN AND CROCODILE SKINS

Three species, *Caiman crocodylus fuscus*, *Alligator mississippiensis* and *Crocodylus niloticus*, consistently account for approximately 85 percent of global crocodilian skin trade:

- *Caiman crocodylus fuscus*, or the Brown Caiman, is exported from Columbia and Panama;
- *Alligator mississippiensis*, or the American Alligator, is exported exclusively from the United States; and
- *Crocodylus niloticus*, or the Nile Crocodile, is exported variously from Botswana, Central African Republic, Congo, Ethiopia, Guinea, Kenya, Liberia, Madagascar, Malawi, Mali, Mozambique, Namibia, Nigeria, Senegal, Somalia, South Africa, Sudan, Tanzania, Togo, Uganda, Zambia and Zimbabwe, as well as Brazil, Israel and Mauritius.

The species farmed in the Northern Territory, *Crocodylus porosus*, or the Saltwater Crocodile, accounts for approximately 3 percent of global trade in crocodilian skins. *Crocodylus porosus* skins are highly valued by high-end fashion manufacturers in Japan, France and Italy, with significant end-product demand from the United States.

While the species accounts for a small portion of overall trade by volume, it is a growing market and Australia's share of that market has grown from 42 percent in 2004 to almost 60 percent in 2013. This is illustrated in Figure 58¹⁴⁸.

¹⁴⁷ Caldwell, J. (2015), *World Trade in Crocodilian Skins 2011-2013*, United Nations Environment Program World Conservation Monitoring Centre, Cambridge

¹⁴⁸ Caldwell, J. (2015), *World Trade in Crocodilian Skins 2011-2013*, United Nations Environment Program World Conservation Monitoring Centre, Cambridge

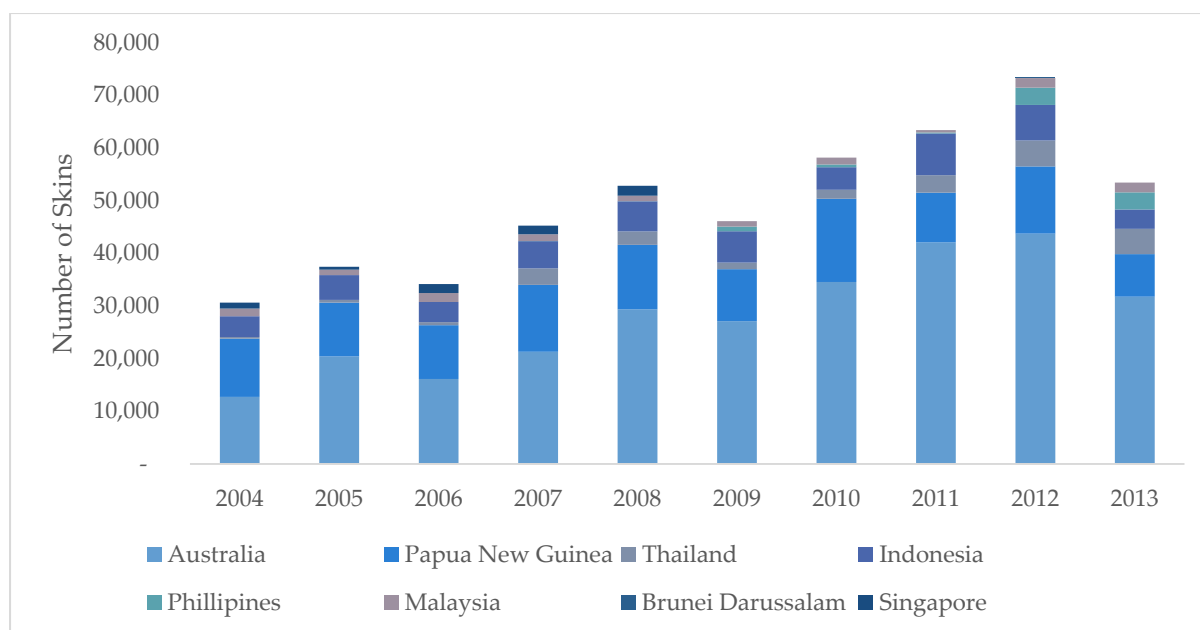


FIGURE 58 – GLOBAL EXPORTS OF CROCODYLUS POROSUS (SALTWATER CROCODILE) SKINS

The Northern Territory crocodile industry accounts for approximately two-thirds of Australian crocodile skin exports and approximately 73 percent of the GVP of Northern Territory crocodile industry in 2014–15 was derived from the sale of approximately 18,000 skins.¹⁴⁹

Other products include live animals, crocodile meat, teeth, feet, heads and skeletons that are sold primarily in the domestic market. In 2014–15, there were 10,386 live animal sales producing GVP of \$2.9 million. While the value of crocodile meat sales was only \$1.3 million in 2014–15, it is a growing market, with sales increasing from approximately 20 tonnes in 2006–07 to almost 160 tonnes in 2014–15.¹⁵⁰ Other crocodile products accounted for revenue of \$1.8 million

9.5. Key Issues and Marine Science Knowledge Needs

The following subsections summarise the key issues facing the pearling, aquaculture and crocodile industries in the Northern Territory and the associated marine science knowledge needs. The marine science knowledge needs of the industry are detailed in Table 17.

9.5.1. Ensuring Biosecurity

Because unknown pathogens can devastate stocks, the ongoing management of biosecurity is a major focus of all pearling, aquaculture and crocodile operations. Further, as discussed in Section 9.1 above, the relatively high cost structure faced by aquaculture and pearling operations in particular in the Northern Territory (and across northern Australia) means that to remain competitive with low cost Asian producers, those operations must be able to maintain and grow market share in premium product markets. Underpinning the ability of operators to do this is Australia's relative bio-secure status.

Aquaculture operations that are poorly managed can present a biosecurity risk to wild stocks and, as a result, aquaculture activities and biosecurity threat posed by aquaculture operations

¹⁴⁹ Department of Primary Industry and Fisheries (2016), *Overview and Outlook 2015*, Northern Territory Government, Darwin

¹⁵⁰ Ibid

are highly regulated. However, if a pathogen is introduced to the external natural ecosystem, it can very easily be introduced to the aquaculture production system, resulting in deterioration of product quality, high treatment costs and/or extensive mortalities. Ensuring the biosecurity of the region is of paramount concern to the future viability of aquaculture and pearling in the Northern Territory.

9.5.2. Managing Other External Threats to Industry Viability

In addition to the threat of introduced pathogens, several factors represent external threats to aquaculture and pearling operations in the Northern Territory. Understanding the impact of seismic and dredging on water quality and particularly the viability of juvenile production animals that are exposed to these activities is important for managing and mitigating any associated risk.

9.5.3. Improving Industry Productivity

Because of the high cost structure, the viability of the industry is also highly sensitive to productivity improvement, irrespective of achieving premium pricing in markets that value a biosecure and 'clean and green' production environment. Ensuring regulation is efficient, that the industry has cost-effective and biosecure access to productive genetics and handling processes are optimally automated are important to underpinning current and future economic viability of the industry.

Key Issue	Description	Specific Marine Science Needs
ENSURING BIOSECURITY		
Monitoring and Regulation of the Environment for New Pathogens and Exotic Pests	Early identification of introduced exotic pests and/or pathogens to the natural environment enables an early first response, substantially reducing the risk of the pathogen entering biosecure production environments and allowing exposed stock to be intensively monitored and early preventative measures and treatments to be applied.	<p>Identification high risk entry points (e.g. vessels).</p> <p>Development of monitoring technology and systems.</p>
Tighter Controls on Imported Seafood Products	Imported seafood such as Barramundi and prawns invariably enter the natural ecosystem, typically as bait. This substantially increases the risk of foreign pathogens being introduced to the natural environment, as evidenced by the recent outbreak of white spot disease in natural prawn stocks. Very tight controls on the importation of high-risk seafood products must be in place to protect Australia's biosecure comparative advantage in the markets for both wild-catch and aquaculture produced product.	Improved understanding of the threat to biosecurity of particularly the Barramundi and prawn aquaculture sectors from imported seafood products that are frequently used as a bait as the basis for tighter controls on imported seafood products.
Scientific Knowledge to Support Proactive Approach to Biosecurity Management	The most effective means of managing biosecurity risk is to address the risk before an exotic pest or pathogen enters Australia. This can be achieved by identifying the source of existing and emerging pathogens and working with host countries (which are typically under-resourced developing nations) to manage the risk in-country.	Work with other countries to track emerging pathogens and assist what are often emerging Nations better manage disease.

Key Issue	Description	Specific Marine Science Needs
MANAGING OTHER EXTERNAL THREATS TO INDUSTRY VIABILITY		
Impact of Seismic on Ocean Based Operations	Where aquaculture and pearling operations are dependent on harvesting juveniles or broodstock from wild resources or grow-out occurs in an ocean environment, the potential for seismic noise to adversely affect animal behaviour needs to be understood so that any detrimental consequences can be managed.	Understanding the impact of seismic on <i>P. maxima</i> natural broodstock resources across northern Australia and on ocean-based grow-out operations.
Impact of Dredging on Water Quality	Where hatchery, nursery and/or grow-out facilities are in an open environment or dependent on water resources that are near port activity and other development that involves dredging, understanding the impact of dredging on water quality is important for identifying and managing any potential adverse effects.	Understanding the potential impact of dredge plumes on port-based hatchery, nursery and grow-out facilities.
IMPROVING INDUSTRY PRODUCTIVITY		
Data that Supports Efficient Project Approvals and Regulation	Because large-scale aquaculture projects tend to be established in relatively remote locations, the project approvals process is typically hampered by an absence of baseline data on environmental impact assessments. The absence of baseline data results in a protracted, expensive and uncertain approvals process detracting from investment in the industry. While it is important that project approvals are based on sound assessment of environmental impact, it is also important that approvals processes are efficient.	<p>Review to identify species in addition to Barramundi, prawns and <i>P. maxima</i> pearl oysters that might form the basis of economic aquaculture in the Northern Territory.</p> <p>Review of coastal and estuarine areas in the Northern Territory that demonstrate bio-physical, infrastructure and social characteristics that render those areas suitable for large-scale aquaculture in the identified species.</p>

Key Issue	Description	Specific Marine Science Needs
Diversified Sources of Genetics	Optimising efficient production and achieving production objectives in any agribusiness venture is dependent on sourcing genetics that demonstrate characteristics such as high biological feed conversion rates and deliver on other specific production objectives. The only current large-scale Barramundi operation in the Northern Territory and the planned large-scale prawn farm both source genetics from operations outside of the Northern Territory. While the biosecurity risk associated with this practice can be adequately managed, it does present some risk. However, it also renders Northern Territory aquaculture operations dependent on these sources of genetics.	Evaluate the respective merits of undertaken rudimentary baselines in those areas to inform an assessment of likely environmental impact before investing in a full approvals process, or undertaking full environmental impact assessment as the basis for declaring aquaculture development zones that are 'pre-approved'.
Biosecure Cross Jurisdictional Movement of Stock	In addition to managing the transfer of genetics across borders, it is in the interest of large-scale aquaculture to have geographically distributed operations to manage disease and other normal agribusiness risk such as potential damage to operations from adverse weather.	In the key species that comprise the existing Northern Territory aquaculture industry, as well as potential future species, determine the relevant jurisdictions and key biosecurity risks

Key Issue	Description	Specific Marine Science Needs
	<p>This is particularly important in northern Australia, where tropical cyclones and tropical cyclone related storm activity can significantly impact on operations. In many cases, operations that are distributed adequately to manage this risk in northern Australia will cross state jurisdictions, implying a need to be able to biosecurely and cost-effectively move stock across State borders.</p>	<p>associated with cross border translocation between those jurisdictions.</p> <p>Review of current regulations applying to cross border translocation of livestock in those jurisdictions.</p> <p>Development of an effective and efficient framework for regulation of cross border translocation for those species across those jurisdictions.</p>
<p>Automation</p>	<p>Irrespective of the ability to attract premium market pricing, the ability of aquaculture and pearling operations in the Northern Territory to remain competitive remains a function of minimising costs. As with other agribusiness in Australia, relatively high labour costs make a significant contribution to the high cost structure in Australia. As such, it is imperative that ongoing investment in innovation is targeted at achieving optimal levels of automation.</p>	<p>Review of aquaculture business processes in the Northern Territory to identify areas of poor productivity as targets for increased automation.</p> <p>Review of automation technologies in use and under development in aquaculture and seafood industries globally.</p> <p>Development of an automation technology roadmap for the Northern Territory aquaculture industry, which as well as identifying technology development needs identifies potential collaborators and co-investors in that development.</p>
<p>Community Enterprise Models</p>	<p>The development of small-scale aquaculture operations is consistent with the cultural economy and livelihood needs of many Aboriginal communities along the Northern Territory coast. The ability to render these</p>	<p>Review of existing Aboriginal community aquaculture operations and aspirations with</p>

Key Issue	Description	Specific Marine Science Needs
New Market Development	<p>operations economically sustainable or to grow them to more substantive commercial enterprises is limited by remoteness, limited infrastructure (particularly cold-chain enabling infrastructure and logistics), resulting poor access to markets, limited local capacity and poor access to capital.</p> <p>The ongoing viability of a Northern Territory aquaculture and pearling industry can also be underpinned by ensuring that the optimal portfolio of markets from a commercial perspective are being addressed. This includes the examination of possible markets for by-products from the production process. The Northern Territory Government can also assist by promoting Northern Territory produce in those markets.</p>	<p>respect to aquaculture (both species and scale of operation).</p> <p>Assessment of markets for products from those operations that are external to the direct needs of the community.</p> <p>Assessment of infrastructure needs to deliver products to market, as well as product forms that might mitigate infrastructure challenges.</p> <p>Review of business models that could render community-based aquaculture viable as a commercial enterprise.</p> <p>Assessment of global markets for the product being produced by the existing Northern Territory aquaculture industry, as well as those that might be produced from future sectors to determine the likely most lucrative markets.</p> <p>Assessment of by-products produced by the Northern Territory aquaculture and pearling industry to identify potential new product markets.</p>

TABLE 17 – MARINE SCIENCE NEEDS OF THE AQUACULTURE AND PEARLING INDUSTRY

10. Offshore Petroleum Industry

10.1. Offshore Petroleum Industry and the Northern Territory Economy

The offshore petroleum industry is a key driver of the Northern Territory economy. Darwin Port is a major regional service port for exploration and production operations in the Timor Sea, Arafura Sea and JPDA, as well as assets off the Western Australian coast in the Bonaparte and Browse Basins. It is also the receiving point for two major offshore pipelines, hosts two onshore LNG plants and export facilities and a gas-fired power station that receives natural gas via a terrestrial pipeline from a domestic gas plant that sources its raw gas from an offshore facility in the Bonaparte Gulf. Darwin's proximity to various regional offshore assets is illustrated in Figure 59¹⁵¹.

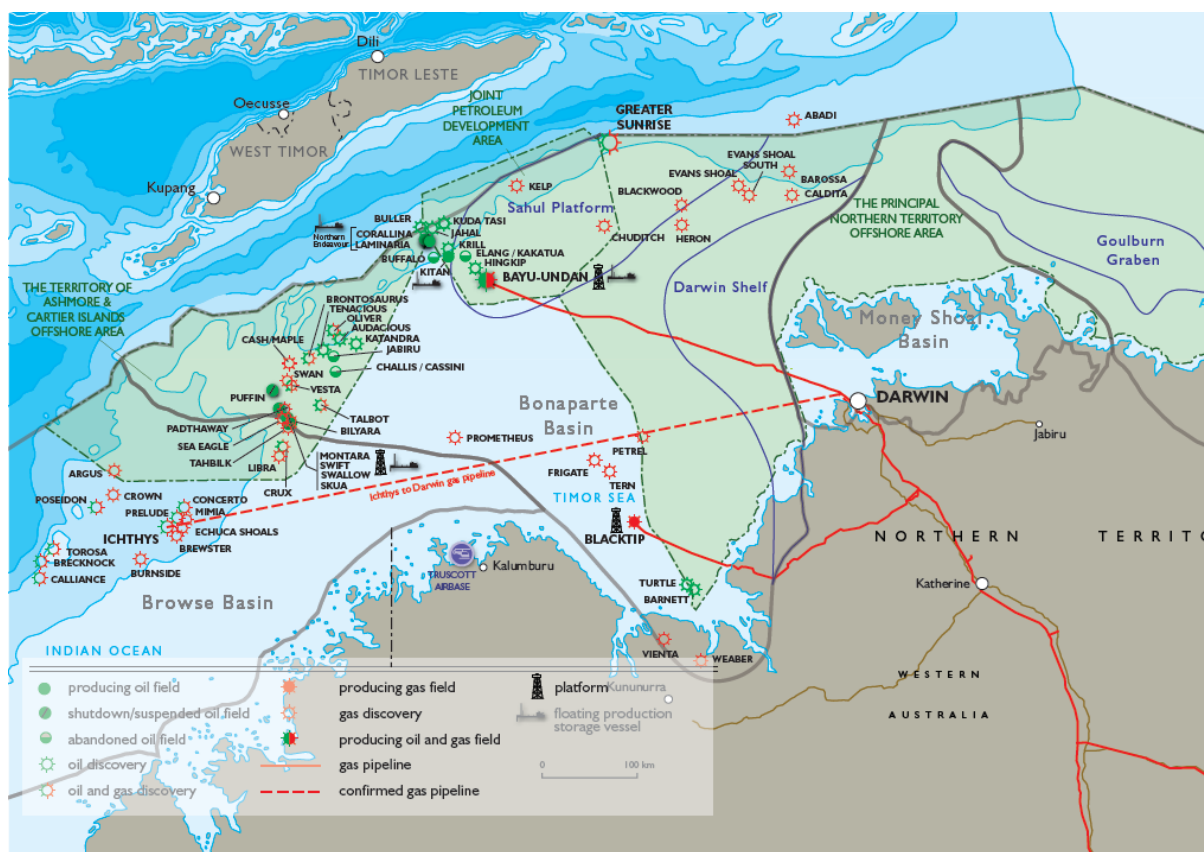


FIGURE 59 – REGIONAL OFFSHORE OIL AND GAS ASSETS

¹⁵¹ Heyes, N. and de Weijer, R. (2015), 'Northern Australia oil and gas: a new engine for Australia's prosperity', *Journal of the Australian Petroleum & Exploration Association*, 55(2), pp.405-405

10.2. Major Projects

10.2.1. Bayu Undan and Darwin LNG

The Bayu Undan Field was discovered in 1995 and is a gas-condensate field located within the JPDA, 500 kilometres off the coast of the Northern Territory. The asset is operated by ConocoPhillips on behalf of the other joint venture partners Santos, Inpex, Eni and Tokyo Timor Sea Resources (a consortium comprised of Tokyo Gas, Tokyo Electric and Chibu Electric).

Offshore operation assets at the Bayu Undan Field include:

- A Central Production and Processing (CPP) complex comprised of a drilling, production and processing platform and compression, utilities and quarters platform;
- An unmanned wellhead platform; and
- A Floating Storage and Offloading facility located 2 kilometres from the CPP, which processes and exports condensate directly.

Natural gas from the Bayu Undan Field is transferred to the Darwin LNG facility at Wickham Point on Middle Arm in Darwin Port via a 502 kilometre, 26" subsea pipeline. Construction of the 3.7 million tonnes per annum, single train, Darwin LNG plant commenced in 2003, with the plant commissioned in 2006. Since that time, an average of one cargo of LNG per week has been shipped to the plant's customers Tokyo Gas and a joint venture between Tokyo Electric and Chibu Electric in Japan.

ConocoPhillips is presently assessing potential LNG backfill supply opportunities that could provide gas to the Darwin LNG plant after the Bayu Undan reservoir ceases production in 2022.

10.2.2. Ichthys

The Ichthys LNG Project is a joint venture between its operator, Inpex Corporation, and Total, CPC Corporation Taiwan, Tokyo Gas, Osaka Gas, Kansai Electric Power, JERA (a joint venture between TEPCO and Chubu Electric) and Toho Gas. The project is based on production from the Ichthys Field, located approximately 220 kilometres off the Kimberley coast of Western Australia in the Browse Basin.

Located at the field will be a floating Central Processing Facility (CPF), known as the Ichthys Explorer. This is a column-stabilised, offshore, semi-submersible production unit supporting hydrocarbon processing systems and utilities, as well as living quarters for approximately 200 personnel. Raw hydrocarbon streams from a network of subsea wells connected to the CPF will undergo initial processing on the CPF to extract condensate and water, as well as remove impurities so that the gas is suitable for transmission via pipeline to Darwin.

Most of the condensate will be stripped from the raw hydrocarbon stream and shipped directly to market from a Floating Production Storage and Offloading (FPSO) facility that is to be permanently moored on a non-disconnectable turret approximately 3.5 kilometres from the CPF and connected to the CPF via subsea transfer lines. This 336-metre-long, weathervaning vessel, known as the Ichthys Venturer, will process and store most of the condensate from the CPF before periodically offloading it to carriers for export to market. The remaining product will be compressed and returned to the CPF for transfer via the pipeline to Darwin.

The 890 kilometre, 42" subsea pipeline connecting the CPP to the LNG plant at Darwin Port is composed of approximately 700,000 tonnes of steel and coated with 550,000 tonnes of concrete and is one of the longest subsea pipelines ever built.

The Ichthys LNG Plant is located at Bladin Point on the Middle Arm of Darwin Harbour. It is comprised of two LNG processing trains, LPG and condensate plants, product storage tanks, a combined cycle power plant, administration facilities, utilities and an export jetty.

The project is expected to commence production in March 2018 and will produce 8.9 million tonnes of LNG, 1.6 million tonnes of LPG and 100,000 barrels of condensate per annum. It is estimated that at peak production the Ichthys Project will produce economic output of \$4.5 billion per annum for the Northern Territory economy.¹⁵²

10.2.3. Prelude

Similar to the Ichthys project, the Prelude offshore production facility is located in the Browse Basin off the Kimberley coast of Western Australia. The project is operated by Shell on behalf of the other joint venture partners, Inpex, KOGAS and OPIC. The production facility is the Prelude Floating LNG vessel with extraction, liquefying, storage and offloading of gas all given effect from this vessel at sea. The vessel is 488 metres long and 74 metres wide and, in addition to its processing plant, will accommodate 120 to 140 operational staff at any one time.

When operational, the floating facility will produce 3.6 million tonnes per annum of LNG, 1.3 million tonnes per annum of condensate and 0.4 million tonnes per annum of LPG.

Prelude's onshore supply-base is located at Darwin Port and includes warehousing for equipment and spare parts under the management of ASCO. A special-purpose platform supply vessel, Skandi Darwin, will be based in Darwin, making weekly trips to the Prelude facility to deliver supplies and support subsea maintenance and inspection.

A major contractor to the Prelude project, Monadelphous, will also provide maintenance, brownfields modifications and turnaround services for Prelude from a fabrication workshop based in Darwin.

10.2.4. Blacktip

The Blacktip Field is located in the Bonaparte Basin, approximately 110 kilometres off the Western Australian coast near the Northern Territory border and is owned 100 percent by its operator Eni. Blacktip was developed to exclusively supply gas to the domestic market with first production in 2009.

Condensate is stabilised and stored at the onshore processing facility and transferred onto tankers periodically through a condensate export system located seven kilometres offshore. The condensate export system includes an export pipeline and a tanker mooring and offloading system. Gas produced from the unmanned platform is transmitted via a 108-kilometre pipeline to an onshore treatment plant with a capacity of 44 petajoules per annum located near the coastal community of Wadeye in the Northern Territory. The gas is sold under a 25-year supply agreement with a power plant operated by the Northern Territory PWC to meet demand starting at 23 petajoules per annum in 2009 and increasing to 37 petajoules per annum for a total of approximately 750 petajoules over the 25-year contract life.

¹⁵² Acil Allen Consulting (2017), *An Economic Impact Assessment: The Ichthys LNG Project*, INPEX Corporation

10.3. Key Issues and Marine Science Knowledge Needs

The following subsections summarise the main issues and marine science knowledge needs facing the offshore petroleum industry, with detailed marine science knowledge needs contained in Table 18.

10.3.1. Environmental Baseline Data

By their nature, offshore petroleum projects are subject to rigorous environmental impact assessments and ongoing environmental impact monitoring. Additionally, knowledge of environmental dynamics is important to inform operational decisions and, to maintain social licence to operate, industry must continue to demonstrate to the community that its impact is minimised. Each of these issues must be informed by a range of core environmental data.

The project approvals process requires project proponents to have access to local and regional scale environmental datasets to undertake environmental impact predictions and to establish appropriate baselines for monitoring the potential environmental impacts from operations. The relative absence of marine datasets means that this information is collected by the oil and gas industry generally on a project-by-project basis and in proximity to their operating assets. The long timeframes for gaining environmental approvals are to a large part determined by the lengthy and expensive surveys required to underpin approval processes, impacting upon the productivity of future developments and various other operational activities such as hydrocarbon spill response.

10.3.2. Infrastructure Planning

The ongoing development of hydrocarbon fields in the Timor and Arafura Sea will, over time, require ongoing investment in new infrastructure and expansion and refurbishment of existing infrastructure such as platforms, subsea equipment and subsea pipelines. The absence of certainty around usage of the marine estate that currently exists because of the absence of management plans relating to the significant areas of Commonwealth marine reserves, as well as the evolving legal framework pertaining to Aboriginal interests in the marine estate unless resolved, will serve as a barrier to infrastructure planning in the short term and potentially detracts from investment in the longer term.

From an engineering perspective, the main forcing factors in the region (ITF and Monsoons) are reasonably well understood and the seafloor is tectonically stable. However, the bathymetry of the seafloor in certain parts of the Timor and Arafura Seas presents some challenges to pipeline construction.

10.3.3. Hydrocarbon Spill Response

Large hydrocarbon spills are an extremely rare event. However, if they do occur and are not adequately managed they can have devastating impact on the natural environment and communities they contain. Petroleum asset operators in the Northern Territory marine environment have detailed oceanographic data pertaining to the immediate vicinity of assets so that an immediate response to a spill event is optimally informed. There is also a reasonable understanding of the wider regional oceanographic processes and a range of technical and operating assets (e.g. aerial observations from aircraft or drones, satellite tracking, on-water observations, etc.) can be deployed once a spill is detected. However, sub-regional oceanographic processes, particularly in near-shore and coastal environments, are less well

understood and a better understanding of these could provide improved predictive capability for spill planning and responses as well as complementing existing planning and modelling.

Similarly, the absence of extensive common shared baselines across the Northern Territory marine environment means that operators are required to perform extensive data collection activities to underpin regulatory approvals applications, which carries attendant costs and risks of siloing. Operators must demonstrate which ecosystems might be affected and how impacts may be managed and, therefore, may adopt an overly precautionary approach that unnecessarily sterilises areas from development. Even with such a precautionary approach, gaps in the marine science knowledge base leaves residual uncertainty as to what ecosystems might be affected by an uncontained spill, the impact the hydrocarbons might have on those ecosystems and the resilience that might be demonstrated by those ecosystems.

There is also a need to better incorporate and respond to Aboriginal traditional, cultural, spiritual and other links, values and usage of the marine estate. Traditional hunting practices and customary practices are inextricably tied to specific places and ecosystems. Adverse changes can have negative impacts on not only livelihoods and subsistence, but also cultural survival and community viability, meaning Indigenous communities and peoples are disproportionately affected by any hydrocarbon spill.¹⁵³ This is particularly so in the unique environment of the Northern Territory, where an estimated 85 percent of the intertidal zone along the coastline is Aboriginal land and the vast majority of communities outside Darwin are either a majority or entirely Aboriginal. The need to engage early and comprehensively with Indigenous peoples in planning for, or responding to, hydrocarbon spills is a global trend in the oil and gas industry.¹⁵⁴

10.3.4. Managing Seismic Noise

An issue of significant contemporary controversy is the impact of seismic noise on local fish stocks and the ecosystems that support them, and therefore other users of the marine resource that depend on those fish stocks, such as the commercial, recreational, charter and customary fishing sector, as well as Aboriginal communities.

While the subject of a number of international and FRDC reports¹⁵⁵ over the years, as well as research undertaken by Woodside, Santos and others, marine noise pollution has become an

¹⁵³ IPIECA (2012), *Indigenous Peoples and the oil and gas industry: Context, issues and emerging good practice*, IPIECA

¹⁵⁴ Gregory, R., and Trousdale, W. (2009), 'Compensating aboriginal cultural losses: an alternative approach to assessing environmental damages', *Journal of Environmental Management*, 90(8):2469-2479; *Federation of Sovereign Indigenous Nations demands seat in oil spill command centre* (2016), Anon, published CBC News Canada 25 July 2016; *Alutiiq Culture Before and After the Exxon Valdez Oil Spill* (1995), Wooley, C.B, *American Indian Culture and Research Journal* 19:4 (1995) 125-153; *Long-term community impacts of the Exxon Valdez oil spill: patterns of social disruption and psychological stress seventeen years after the disaster* (2007), Picou, J.S; Martin, C.G, published Office of Polar Research, National Science Foundation, Washington, USA

¹⁵⁵ *Effects of Seismic Energy on Fish: A Literature Review* (2006), Worcester, T, Fisheries & Oceans Canada Research Document 2006/092, published Canadian Science Advisory Secretariat, available www.dfo-mpo.gc.ca; *Sound Effects* (2013), McPherson, G., and Knuckey, I., Fisheries Research and Development Corporation Research Paper 2013/209;2014/004, available www.frdc.com.au

issue of public note since late 2016,¹⁵⁶ with compensation payments made by the offshore industry to lobster fishers along the Victorian coast for loss of access to the fishing area. The titleholder for the survey, Santos, received a prohibition notice from NOPSEMA that delayed commencement on the grounds that a significant and immediate threat to the environment was posed, and additional control measures needed to be explored.¹⁵⁷

In particular, exposure to high levels of noise typically seen in marine seismic surveys, while not immediately fatal, was found to have significant long-lasting neurological and immunological impacts on adult lobsters, whereas scallop populations experienced elevated post exposure mortality associated with immunological issues and observed physical impairment.¹⁵⁸ The effects on bony and cartilaginous fish populations in Australian waters and on native species are not well understood; however, prior research¹⁵⁹ indicates several areas of concern, including long-term damage to mobility, internal bleeding and blindness. Population-level effects are unclear and poorly understood, but may include effects on breeding, spawning and recruitment, migration patterns, feeding ability and growth rates,¹⁶⁰ although the degree of certainty around these outcomes is very low.

Further, much of the work done in this area to date has focused on threatened and endangered species, and knowledge regarding the juvenile and larval stages of many species is scarce, conflicting, tested under contestable assumptions or missing entirely, with marked differences between results obtained under laboratory conditions and those observed in the field.¹⁶¹ A recent survey of literature in this field illustrates that while more studies show no discernible effects than otherwise, the response of a large majority of marine species to seismic survey noise is unknown(Figure 60 and Figure 61¹⁶²).

¹⁵⁶ Zervos, C. (2016), 'Underwater seismic testing in Apollo Bay could see lobster prices skyrocket this Christmas', *Herald Sun*, 26th November

¹⁵⁷ Notice Number 623 (2016) pursuant to Offshore Petroleum and Greenhouse Gas Storage Act 2006 (Cth), Schedule 2A

¹⁵⁸ *Assessing the impact of marine seismic surveys*, op cit

¹⁵⁹ *Effects of Seismic Energy on Fish*, op cit

¹⁶⁰ *Ibid*, *Sound Effects*, op cit

¹⁶¹ Carroll; A.G et al. (2016), 'A critical review of the potential impacts of marine seismic surveys on fish and invertebrates', *Marine Pollution Bulletin*, 114(1) (Jan 2017): 9-24

¹⁶² *Ibid*

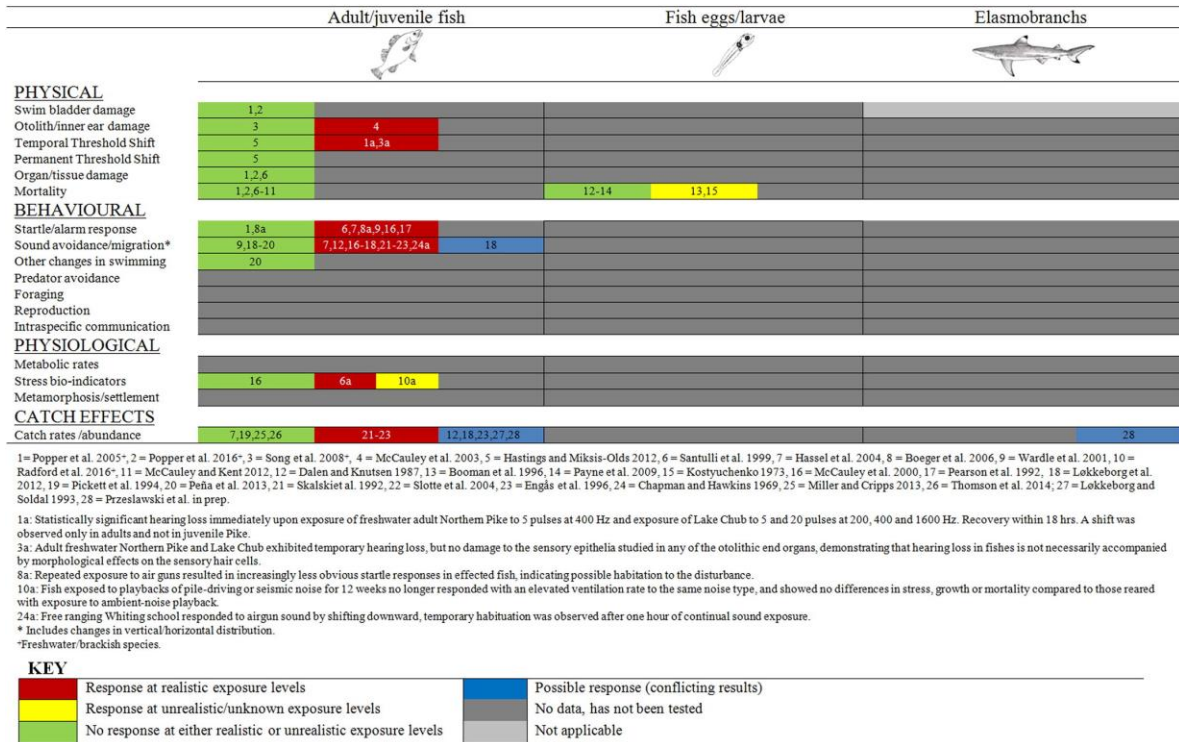


FIGURE 60 – EXTENT OF UNKNOWN IMPACTS OF MARINE NOISE – ADULT FISH, JUVENILE FISH, FISH EGGS, FISH LARVAE AND ELASMOBRANCHS

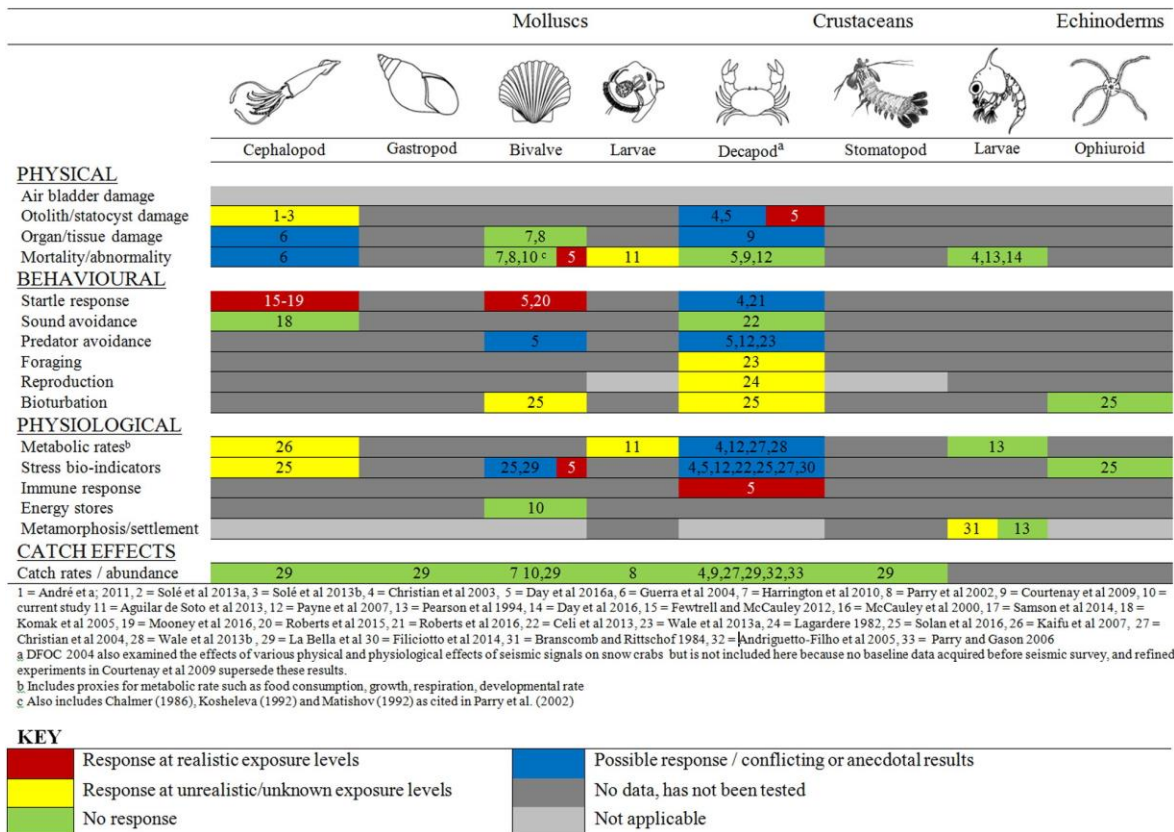


FIGURE 61 - EXTENT OF UNKNOWN IMPACTS OF MARINE NOISE – CEPHALOPOD, GASTROPOD, BIVALVE, DECAPOD, STOMATOPOD AND OPHIUROID

In addition to the impact on macroscopic fauna, recent Australian studies have indicated that seismic noise may have an impact on zooplankton beyond that formerly understood. As simple creatures without hearing structures and at the same density as surrounding water, little impact was presumed and previous studies had borne out a conclusion that no impact was observed beyond 10 metres from the point source.¹⁶³ With most marine food webs reliant on plankton, potential impacts on primary production could have significant flowthrough effects. While conducted in colder southern waters off Tasmania, results showed that seismic surveys could increase plankton mortality by two to three times out to the maximum assessed range of 1.2 kilometres from the survey site.¹⁶⁴

The great disparity between previously obtained results and these findings prompted further investigation by the CSIRO, with funding from the Australian Petroleum Production and Exploration Association, focusing on the potential impact on the Northwest Bioregion contiguous to the Northern Territory marine environment.¹⁶⁵ While noting some areas of potential improvement in method, and a potential anomaly in the results (mortality did not fall off with distance from point source), the CSIRO analysis generally validated the experimental design and simulated the impact on zooplankton biomass in Northwest regions. While for the simulated survey the predicted impact on populations within the area was substantial, the population recovery time of 15 kilometres from the impact site was only three days, and the impact on the region as a whole was not discernible.¹⁶⁶ As a modelling exercise, these results are useful but not determinative, and further study is required in this area.

10.3.5. Decommissioning of Infrastructure

There is very little experience with decommissioning offshore infrastructure in the Northern Territory, with only a single FPSO facility decommissioned to date. Furthermore, the only existing asset potentially soon scheduled for decommissioning is Eni's Kitan platform, and it is likely that in some cases operators will want to keep pipelines in place to support backfill options. Nevertheless, as the Northern Territory offshore industry matures, more assets will approach end of life. This will require assessment of the most appropriate decommissioning protocols and assessment as to whether decommissioned infrastructure has *in situ* value.

¹⁶³ *Effect of elastic waves generated in marine seismic prospecting on fish eggs in the Black Sea* (1972), Kostyuchenko, L.P, *Hydrobiological Journal*, 9:45-48; *Effects of sounds from a geophysical survey device on behaviour of captive rockfish (Sebastes spp)* (1992), Pearson, W.H, Skalski, J.R, Malme, C.I *Canadian Journal of Fisheries and Aquatic Sciences*, 49: 1343-1356; *Assessment of environmental effects of seismic testing on scallop fisheries in Bass Strait* (1992), Parry, G.D et al, published Marine and Freshwater Resources Institute Report No.50

¹⁶⁴ *Widely used marine seismic survey air gun operations negatively impact zooplankton* (2017), McCauley et al, *Nature Ecology and Evolution*, 1:0915 (June 2017)

¹⁶⁵ *Potential impacts on zooplankton of seismic surveys* (2017), Richardson, A.J, Matear, R.J, Lenton, A, published CSIRO Oceans and Atmosphere division, available www.csiro.au

¹⁶⁶ *Ibid*

Key Issue	Description	Specific Marine Science Needs
ENVIRONMENTAL BASELINES		
Baseline Data for Approvals, Operational Decision making and Ongoing Licence to Operate	The design, approvals, ongoing operations and licence to operate the offshore oil and gas industry is informed by its environmental impact. Measuring this impact requires a baseline understanding of a wide range of environmental variables.	<p>Definition of coral spawning times and methods in the Northern Territory marine environment.</p> <p>Identifying key foraging, aggregation and breeding areas for coastal dolphins, Dugongs and marine turtles.</p> <p>Identification and mapping of coral and seagrass distribution.</p> <p>Identification and mapping of key seabird nesting and foraging areas.</p> <p>Identification of spawning periods and locations for key commercial and recreational fish species.</p> <p>Develop and maintain invasive marine species baseline in current and future ports.</p> <p>Develop and maintain TBT, copper and herbicide baselines in current and future ports.</p> <p>Develop and maintain water and sediment quality baselines in current and future development areas, as well as at selected representative pristine or un-impacted reference sites.</p>

Key Issue	Description	Specific Marine Science Needs
Assessment of Resilience	Where disturbances are unavoidable or there is risk they could inadvertently occur to a minor extent, there is a need to understand the extent certain ecosystems demonstrate resilience to this disturbance so that impact can be minimised.	<p>Benthic habitat mapping and identification of key species for KEFs.</p> <p>Assimilative capacity in Darwin Harbour for nutrients and storm drain and industry point source hydrocarbon and metals discharges.</p> <p>Turbidity impact thresholds for corals, seagrass, fish, fish eggs, larvae and plankton.</p>
Innovative Methods for Undertaking Baseline Studies and Assessments	Undertaking baseline and other environmental studies in the Northern Territory marine environment is expensive, sometimes technically challenging (because of issues such as high levels of turbidity) and often dangerous (because of tides, currents and predators). As such, the development of technologies and methods that mitigate these factors is important.	<p>Develop and refine remote sensing techniques for water quality and mangrove health.</p> <p>Develop impact assessment methodologies suitable for rapid deployment for large-scale events such as coral bleaching, regional dieback of mangrove, cyclone impacts and tier 3 hydrocarbon spills that do not require a Before-After-Control-Impact design.</p> <p>Develop acceptable risk/significance tests for environment sectors (e.g. mangroves, corals, benthic primary producers, protection of protected species) that can guide environmental impact assessment and project development.</p> <p>Further develop and validate use of habitat models for marine parks.</p>

Key Issue	Description	Specific Marine Science Needs
INFRASTRUCTURE PLANNING		
Certainty of Access to the Marine Estate	Uncertainty pertaining to the zoning of the extensive Commonwealth marine reserves, as well as the evolving legal framework pertaining to water controlled by Aboriginal interests is creating uncertainty that limits current infrastructure planning. These issues need to be resolved such that future investment is not compromised.	Research, primarily baselines, which supports the finalisation of management plans pertaining to the Commonwealth marine reserves. Frameworks for better integration of Aboriginal interests into infrastructure planning processes.
Detailed Seafloor Mapping	Some areas of the Timor and Arafura Seas seafloor are characterised by steep hills and cliffs that present challenges to the placing and laying of subsea pipelines. A better understanding of these features will assist in more efficient planning of pipeline infrastructure.	Bathymetric mapping of likely subsea pipeline corridors.
HYDROCARBON SPILL RESPONSE CAPABILITY		
Regional Physical Oceanography	Hydrocarbon spills are rare events and because in the case of the Northern Territory marine environment, any liquids in the gas are typically stripped out at the offshore asset meaning a spill of liquid hydrocarbons in an environment not conducive to immediate containment is unlikely. Nevertheless, there is limited detailed understanding of oceanographic processes at the sub-regional level, particularly in near-shore	Sub-regional oceanographic surveys, with a particular focus on near-shore environments as inputs to models. Shift in academic modelling philosophy so that model components can be easily integrated with third-party government and industry models.

Key Issue	Description	Specific Marine Science Needs
Aboriginal Marine and Coastal Interests	<p>environments, rendering it difficult to formulate a response to a spill that is not immediately contained.</p> <p>A deeper understanding of Aboriginal coastal and marine cultural and other values is required to design hydrocarbon spill responses that ensure those values are not compromised.</p>	<p>Framework that allows industry to work closely with communities and Traditional Owners with interests in the Northern Territory marine environment to respectfully understand important values and how those values are best protected in the event of an uncontained hydrocarbon spill.</p> <p>Framework for engaging communities and Traditional Owners in hydrocarbon spill response planning, decision making and implementation.</p>
Fishery Regulator Requirements	<p>Data Industry needs to have a deeper understanding of the information and data that fishery operators require to make decisions regarding the closure and subsequent reopening of a fishery in the event of an uncontained hydrocarbon spill so that the impact of such an event on the fishing industry is minimised.</p> <p>Industry would also benefit from access to current fishery data to understand areas of high importance and productivity for fishers to inform impact assessments.</p>	<p>Establish decision-making criteria and data requirements needed by fisheries regulators to make decisions on the status of Northern Territory fisheries.</p> <p>Development of a strategy to expediently acquire, publish and interpret that information and data in the event of an uncontained hydrocarbon spill.</p>
Disbursement Studies	<p>In the event of an uncontained hydrocarbon spill, operators need to be confident of when the spill has been adequately contained and cleaned. This requires an understanding of hydrocarbon</p>	<p>Effects of dissolved and dispersed hydrocarbons on planktonic and benthic communities.</p>

Key Issue	Description	Specific Marine Science Needs
	<p>degradation in the Northern Territory marine environment and the ability of dissolved and disbursed hydrocarbons to remain in the ecosystem and affect micro-organisms.</p>	<p>Study the <i>in situ</i> degradation of hydrocarbons around outfalls with specific reference to light oil and condensate characteristics of fields within the Northern Territory marine environment.</p>
SEISMIC NOISE		
<p>Impact of Seismic Noise on Northern Territory Fisheries</p>	<p>A significant amount of research has already been undertaken in other regions investigating the impact of seismic noise on various fish species. However, much of that work will require contextualisation for the Northern Territory marine environment and species in the Northern Territory.</p>	<p>A review of research into the impact of seismic noise on fish and marine mammals undertaken in other regions to date to identify work that may be applicable to assessing impacts on species targeted by the commercial, recreational and customary sectors in the Northern Territory.</p> <p>Based on identified gaps, research to improve the understanding of the impact of underwater noise associated with seismic surveys on specific species targeted by the commercial, recreational and customary sectors in the Northern Territory.</p> <p>For species where an impact has been determined, research into the genetic structure of that species to determine how geographically distributed it is and, therefore, the impact on specific commercial, recreational and customary interests.</p>

Key Issue	Description	Specific Marine Science Needs
DECOMMISSIONING OF INFRASTRUCTURE		
Alternative Uses for Decommissioned Infrastructure	As certain fields in the region mature, the offshore petroleum industry operating in the Northern Territory marine environment will enter a phase of increasing decommissioning of offshore infrastructure. Methods for safely decommissioning offshore infrastructure and monitoring post-decommissioning integrity are well understood and practiced worldwide. However, as the industry enters a decommissioning phase opportunity to explore alternative uses for decommissioned infrastructure will require assessment.	<p>Risk and cost-benefit assessment of leaving decommissioned offshore infrastructure <i>in situ</i>, or repurposing as fish attracting devices for the recreational or commercial sectors, or as refugia for over-fished species, following consultation with commercial and recreational fishers.</p> <p>Investigation of the potential to use depleted wells for the storage of CO₂ (given that natural gas in the region tends to exhibit high CO₂ content) or as storage of gas for the domestic market.</p>

TABLE 18 – MARINE SCIENCE NEEDS OF THE OFFSHORE PETROLEUM INDUSTRY

11. Marine Tourism Industry

In 2015–16, an estimated 1.7 million people visited the Northern Territory, of which 815,000 (48 percent) were holidaymakers.¹⁶⁷ While visitor information is largely reliant on surveys and self-reporting, recent analysis indicates that tourism in the Northern Territory is temporally concentrated, with most tourists visiting during the April to November dry period, as well as geographically concentrated in and around Darwin, with 75 percent of visitors only leaving the Darwin Area for day trips.¹⁶⁸ The most popular attractions are terrestrial and include the Kakadu, Litchfield and Nitmiluk National Parks.

Nevertheless, the Northern Territory's pristine tropical marine environment, marine-oriented Aboriginal culture and significant recreational fishing stocks render it a popular marine tourism destination. The main aspects of tourism that intersect with the marine environment are cruise ships and fishing charters. These are discussed in the following subsections.

11.1. Passenger and Recreational Cruising

The number and duration of cruise ship visits to Darwin Port (see Section 7.2.2) has increased over the past decade,¹⁶⁹ with the sector now contributing approximately \$54 million to the Northern Territory economy annually.¹⁷⁰ While the cruiseliners themselves obviously interact with the marine environment, existing market research suggests that disembarked passenger interaction with the marine environment is minimal, and largely confined to waterfront dining, the 'Jumping Crocodile Cruise' on the Adelaide River, Darwin Harbour Cruises or water activities at Cullen Bay.

11.2. Fishing Charters

Fishing charter operations are the most visible component of Northern Territory marine tourism. It is a sector that has grown steadily in recent years with 63 operations accounting for a total of 300,000 fishing days over 2012–13.¹⁷¹

Fishing charter operators are now required to be licenced, keep logbooks and may be inspected, and as of 1 January 2017 all fishing charter operators need to hold an approved operator card and successfully pass an industry specific interview.¹⁷²

Most customers (90 percent) are male and between 35 and 60 years of age with high disposable incomes. A typical trip is between two and ten nights, with almost the entire trip

¹⁶⁷ Data sourced Tourism NT Corporate Research, available www.tourismnt.com.au

¹⁶⁸ Ibid

¹⁶⁹ Data sourced Ports Australia, *op cit*

¹⁷⁰ Tourism NT, *op cit*

¹⁷¹ Data sourced AFANT, available <http://afant.com.au>; *Sector Profile: Fishing Tourism* (2012), Tourism NT, available www.tourismnt.com.au

¹⁷² *Changes to commercial fishing licences from 1 January 2017*, in *Commercial Fishing*, published NT Department of Fisheries, available <https://nt.gov.au/marine/commercial-fishing>

devoted to fishing activities, with very little engagement with other cultural or leisure experiences.¹⁷³

The majority of patrons of fishing charters in the Northern Territory are interstate visitors, primarily from New South Wales, Victoria and Queensland, with Northern Territory residents accounting for only 21 percent of fishing charter customers. Interstate customers are more likely to invest in an experience outside of the immediate Darwin Harbour Area, with 31 percent taking charters out to Bynoe Harbour and 41 percent to Mary River.¹⁷⁴

Indeed, interstate visitors on fishing charters comprise a very large portion of the total fishing effort in remote and regional Northern Territory. The Northern Territory Government estimates that approximately 70 percent of the total fishing effort that occurs in regional areas is derived from fishing charters. Remote and regional areas of particular focus include the Daly, Roper and McArthur Rivers (particularly King Ash Bay) and Dundee Beach, as well as Aboriginal settlements and outstations throughout the Tiwi Islands, Arnhem Land and Groote Eylandt.

11.3. Key Issues and Marine Science Knowledge Needs

This study has not ascertained key issues and marine science knowledge needs for the Northern Territory marine tourism industry. However, with respect to the fishing charter sector it is anticipated that the knowledge needs will be similar to those of the commercial and recreational fishing sectors and Aboriginal interests, particularly with respect to allocation of the fishery resource and access to fishing areas.

¹⁷³ Data sourced AFANT, available <http://afant.com.au>; *Sector Profile: Fishing Tourism* (2012), Tourism NT, available www.tourismnt.com.au

¹⁷⁴ Ibid

12. Minerals Industry

12.1. Minerals Industry and the Northern Territory Economy

The minerals industry is a critical component of the Northern Territory economy. Since 1999–00, the value of minerals production has increased at a CAGR of 4.8 percent to a current GVP of approximately \$3.0 billion, with manganese, gold, zinc-lead concentrate and uranium being the major drivers of that growth. This is illustrated in Figure 62¹⁷⁵ below.

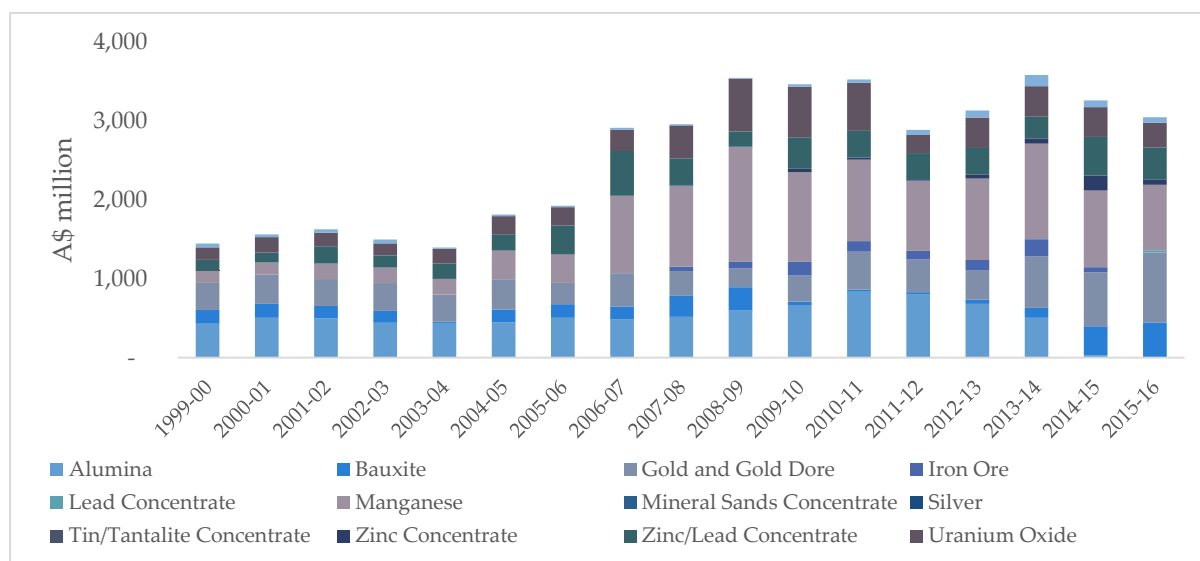


FIGURE 62 – NORTHERN TERRITORY MINERALS INDUSTRY – GROSS VALUE OF PRODUCTION (1999–00 TO 2015–16)

In 2014–15, the Northern Territory minerals industry accounted for 12 percent of GDP and provided 5,700 direct jobs.¹⁷⁶

¹⁷⁵ Department of Primary Industry and Resources (2016), *Mineral Production Statistics*, Northern Territory Government

¹⁷⁶ Minerals Council of Australia, *Agenda for Growth-Northern Territory Mining Industry*

12.2. Key Projects

The vast majority of current GVP is produced by the projects listed in Table 19.

Mine	Operator	Commodity
Gove	Alcan (Rio Tinto)	Bauxite
Cosmo	Kirkland Lake Gold	Gold
Gemco	South 32	Manganese
Bootu Creek	OM Holdings	Manganese
McArthur River	Glencore	Zinc-lead
Ranger	Energy Resources of Australia	Uranium
SILL80 Roper	Australian Ilmenite Resources	Mineral sands
Callie	Newmont Mining	Gold
Union Reefs	Kirkland Lake Gold	Gold

TABLE 19 – MAJOR OPERATING MINES IN THE NORTHERN TERRITORY

The locations of these operating mines and other potential mines are illustrated in Figure 63.¹⁷⁷

¹⁷⁷ Northern Territory Department of Primary Industries and Resources

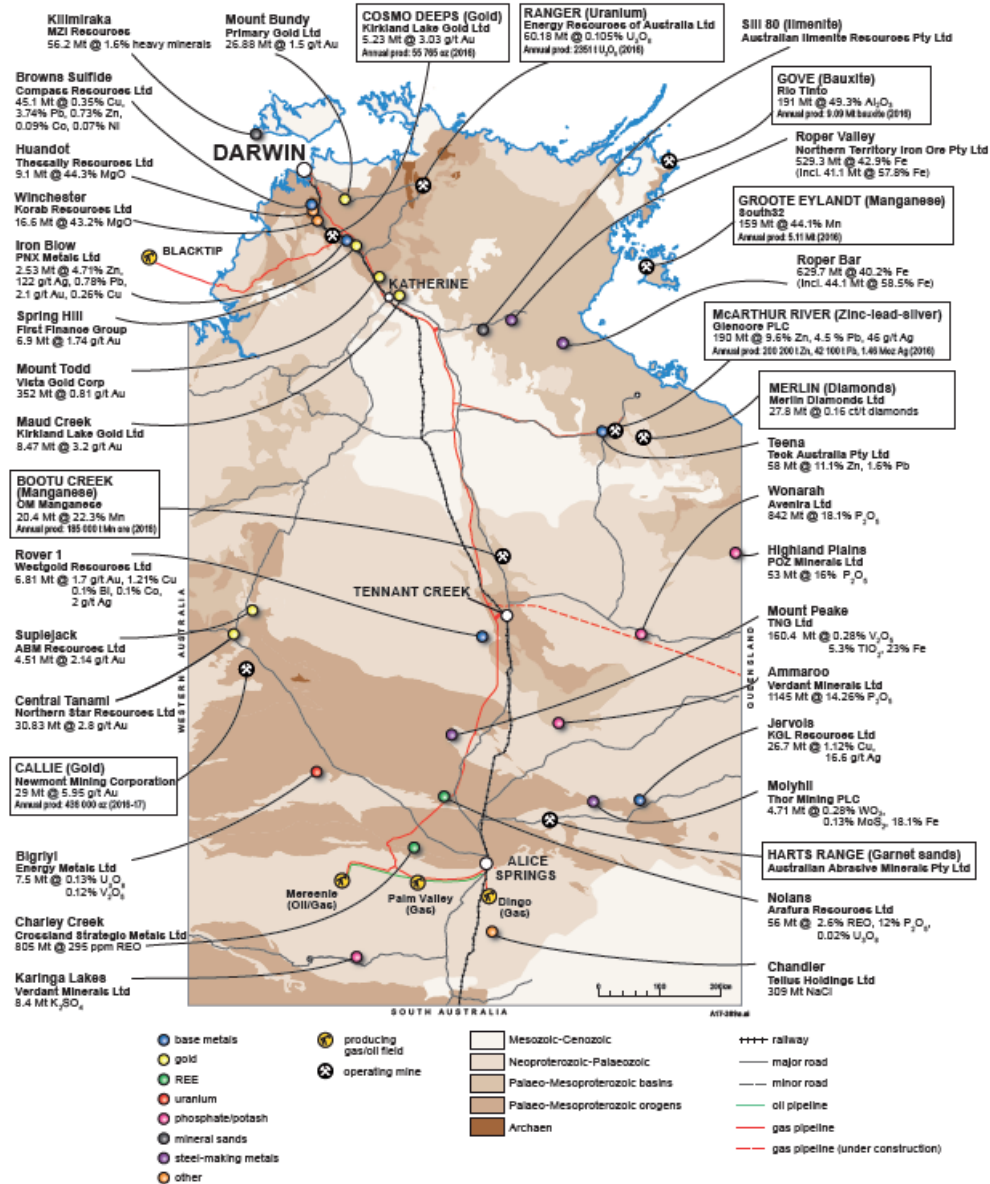


FIGURE 63 – NORTHERN TERRITORY MINERALS PROJECTS

In addition to iron ore from Frances Creek and manganese from Bootu Creek, which is exported through Darwin Port (see Section 7), the main projects that have an operational intersection with the Northern Territory marine environment are the McArthur River zinc-lead, Gove bauxite and Groote Eylandt Mining Company (GEMCO) manganese operations. These projects are discussed in the following subsections.

12.2.1. McArthur River

The McArthur River mine is owned and operated by Glencore and is the world's second largest zinc-lead mine. Located 900 kilometres southeast of Darwin near the community of Borroloola, the mine has been operating since 1995.

Ore is mined using conventional open-pit drilling, blasting, loading and haulage methods. Ore is trucked from the mine to the processing plant where it goes through three stages of crushing and screening, pre-concentration via heavy metal media separation, followed by flotation,

oxidative leaching and dewatering. Tailings from the process are pumped to the tailings storage facility located west of the mine via a rubber lined steel pipeline.

Bulk and zinc concentrate produced by the processing circuit is trucked 120 kilometres to a loading facility at Bing Bong. The truck's trailers are fully covered, side-tipping trailers and have a payload of approximately 120 tonnes. When they arrive at the Bing Bong facility, the concentrate is stored in a storage shed with capacity for 90,000 tonnes via a fully covered unloading dock.

At Bing Bong, a purpose-built barge transports the concentrate to ships waiting at sea, where it is exported to various refineries around the world. This barge has a capacity of 3,200 tonnes. It self-loads and discharges at an average rate of 900 to 1,000 tonnes per hour, with cargo capacity of each shipping consignment between 6,400 and 45,000 tonnes.

The loading system has an 'auto-dock' capability that secures the barge against the wharf at Bing Bong using a hydraulic claw and swing arm, guaranteeing its precise location under the loading chute and that the concentrate is enclosed at all stages of the loading process.

The offshore transfer zone where the concentrate is transferred from the barge to the bulk carriers is defined and has an average depth at low tide of 14.75 metres. All stages of the loading and discharging operations are managed by computer process control systems overseen by closed-circuit cameras.

12.2.2. Gove

The Gove bauxite mine and operation is located in northeast Arnhem Land. The operation is comprised of an open-cut mine, alumina refinery, residue disposal area, power station, port and ship loading facilities. The project is operated by Pacific Aluminium, a subsidiary of Rio Tinto Alcan. It is situated on extensive deposits of high-grade bauxite. Mining of bauxite commenced at Gove in 1970 and since then has produced over seven million tonnes of bauxite per annum.

Escalating energy costs placed the ongoing viability of the refinery in doubt in 2012. Unable to reach an arrangement for the supply of natural gas to the site, the refinery was placed into care and maintenance in 2014. The operation now directly exports bauxite to overseas refineries and is expected to continue to operate on this basis to 2030.

12.2.3. Groote Eylandt Mining Company

The mining of manganese by GEMCO commenced in 1964 under ownership of BHP. The operation rapidly developed to include crushing and wet screening. A beneficiation facility was introduced in 1972 with a 1 million tonne per annum capacity. This facility has been upgraded several times to facilitate expansions.

Located on Groote Eylandt approximately 16 kilometres from the coast, GEMCO is an open-cut, progressive rehabilitation strip mining operation, operated by South 32 and owned in joint venture with Anglo America. The high-grade manganese ore produced from the mine is shipped to South 32's manganese alloy plant in Tasmania and to other customers across the globe. The operation is currently the world's largest and lowest cost manganese producer.

The mine has been operating for over 50 years. Operations involve conventional open-cut mining and an ore washing and concentrator facility. Concentrated ore is transported from the mine by truck to the operation's port facility at Milner Bay. The mine has been through

several expansion phases, including most recently in 2014, and there are considerable resources remaining *in situ*. The most recent expansion included the construction of a new ore processing plant, development of new mining areas and upgraded port facility to allow for improved handling and blending of concentrates

The mine is supported by residents of the nearby town of Alyangula, as well as a Fly In Fly Out workforce.

12.3. Key Issues and Marine Science Knowledge Needs

As a principally terrestrial activity, the minerals industry in the Northern Territory currently intersects with the Northern Territory marine environment through the following main vectors:

- Shipping operations and associated loading facilities that support export operations;
- Direct discharges of process water to the marine environment;
- Leaching of heavy metals and escaped pollutants from operations into the water table, inland waterways and ultimately the marine environment; and
- Potentially in the future of subsea mining would obviously involve significant direct interaction with the marine environment.

The industry's ongoing social licence to operate is dependent on it demonstrating that its impact on the natural environment is managed and minimised.

These issues are discussed in the following subsections and marine science knowledge needs are detailed in Table 20.

12.3.1. Wider-scale Cumulative Impacts of Direct Interactions with the Marine Environment

Some existing and former mining and mineral processing operations discharge stormwater and/or process water directly into the Northern Territory marine environment. While the discharge is relatively innocuous, the dispersion and cumulative impacts of this activity are not well understood. Furthermore, while shipping operations are loading and transporting relatively inert products and systems are deployed to minimise any contamination of the marine environment during transport and loading, the extent to which some contamination inevitably occurs through wind and wash is not known, nor is its environmental impact.

12.3.2. Impacts of Acid and Metalliferous Drainage and Escaped Pollutants on the Marine Environment

Understanding the extent to which acid and metalliferous drainage (AMD) can occur from mine tailings and enter the marine environment and its regulation is important for managing the potential impact of the mining industry on the marine environment. Indeed, historical regulation and management of AMD has often been unsatisfactory. The potential extent to which leaching of metals, sulphates and nitrates from tailings of particularly historical mines into groundwater and waterways, and ultimately into the marine environment and the impact on marine ecosystems is largely unknown. While in many instances there may not be a pathway for AMD to enter the marine environment, ecosystems that are potentially compromised by AMD may have adverse impacts on the productivity of the fisheries and potentially on the livelihoods and customary economies of coastal Aboriginal communities, particularly given many of these communities rely as much on the affected inland waterways for subsistence and cultural practice as they do the marine resource.

If poorly managed, there is also potential for other pollutants to escape from the mining and processing process and similarly enter the marine environment and have adverse effects on the ecosystems, particularly coastal and estuarine ecosystems that other users of the marine environment rely on.

12.3.3. Efficient Regulation of the Mining Industry's Interface with the Marine Environment

Some regulatory frameworks that govern the direct interaction of the mining industry with the marine environment in the Northern Territory have subjective performance criteria, which creates an environment of uncertainty when investing in systems to manage that interaction.

Furthermore, increased focus on the environmental impact of mining in the Northern Territory will likely bring increased regulatory focus on closure and rehabilitation criteria, which need to be defined for investment certainty. Mining operations are also often significant users of water and, as such, have potential to impact on the hydrological balance where surface and groundwater sources are linked to the marine environment. As competition increases for use of water resource, the industry's ability to recycle water will also be important.

While for economic and social reasons, subsea mining is probably unlikely to occur in the Northern Territory for some time there has been some limited recent interest in exploring for subsea minerals. Subsea mining methods have the potential to cause significant disturbance to the marine environment and could only be undertaken in accordance with a very solid regulatory framework, which has not yet been established.

Key Issue	Description	Specific Marine Science Needs
WIDER-SCALE CUMULATIVE IMPACTS OF DIRECT INTERACTIONS WITH THE MARINE ENVIRONMENT		
Dispersion and Cumulative Impacts of Mine and Process Water Discharge	Environmental impact and toxicology in the immediate vicinity of the discharge point for storm and process water is well understood. Because of significant daily (tidal) and seasonal (monsoon driven ingress) water exchange there is adequate dispersion of the relatively inert discharge for impacts to be significant; however, the extent of dispersion and cumulative impacts of these discharges is unknown.	Regional water chemistry and toxicology studies in the Gulf of Carpentaria to determine areas of heightened toxicity and the source of that toxicity.
Extent of Ore and Concentrate Contamination, its Dispersion and Cumulative Impact	As the result of enclosed transfer systems, the escape of large amounts of ore or concentrate from boat loading facilities is unlikely. Furthermore, the ore products and concentrates are relatively inert. Nevertheless, accumulations of ore or concentrates in certain ecosystems could be detrimental to the function of those ecosystems.	Survey of key ecosystems near loading/transfer areas in conjunction with surveys that identify the level of accumulation of ore/concentrate are required to identify the impacts of any dispersion from the source. If deemed necessary, survey of key ecosystems in the Gulf of Carpentaria to identify any build-up of escaped ore or concentrate in ecosystems not in the immediate vicinity of the source.
IMPACT OF ACID AND METALIFEROUS DRAINAGE AND ESCAPED POLLUTANTS ON THE MARINE ENVIRONMENT		
Extent of AMD Contamination from Historical and Current Mining Operations	Determining the extent of AMD contamination in groundwater and surface water that are connected to historical and current mining operations and the associated ecosystems is the first step in determining the extent of this threat to the marine environment and a pathway to any required remediation.	Water chemistry testing of surface water and groundwater resources in proximity to historical and current mining operations. Testing of likely affected flora and fauna to determine fate of metal toxicants.

Key Issue	Description	Specific Marine Science Needs
Extent of Escaped Pollutants	Determining the extent of other pollutant contamination in groundwater and surface water that are connected to historical and current mining operations and the associated ecosystems is the first step in determining the extent of this threat and a pathway to any required remediation.	<p>Determine whether AMD contamination is entering the marine environment.</p> <p>Water chemistry testing of surface water and groundwater resources in proximity to historical and current mining operations.</p> <p>Testing of likely affected flora and fauna to determine fate of any escaped pollutants.</p>
Systems for Monitoring and Determining the Origins of Metals, Sulphates and Nitrates in Waterways and Ecosystems	The development and deployment of low-cost, real-time <i>in situ</i> monitoring systems could ensure that any future AMD or escaped pollutant contamination is detected early so that any widespread dispersion into the marine environment can be prevented by the operator. Similarly, such technology would underpin compliance with regulations.	Review of potential technologies that could be economically deployed in remote areas of the Northern Territory to give effect to real-time monitoring of metals, sulphates and nitrates in groundwater and surface water systems.
Managing the Impact of AMD and Escaped Pollutants	The extent to which remediation of past AMD and escaped pollutant toxicity in ecosystems is required is a function of the resilience of ecosystems and individual flora and fauna species to that toxicity and whether the toxicity presents risk to human health once it enters the food chain.	<p>Assessment of the resilience of affected ecosystems, flora and fauna species to identified toxicity.</p> <p>Assessment as to whether levels of toxicity in the food chain exceed human health standards.</p> <p>If required, design of remediation programmes.</p>
EFFICIENT REGULATION OF THE MINING INDUSTRY'S INTERFACE WITH THE MARINE ENVIRONMENT		
Defined Criteria for Systems	Current Northern Territory legislation that regulates some of the interface between mining and processing operations and the marine environment (such as stormwater discharge	Review of regulation of industrial process interface with the marine environment in other

Key Issue	Description	Specific Marine Science Needs
	<p>systems) does not prescribe criteria for design in detail, but rather requires the operator to adopt best practice. While this is beneficial in the sense that it allows systems to be adapted to the specific operating environment, it introduces subjectivity to assessment of best practice. This leads to uncertainty in system design and inefficiencies when systems must be reconstructed or modified to address changing regulator expectations with respect to best practice.</p>	<p>jurisdictions to identify best practice regulatory frameworks.</p> <p>Research to determine minimum systems requirements for discharge of stormwater and process water into the marine environment as a basis for more definitive systems requirements.</p>
<p>Evolution of Water Allocation Policy</p>	<p>Increased mining and agricultural activity in the Northern Territory will place increasing pressure on water resource allocation policy. The dependency of the health of particularly estuarine and coastal ecosystems on a minimum quantum and timing fresh water ingress (which is not yet well understood), together with the dependency of industry and communities on those ecosystems, means that the amount of inland surface water and groundwater that can diverted is finite. For the mining industry to continue to have access to the water it requires it will need to be part of the allocation discussion and provide an evidence-based argument that it is an efficient user of water.</p>	<p>Study to quantify the current water usage of the minerals industry and likely scenarios for future water usage.</p> <p>Review existing technologies and technologies under development that could render the recycling of water cost-effective for mining operations.</p>
<p>Defined Completion Criteria</p>	<p>Increasing pressure from the community to ensure that the environmental impact of mining operations is minimised will likely see continued pressure for extensive remediation at mine closure. Uncertainty with respect to completion criteria affects project net present value, creating investment uncertainty.</p>	<p>Assessment of likely residual impacts associated with current completion criteria.</p> <p>Assessment of trends in completion criteria in other mature mining jurisdictions such as Western Australia, Canada and the United States.</p>

Key Issue	Description	Specific Marine Science Needs
Subsea Mining Regulation	<p>While for economic and social reasons subsea mining in the Northern Territory is likely some time away, at some point commodity markets and technology development will converge to render it viable and an attractive investment. It is likely that for subsea mining to be undertaken with minimised environmental impact, new regulation would need to be put in place. The development of this regulation must be informed by the nature of the mining process and the environmental values it is likely to impact.</p>	<p>Identify completion criteria that might be required to ensure world-class remediation and that may be required to satisfy communities.</p> <p>Review of subsea mining operations in other jurisdictions, current methods and technologies and methods and technologies in development.</p> <p>Review of regulation of subsea mining in other jurisdictions to determine best practice and elements of best practice regulation of subsea mining that are likely to apply to the Northern Territory.</p> <p>Identify areas of the Northern Territory marine environment that are likely to be prospective for subsea mining.</p> <p>Determine key principles that should underpin new regulation pertaining to subsea mining in the Northern Territory, issues that regulation must address and potential mechanisms for addressing those issues.</p>
SOCIAL LICENCE TO OPERATE		
Effective Communication of Science	<p>The minerals industry's ongoing licence to operate is in part dependent on it being able to demonstrate that it activity and effectively manages its impact on the natural environment and that, in fact, the impact is minimal. While ecological science can be undertaken to provide</p>	<p>Social science research that results in the development of effective tools for communicating scientific evidence of the minerals industry's environmental stewardship to diverse community interests groups.</p>

Key Issue	Description	Specific Marine Science Needs
	evidence of this, it can often prove difficult to effectively communicate this evidence to the diverse community stakeholders that the industry must convince.	

TABLE 20 – MINERALS INDUSTRY MARINE SCIENCE KNOWLEDGE NEEDS

13. Irrigated Agriculture and Forestry Industry

13.1. Agriculture and the Northern Territory Economy

In 2014–15, the Northern Territory agricultural industries produced GVP of \$493.5 million, representing approximately 2.2 percent of GSP. Comprised of beef cattle, horticulture and mixed farming sectors, the industry has grown at a CAGR of approximately 5 percent over the past 15 years. The trend in GVP for the Northern Territory agricultural industry is illustrated in Figure 64.¹⁷⁸

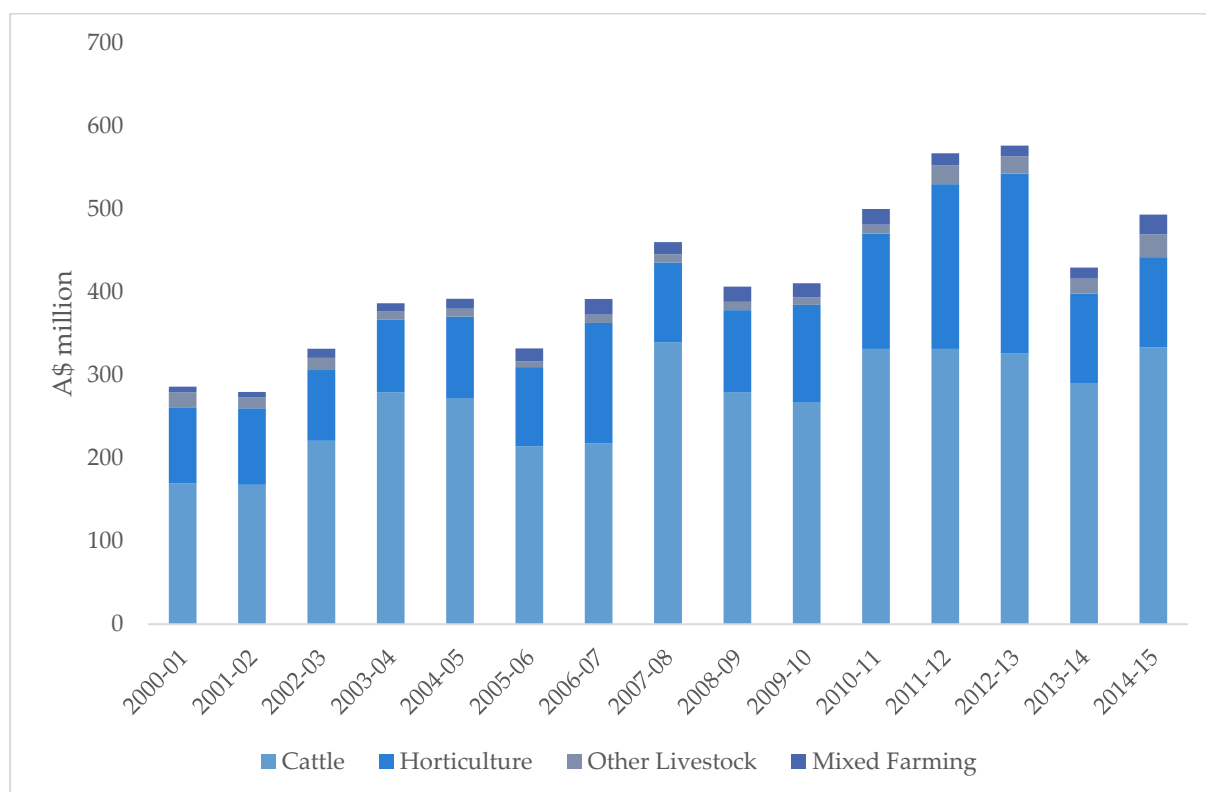


FIGURE 64 – NORTHERN TERRITORY AGRICULTURAL GVP (2000–01 TO 2014–15)

Beef Cattle

In 2015, there were approximately 2.1 million head of cattle in the Northern Territory, representing approximately 7.7 percent of the national beef cattle herd.¹⁷⁹ It is estimated that approximately 32 percent of the Northern Territory herd are located in Victoria River District and Katherine, 30 percent in Barkly Tablelands and Tennant Creek, 20 percent in the Alice Springs Pastoral District and 18 percent around Darwin, Esey and the Gulf.¹⁸⁰ In 2015, Northern Territory cattle accounted for 24.1 percent of all Australian live exports.¹⁸¹

¹⁷⁸ Department of Primary Industry and Fisheries (2016), *Overview and Outlook 2015*, Northern Territory Government, Darwin

¹⁷⁹ Meat and Livestock Australia (2016), *Fast Facts: Australia's Beef Industry*

¹⁸⁰ Department of Primary Industry and Fisheries (2016), *Overview and Outlook 2015*, Northern Territory Government, Darwin

¹⁸¹ Ibid

Horticulture and Mixed Farming

The Northern Territory horticulture sector includes production of various fruit, vegetables and nursery and cut flower products, producing GVP of approximately \$109 million in 2014–15. Mixed farming, or production of field crops, produced an additional GVP of \$24.0 million in the same year. The relative contributions of various produce to Northern Territory horticulture and mixed farming GVP is illustrated in Figure 65.¹⁸²

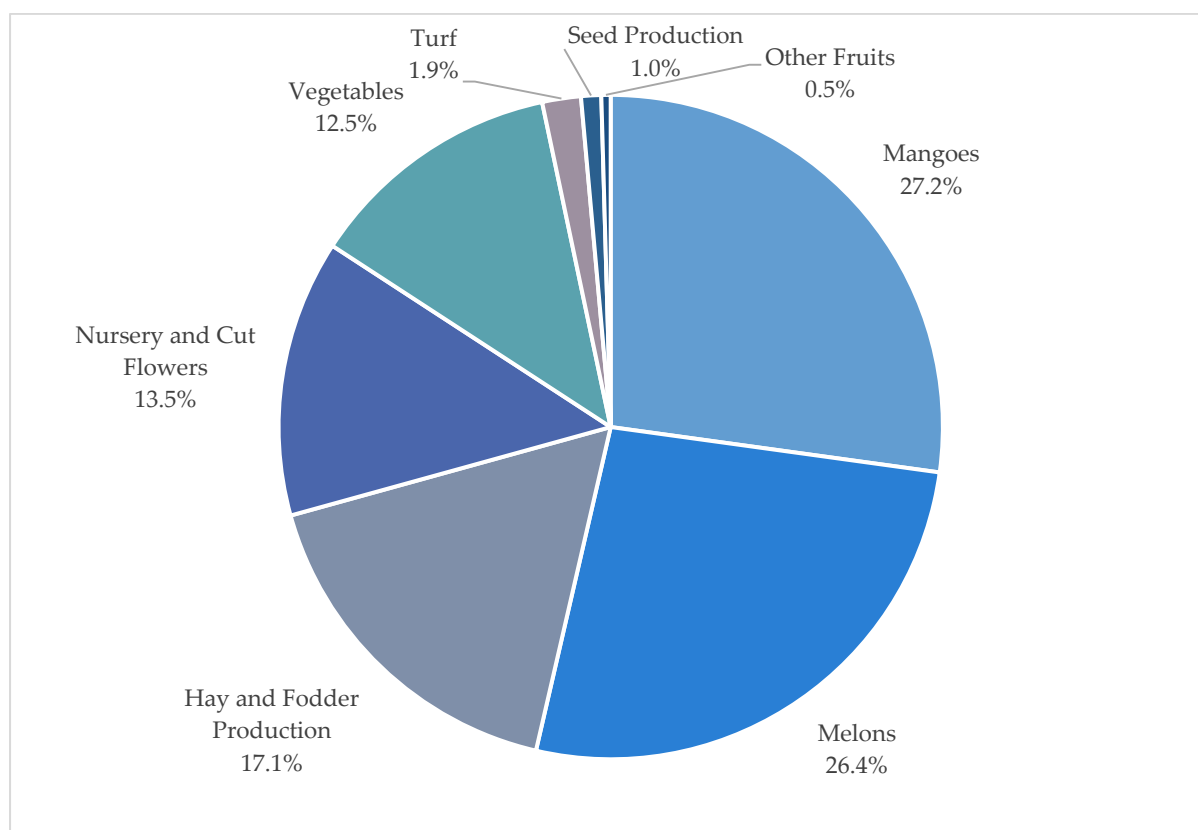


FIGURE 65 – PRODUCE CONTRIBUTION TO NORTHERN TERRITORY HORTICULTURE AND MIXED FARMING GVP IN 2014–15

It should be noted that the industry peak body, NT Farmers, estimates GVP from the sector to be much higher at \$244.5 million.¹⁸³

Mangoes and melons account for the majority of fruit produced by the Northern Territory horticulture sector, with other production periodically including table grapes, bananas and citrus. In 2014–15, \$36.1 million of mangoes were produced from approximately 6,030 hectares and \$35.1 million of melons from 1,100 hectares.¹⁸⁴ Production is located in the Litchfield and Katherine/Mataranka districts and all production is irrigated using groundwater under tree sprinkler systems. Production is dominated by large operations, with six operators accounting for almost all the production in the Katherine/Mataranka district and seven producers

¹⁸² Department of Primary Industry and Fisheries (2016), *Overview and Outlook 2015*, Northern Territory Government, Darwin

¹⁸³ NT Farmers (2016), *Economic Profile of Plant Based Industries in the Northern Territory*

¹⁸⁴ Department of Primary Industry and Fisheries (2016), *Overview and Outlook 2015*, Northern Territory Government, Darwin AND NT Farmers (2016), *Economic Profile of Plant Based Industries in the Northern Territory*

accounting for over 50 percent of production from the Litchfield district.¹⁸⁵ Melons are produced in the Katherine/Mataranka, Litchfield and Central Australian regions, with all production based on drip tape irrigation systems using groundwater. Production is concentrated across four large farms that collectively account for approximately 80 percent of production, with another six to eight farms accounting for the balance.¹⁸⁶

The main vegetables produced are cucumber, bitter melon, okra, snake beans and pumpkin, with vegetables worth \$16.6 million produced in 2014–15 from an estimated 1,000 hectares.¹⁸⁷

Field crop production in the Northern Territory has historically included pasture seed production, cereal crops (sorghum, maize, etc.) and other crops such as sesame and soybeans. Today, hay and other fodder crops account for the vast majority of production and is a growing sector, currently producing GVP of approximately \$22.7 million from around 20,000 hectares.¹⁸⁸ Hay crops are grown from monsoon season rainfall in Katherine, Douglas-Daly River and Litchfield Regions and lucerne and forage sorghums are grown in Central Australia.

The \$18 million turf and nursery industry is dominated by a small number of large nurseries.

13.2. Forestry in the Northern Territory

With a total area planted of approximately 50,000 hectares, the forestry industry is the second largest production land user in the Northern Territory after the beef cattle industry. The Northern Territory forestry industry is currently comprised of three sectors, which are mostly at a planting, development or early harvest stage.

- **Black Wattle (*Acacia mangium*)**
There is currently approximately 30,000 hectares of Black Wattle planted on the Tiwi Islands for wood chipping to produce pulp. This operation is expected to produce between 200,000 and 400,000 green metric tonnes of woodchip for export per annum, with the first harvest conducted in 2015.
- **African Mahogany (*Khaya senegalensis*)**
There are 15,000 hectares of African Mahogany planted in the Douglas-Daly River Region. This un-irrigated plantation is the largest African Mahogany plantation in the world, with a predicted rotation of 17 to 22 years. The product will be high-value sawn timber for flooring, fine furniture and veneer applications.
- **Sandalwood (*Santalum album*)**
Sandalwood is grown in irrigated, mixed species plantations in the Katherine and Douglas-Daly River Regions, with a total of 5,000 hectares planted. The harvest product will be used to produce sandalwood oil for pharmaceutical and ceremonial markets.

13.3. Potential Future Irrigated Agriculture and Forestry in the Northern Territory

Currently irrigated agriculture and forestry in the Northern Territory sources water from groundwater resources. Based on current knowledge, there is inadequate economic

¹⁸⁵ NT Farmers (2016), *Economic Profile of Plant Based Industries in the Northern Territory*

¹⁸⁶ Ibid

¹⁸⁷ Department of Primary Industry and Fisheries (2016), *Overview and Outlook 2015*, Northern Territory Government, Darwin AND NT Farmers (2016), *Economic Profile of Plant Based Industries in the Northern Territory*

¹⁸⁸ Ibid

groundwater resources to grow the industry. For the industry to reach its potential, there will likely need to be some off-stream harvesting of peak flows. However, this will be largely limited to areas upstream from floodplains and where the topography facilitates adequate capture.

In the case of many Northern Territory rivers, it is likely that only very small volumes of peak season flows would need to be harvested to sustain an economic operation.

13.3.1. Expansion of the Ord River Irrigation Area

As illustrated in Figure 66,¹⁸⁹ planned expansion of the Ord River Irrigation Area, currently exclusively within the jurisdiction of Western Australia, involves bringing areas in the Northern Territory on-stream post 2020.

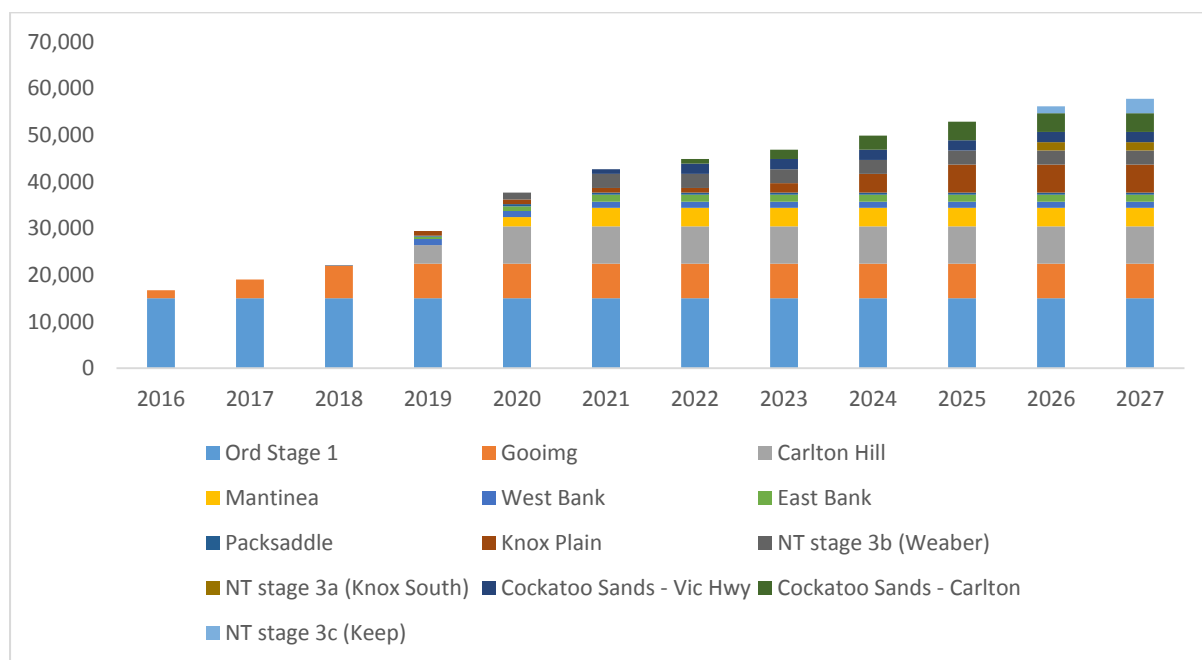


FIGURE 66 – ORD RIVER IRRIGATION AREA – PLANNED EXPANSION

As illustrated in Figure 67¹⁹⁰, the longer-term potential of the Ord River Irrigation Area, covers a significant footprint in the Northern Territory, known as Spirit Hills.

¹⁸⁹ Western Australian Department of Regional Development

¹⁹⁰ Northern Territory Department of Primary Industry and Resources

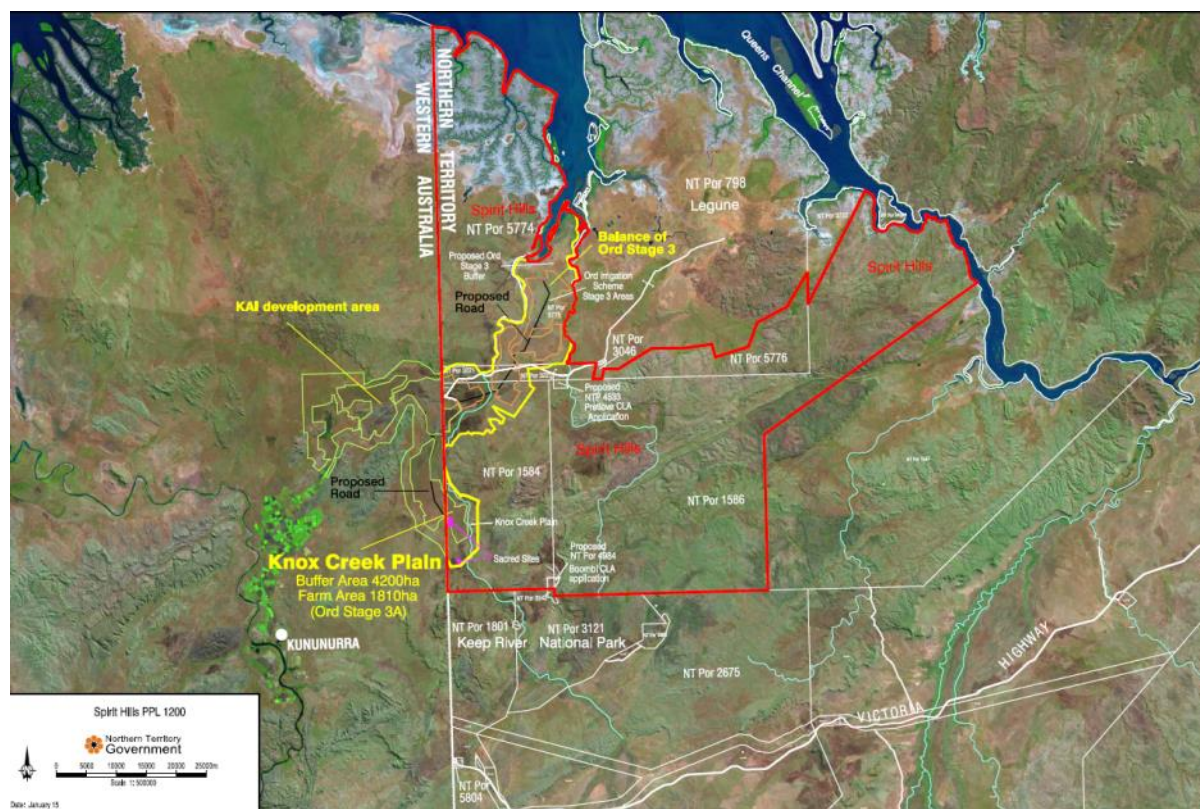


FIGURE 67 – FUTURE POTENTIAL EXPANSION OF THE ORD RIVER IRRIGATION AREA

13.3.2. Other Potential Areas

With extensive groundwater and surface water systems, there is significant potential to expand irrigated agriculture and forestry in the Northern Territory. Potential has been identified for the expansion of existing irrigation in the Douglas-Daly River Region and Central Australia, new irrigation systems on Tipperary Station, Auvergne Station and Victoria River, East and West Baine Rivers areas and additional forestry in Tiwi Island and establishment of forestry in East Arnhem Land. However, the two most advanced potential new irrigation projects are as follows:

- **Roper River, East Arnhem**

There has been limited water allocations from the Roper River to date. There are pastoral leases on Aboriginal land in the region that host very high-quality soils. There is a proposal to harvest peak wet season flows for irrigated agriculture during the dry season, most likely cotton rotating with high-value grains. Preliminary modelling has been undertaken that suggests environmental impacts will be minimal.

- **Wildman River**

This potential project is based on a pastoral lease owned by the Northern Territory Government. Soil studies have identified approximately 10,000 hectares of high-quality soils and water studies are currently underway.

13.4. Key Issues and Marine Science Knowledge Needs

The key marine science issue for the irrigated agriculture and forestry industries is understanding the resilience of estuarine and coastal ecosystems to changes in volume and timing of freshwater ingress to identify optimal sustainable levels of freshwater harvest for the industry. Table 21 details the marine science knowledge needs of the irrigated agriculture and forestry industries.

Key Issue	Description	Specific Marine Science Needs
Understanding the Surface Water, Groundwater and Marine Interface and Balance	Understanding the hydrological balance between terrestrial surface waters, groundwater resources and the marine environment is important to understanding the impact of diversion of freshwater on the marine environment.	Terrestrial surface water, groundwater and marine connectivity studies.
Understanding Resilience of Marine Ecosystems to Changes in Freshwater Ingress	To understand optimal levels of freshwater harvesting from groundwater and surface water resources, an understanding of the resilience of particularly estuarine marine ecosystems to changes in freshwater ingress needs to be understood.	Ecosystem baselines studies in estuaries likely to be impacted by freshwater diversion and assessments of the resilience of those ecosystems to changes in freshwater ingress.
Environmental Flows to Maintain Health and Productivity of Tidal Rivers, Estuaries and Other Near-coastal Environments	Understanding trade-offs among terrestrial and marine environmental values and enterprise health and viability	Methods for whole-of-system analysis and subsequent adaptive management.
Joined-up Land Use and Resource Access and Allocation Planning	Improved capacity to make and defend planning decisions.	Methods of managing uncertainty in both water demand and availability. Approaches to community engagement in effective planning.
Cultural and Aboriginal Water Allocations	Obligations to make allocations, but no present workable mechanism.	Review of potentially relevant systems in other jurisdictions and analysis of applicability to the Northern Territory.

TABLE 21 – IRRIGATED AGRICULTURE AND FORESTRY MARINE SCIENCE KNOWLEDGE NEEDS

14. Coastal Communities

As is the case for the Nation more generally, the vast majority of Northern Territorians live in cities, towns or settlements that are on or near the coast. As discussed in Section 2.2 and detailed in Table 3, almost 60 percent of the population of the Northern Territory resides in the Greater Darwin Area. As detailed further in Table 4, an additional 18 percent of the population reside in LGA's that have a coastline.

Most of the coastal population that resides outside of the Greater Darwin Area is Aboriginal and is concentrated in the coastal communities illustrated in Figure 68¹⁹¹, as well as a number of other smaller communities and outstations that are discussed further in Section 14.2. These smaller outstations may be seasonally occupied or used temporarily for ceremonial or sacred business, and their usage of the marine estate is limited primarily to traditional fishing and hunting practices or recreational fishing.

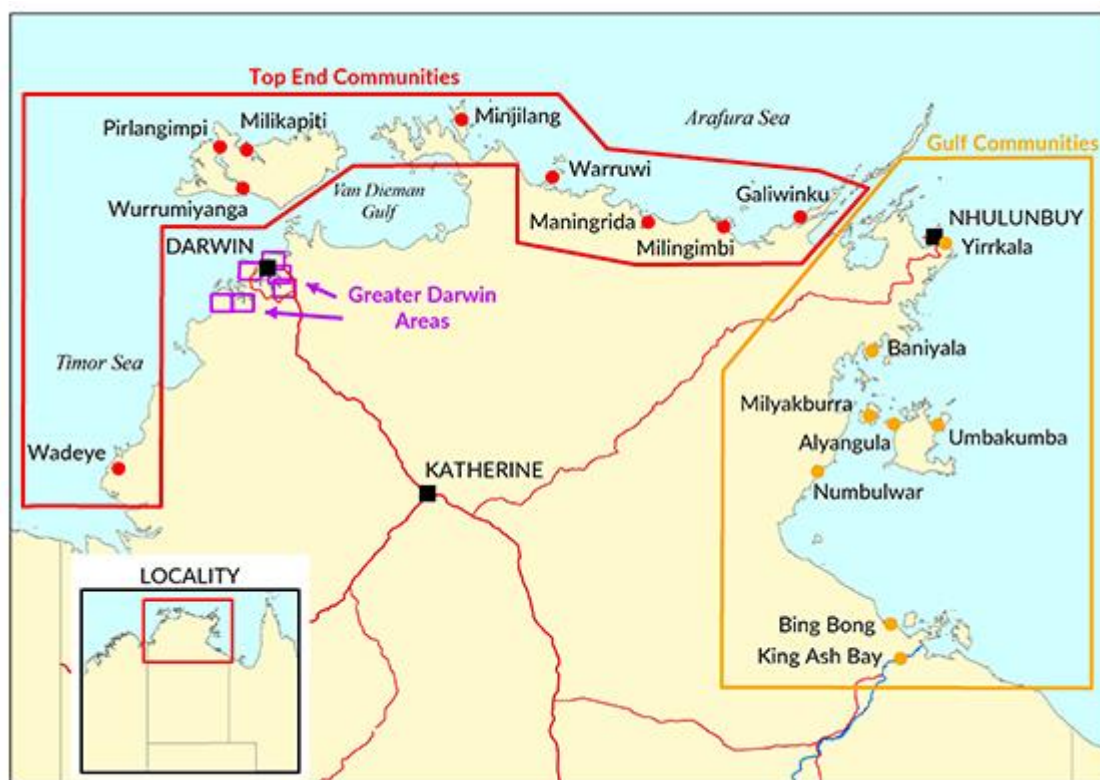


FIGURE 68 – MAJOR COASTAL COMMUNITIES IN THE NORTHERN TERRITORY

¹⁹¹ Northern Territory Department of Environment and Natural Resources

14.1. City of Darwin (Including Palmerston)

The Darwin City CBD and built waterfront occupies a large portion of the Darwin peninsula, with city limits extending northwards and eastwards following the East Arm of Darwin Harbour, before linking with the satellite city of Palmerston.

The majority of usage of the marine estate stems from the retail, restaurant, high density residential and tourism precinct in the Darwin Wharf Area, as well as the Cullen Bay, Kitchener Bay, Tipperary Waters and Bayview Marinas.

Because of somewhat *ad hoc* urban planning and historically unregulated development, the harbour and waterfront area are generally not readily accessible or for the most part viewable from the City. Accordingly, concerns around visual amenity, noise levels and similar issues have been less prevalent in the development and usage of the Darwin peninsula waterfront than has been the case in some other Australian capital cities.

Planning and urban development of the Darwin CBD has seen changes in recent years toward more central control and zoning. Adopted by the City of Darwin in 2015, the new Darwin City Master Plan¹⁹² was prepared after extensive community, industry, commercial and residential consultation. Currently an advisory document, the Master Plan sets out the aspirations of the City in infrastructure development, public works, investment and planning schemes. As of late 2015, discussions were underway with the Northern Territory Department of Lands, Planning and Environment to incorporate the Master Plan into the wider Northern Territory Planning Scheme, which would render the Master Plan a mandatory consideration for all future developments in the Darwin area.¹⁹³

The Master Plan contains numerous proposals to develop and increase utilisation of the coastal estate, including waterfront parks, releasing waterfront land for residential and commercial development and rerouting and upgrading road and public transport links. In particular, the plan calls for significant reclamation activities involving landfill, seawalls and other related stabilisation works to reclaim a significant portion of the northwest shoreline of East Arm, opposite the Charles Darwin National Park.

14.2. Coastal Settlements

Table 22¹⁹⁴ below lists Northern Territory coastal settlements outside of the Greater Darwin Area, many of which are remote Aboriginal communities supporting a number of additional outstations and homesteads that may be permanently or seasonally occupied or are used periodically for customary purposes. The total population of the coastal communities is equivalent to approximately 9 percent of the total population of the Northern Territory and 60 percent of the population of LGAs outside of the Greater Darwin Area that have a coastline.

¹⁹² City of Darwin (2015), *Darwin City Centre Masterplan*, Northern Territory Government

¹⁹³ Pursuant to the *Planning Act 1999* (NT)

¹⁹⁴ Australian Bureau of Statistics, *Census* (2016)

Settlement	Estimated Population	Description
Wadeye (Port Keats)	1,627	Township located Aboriginal Freehold Land (Daly River/Port Keats ALT) and a major air and sea transport link to the western Northern Territory coast area.
Wurrumiyanga (Nguu)	2,579	Aboriginal Community located on Aboriginal Freehold Land (Tiwi Island ALT) and largest community on Bathurst Island
Pirlangimpi (Garden Point)	370	Aboriginal Community located on Aboriginal Freehold Land (Tiwi Islands ALT) located on Melville Island
Milikapiti (Snake Bay)	450	Aboriginal Community located on Aboriginal Freehold Land (Tiwi Islands ALT) located on Melville Island
Minjilang (Croker Island)	309	Aboriginal Community on Aboriginal Freehold Land (Arnhem Land ALT)
Waruwi (South Gouldburn)	423	Aboriginal Community on Aboriginal Freehold Land (Arnhem Land ALT)
Maningrida	2,070	Aboriginal Community on Aboriginal Freehold Land (Arnhem Land ALT)
Milingimbi	650	Aboriginal Community on Aboriginal Freehold Land (Arnhem Land ALT)
Ramingning	800	Aboriginal Community on Aboriginal Freehold Land (Arnhem Land ALT)
Galiwin'ku (Echo Island)	2,200	Aboriginal Community on Aboriginal Freehold Land (Arnhem Land ALT)
Gapuwiyak	874	Aboriginal Community on Aboriginal Freehold Land (Arnhem Land ALT)
Nhulunbuy (Gove)	3,933	Town on Aboriginal Freehold Land (Arnhem ALT) that supports the Gove Bauxite operation and serves as a major air and sea transport hub for the region.
Yirrkala	843	Aboriginal Community on Aboriginal Freehold Land (Arnhem Land ALT)
Milyakburra (Bickerton Island)	180	Aboriginal Community on Aboriginal Freehold Land (Anindilyakwa ALT)
Umbakumba	300	Aboriginal Community on Aboriginal Freehold Land (Anindilyakwa ALT)
Alyangula	1,000	Town on Aboriginal Freehold Land (Anindilyakwa ALT) that supports the GEMCO mine
Angurugu	800	Aboriginal Community on Aboriginal Freehold Land (Anindilyakwa ALT)
Numbulwar	680	Aboriginal Community on Aboriginal Freehold Land (Arnhem Land ALT)
Bing Bong	770	
Gunyangara	260	Aboriginal Community on Aboriginal Freehold Land (Arnhem Land ALT)
TOTAL	21,309	

TABLE 22 – MAIN NORTHERN TERRITORY COASTAL SETTLEMENTS OUTSIDE OF THE GREATER DARWIN AREA

Most of the communities are either island based or are inaccessible by road during the wet season, rendering them heavily reliant on coastal barge services for logistics.

None of the Northern Territory coastal towns or settlements support a local private economy that could be sustained in the absence of public sector transfers. While this situation is likely to continue for the foreseeable future, it is important to identify possible opportunities for these towns and settlements to reduce their dependence on public funding as their populations expand.

The number of these towns and settlements that are likely to draw benefits from future large projects such as resources and agriculture will be relatively few. As such, in many cases, socio-economic development will be dependent on more modest, local enterprise that draws on local resources and capabilities.

14.3. Key Issues and Marine Science Knowledge Needs

The main issues from a coastal development perspective that require marine science investment for resolution are managing run-off from the Darwin CBD into Darwin Harbour, predicting and managing coastal inundation in vulnerable coastal communities, impact on coastal and estuarine environments as a result of destruction or diversion of tidal creeks for the purposes of facilitating urban development, ensuring viability of small coastal communities and public health issues associated with stormwater accumulations. These issues are discussed in the following subsections and the marine science knowledge needs are detailed in Table 23.

14.3.1. Stormwater Run-off from the Darwin CBD

As might be expected from a rapidly expanding capital, stormwater and wastewater run-off into Darwin Harbour that potentially introduces contaminants is a subject of some concern for all stakeholders. Presently, two facilities, Ludmilla and Leanyer treatment plants, both operated by the statutory PWC, provide sewage treatment facilities for Darwin and Palmerston. However, neither facility provides tertiary treatment and hence wastewater discharge licences are required from PWC to handle the volume of wastewater and run-off received.¹⁹⁵

While there are environmental conditions attached to these discharge licences, including that no gross pollutants of floating matter are present and no algal blooms or adverse fish health outcomes should result, significant community concerns remain, notwithstanding the closure of the Larrakeyah discharge outlet known colloquially as the 'poop chute'.¹⁹⁶

Continued poor water conditions exist in areas of the Harbour impacted by wastewater run-off despite infrastructure upgrades in recent years.¹⁹⁷

In parallel to wastewater treatment and as an ongoing process, the NTEPA is seeking to implement a new Stormwater Strategy for the Darwin Harbour Region.

¹⁹⁵ *Water reuse and treatment*, published Power and Water Corporation, available www.powerwater.com.au; *Waste Discharge Licences*, published Northern Territory EPA, available <https://ntepa.nt.gov.au/waste-pollution>

¹⁹⁶ *Harbour Pollution*, published Environment Centre NT, available www.ecnt.org.au/harbour-pollution; *Harbouring a problem (2016)*, Garrick, M., published NT News 3 May 2016

¹⁹⁷ *Darwin Harbour region report cards*, published NT Department of Environment and Natural Resources, available <https://denr.nt.gov.au>

14.3.2. Predicting and Managing Coastal Inundation

There are a number of communities along the Northern Territory coast that are subject to inundation, primarily as the result of periodic storm surge, including Warrawi and Milingimbi. The human safety, economic, social and environmental impact of inundation in these communities is exacerbated by the fact that, during the wet season when inundation is most likely to occur, a sea-barge is the only means of effective logistics access to the communities. When the coastline is damaged by inundation, barge access can be compromised resulting in the loss of supply of key goods for weeks.

The coastal inundation risk presented by storm surge is managed by modelling and resulting warnings issued by the Bureau of Meteorology (BOM). However, data informing the models on which these warnings are dependent is lacking.

14.3.3. Destruction and Diversion of Tidal Creeks

The Northern Territory coastline is characterised by many tidal creeks. Ongoing coastal urban development will invariably involve the diversion or destruction of some of these creeks. Knowledge on the impact of diversion or destruction of key tidal creeks on the local coastal ecosystems is limited.

14.3.4. Viability of Small Coastal Communities

As discussed in Section 14.2, a significant portion of the Northern Territory population reside in many small coastal communities. The vast majority of the population of most of these communities is Aboriginal and many communities are very remote, accessible only by sea-barge or helicopter during the wet season.

Currently, the financial viability of all these communities is dependent on public sector transfers. While this is likely to remain the case for the foreseeable future, models and frameworks for increasing the economic self-sustainability of these communities must be explored and implemented.

14.3.5. Stormwater and Public Health

Managing stormwater is a perennial problem for the Northern Territory because of the mostly low-lying and flat terrain that is characteristic of much of the Northern Territory hinterland and significant monsoon associated precipitation. In any tropical environment, poor management of stormwater accumulation can result in a high incidence of mosquito-borne disease. This is a particular public health problem in remote communities where infrastructure and capability in this regard is typically limited.

Key Issue	Description	Specific Marine Science Needs
STORMWATER RUN-OFF FROM DARWIN CBD		
Darwin Harbour Water Quality Baselines	Water quality in Darwin Harbour has been altered as the result of over a century of various and gradually increasing industrial and defence activity and urbanisation. Being a highly dynamic environment, there is also a significant degree of natural variability in Darwin Harbour water quality. Finally, because of significant daily tidal movements and major seasonal freshwater ingress, there is significant flushing of the Harbour. Collectively, these factors render determining a water quality baseline for Darwin Harbour challenging.	Ongoing water quality and toxicology studies in Darwin Harbour to determine an appropriate timeframe over which water quality and toxicology should be measured to determine a baseline and subsequently an appropriate baseline range.
Darwin Harbour Source Toxicity Studies	There are multiple contemporary and historical sources of contamination in Darwin Harbour. Determining the precise source of any identified contamination is important for determining the relative impact of run-off from the Darwin CBD and the potential cumulative impact of that run-off on ecosystems in Darwin Harbour.	Identification and mapping of sources of any identified contamination.
Assessment of Resilience of Darwin Harbour Ecosystems to Identified Toxicity and Sources of Toxicity	Prioritisation of any remediation or risk management action to address contamination caused by run-off from the Darwin CBD is determined by the extent to which specific ecosystems in Darwin Harbour are resilient to that toxicity.	Identification of any Darwin Harbour ecosystems that are impacted by toxicity caused by Darwin CBD run-off Assessment of the resilience of those ecosystems to the associated toxicity (including that toxicity's contribution to any identified cumulative impact)

Key Issue	Description	Specific Marine Science Needs
Modelling to Determine Future Volumes and Locations of Darwin CBD Run-off into Darwin Harbour and Risk Mitigation Measures	Based on an understanding of the current impact of Darwin CBD run-off, the specific ecosystems it impacts, the resilience of those ecosystems and future urban and industrial development in the Darwin Harbour Area, modelling can be developed to inform pollution prevention and risk mitigation measures.	<p>Collation and analysis of all master plans pertaining to the Darwin Harbour Area including the Darwin CBD and Port Master Plan, as well as other industry and urban development plans to determine future points of run-off water ingress to the Harbour and possible sources of contamination.</p> <p>Development of current and future run-off water modelling as the basis for pollution prevention and risk mitigation planning.</p>

PREDICTING AND MANAGING COASTAL INUNDATION

Inventory of Towns and Settlements that are Vulnerable to Inundation	A deeper understanding of the extent to which coastal inundation occurs and presents environmental, social, cultural and economic risk to specific communities needs to be understood to prioritise investment in data acquisition and risk mitigation.	<p>Mapping of areas of the Northern Territory coast that are prone to inundation and storm surge.</p> <p>Review of historical inundation and storm surge events in coastal communities to determine historical frequency and extent and severity of environmental, social, cultural and economic impact.</p> <p>Assessment of the likely impact of climate change on frequency and intensity of inundation and storm surge for at risk areas of the Northern Territory coastline.</p> <p>Prioritisation of coastal areas and communities based on historical and likely future frequency</p>
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Key Issue	Description	Specific Marine Science Needs
<p>Prioritisation of Topographic and Bathymetric Surveys Required to Support Improved BOM Inundation and Storm Surge Modelling</p>	<p>The BOM's existing storm surge model and its new storm-tide prediction system requires topographic and bathymetric data inputs at a resolution that does not yet exist along most of the Northern Territory coastline. Acquiring particularly bathymetric data is expensive in remote locations and in dynamic environments such as the Northern Territory and as such investment in its acquisition will need to be prioritised.</p>	<p>and severity and extent of inundation and storm surge.</p> <p>Review of existing topographic and bathymetric datasets pertaining to the Northern Territory coastline and gap analysis.</p> <p>Based on the gap analysis and assessment of likely future frequency and extent and severity of impact, prioritisation of topographic and bathymetric data acquisition.</p>
<p>Development of New Inundation and Storm Surge Warning Response Protocols and Risk Mitigation Strategies</p>	<p>Once the BOM modelling has been completed using the new bathymetric and topographic data, response protocols and risk mitigation strategies can be developed.</p>	<p>Review of existing response protocols and risk mitigation strategies and refinement based on the modelling outputs.</p>
<p>Assessment of Infrastructure Required to Mitigate Inundation in Communities that are Particularly at Threat and Prioritisation of that Investment</p>	<p>Where potential impacts are determined to be significant, business cases for infrastructure investment designed to mitigate impact can be developed and considered.</p>	<p>Based on the modelling, identification of areas of potential significant or catastrophic impact.</p> <p>Development of infrastructure options for mitigating impact.</p> <p>Preparation of business cases for investment in that infrastructure.</p>

Key Issue	Description	Specific Marine Science Needs
DESTRUCTION AND DIVERSION OF TIDAL CREEKS		
Mapping of Tidal Creeks Affected and Likely to be Affected by Imminent and Future Development	To determine future impact, an understanding of the precise tidal creeks that have and will be affected by urban development has to be established.	An overlay of all existing master plans and other development plans with mapping of tidal creeks, particularly around the Darwin Harbour Area, but also in other development pressure points along the Northern Territory coastline.
Assessment of Reliance of Local Coastal Ecosystems to Destruction or Diversion of those Tidal Creeks and their resilience.	Where current or potential future diversion or destruction of tidal creeks has been identified, the likely impact of that destruction or diversion on local coastal ecosystems needs to be determined.	Identification of coastal ecosystems that are likely to be impacted by diversion or destruction of local tidal creeks and an assessment of their likely resilience to changes in local tidal creeks.
VIABILITY OF SMALL COASTAL COMMUNITIES		
Mapping of the Economic Viability of Coastal Communities	To identify opportunities for pathways toward economic self-sustainability, an understanding of the enterprise, fiscal and overall economic status of individual communities is required.	Focusing primarily on the larger coastal towns and settlements, a qualitative and quantitative assessment of the local enterprise environment and fiscal status and trends in the community to identify potential pathways.
Options for Enterprise Development	Based on identified pathways and articulated aspirations of individual communities, options for different scales of enterprise development, and business and policy models that de-risk and support that development will need to be identified.	For communities where enterprise development pathways have been identified, an assessment of the aspirations of communities with respect to enterprise outcomes, which may range from simply supporting livelihoods and creating local employment opportunities to the development of much larger commercial enterprise. Identify opportunities that match the articulated aspirations and development of business plans

Key Issue	Description	Specific Marine Science Needs
Governance of Enterprise Development	Once viable business plans and supporting policy frameworks have been established, governance structures need to be in place to ensure that the use and development of local skills and resources are optimised in the execution of the business plan and that distribution of benefits is agreed and realised as agreed.	<p>for the development of enterprise that meets those aspirations.</p> <p>Assessment of business plans to identify risk and challenges associated with commercialisation.</p> <p>Review small business development policy and models to identify frameworks that optimise the likelihood of enterprise success based on those business plans.</p>
Efficient Regulation of Enterprise in Communities	Regulatory frameworks that apply to small enterprise generally may serve as an unnecessary hindrance to the development and operation of small enterprise in remote communities. While it is important that regulations applying to human safety, environmental protection, criminal activity and fraud remain, regulation that is unnecessarily restricting the development and operations of small business in remote communities should be addressed.	<p>Based on the identified enterprise opportunities, develop community-oriented governance frameworks that ensure local capacity and skills are optimised and developed from the enterprise and that benefits are distributed in an equitable and agreed way.</p> <p>Based on the identified business plans, assessment of the Northern Territory, Commonwealth and Local Government regulation that applies to the execution of those business plans.</p> <p>Identification of restrictive regulation and assessment of its necessity and implications of removing specific restrictive regulation.</p>

Key Issue	Description	Specific Marine Science Needs
STORMWATER AND PUBLIC HEALTH		
Mapping of Stormwater Problem Areas	Identification of stormwater accumulation 'hotspots' along the Northern Territory coast, particularly those that are near population centres is the first step in assessing public health risk associated with stormwater accumulation.	Mapping of stormwater accumulation within 10 kilometres of population centres along the Northern Territory coastline.
Assessment of Disease Risk	Identified accumulations need to be assessed for factors such as stagnation that promote insect accumulations and breeding.	<p>An assessment of natural and humanmade drainage associated with identified stormwater accumulations and other factors that promote or detract from insect accumulation and breeding.</p> <p>A review of historical spatial outbreaks of mosquito-borne disease in the Northern Territory and calibration of these outbreaks with identified at risk stormwater accumulations.</p>
Disease Risk Mitigation Strategies	Based on this information, an assessment of public health risk associated with mosquito-borne disease and risk mitigation options.	Based on known at risk accumulations and historical disease outbreak records, an identification of at risk areas and mitigation strategies such as spraying or drainage interventions.

TABLE 23 – MARINE SCIENCE NEEDS OF COASTAL URBAN DEVELOPMENT AND COMMUNITIES

15. Recreational Fishing

15.1. Recreational Fishing Activity in the Northern Territory

15.1.1. Data Limitations

Recreational fishing refers to the capture of fish from the wild that are either kept or released by non-professional fishers, excluding traditional, ceremonial or cultural fishing undertaken by Aboriginal people.

Obtaining reliable data on the recreational take from the Northern Territory fishery is problematic. While some monitoring is undertaken by the Northern Territory Government through compliance officers or Aboriginal Ranger Groups, the absence of a licencing regime that affords reliable identification of the number of recreational fishers and species take complicates data collection. It is very difficult to determine the extent of the recreational catch in terms of number of fishers or quantum taken of any particular species, which has follow-through implications on the enforcement of the regulations and restrictions that are placed on the sector.

While possession and size limits are in place, and checks are conducted, adherence to sustainable fishing practices outside of Darwin Harbour is in the main reliant upon an honour system of education and self-regulation. While concerns are periodically raised with respect to the effectiveness of this system by various stakeholders, no reliable data is available to identify and determine the extent of any potential non-compliance. The Department of Primary Industry and Resources does not consider that there is any reliable evidence of 'systematic non-compliance'.¹⁹⁸

In 2009–10, a survey of recreational fishers in the Northern Territory was undertaken.¹⁹⁹ The ability of this survey to form a comprehensive picture of fishing effort is limited by its voluntary nature and the fact it was dependent on respondents to maintain and update a catch diary. A repeat of this survey paired with targeted boat ramp surveys is currently underway; however, it is confined to the Greater Darwin Area between the Dundee and Adelaide River. It is understood that a Territory-wide survey may be planned for later in 2018.

15.1.2. Recreational Fishing and the Northern Territory Economy

As discussed in Section 15.1.3, recreational fishing is a major pastime in the Northern Territory, incorporating many social and cultural values. The Northern Territory recreational sector prides its self on the notion that the Northern Territory is one of the few places on Earth where you can still be 'guaranteed' to catch a fish on a fishing trip. This perception of the Northern Territory is also a valuable tourism asset.

The sector is estimated to have a significant multiplier effect on the local economy through fishing retail (bait and tackle), recreational vessel hire and purchase, fuel and ancillary services

¹⁹⁸ *Status of Fish Stocks 2014* (2015), Department of Primary Industries and Fishery, available www.nt.gov.au

¹⁹⁹ West, L., et al. (2012), *Survey of Recreational Fishing in the Northern Territory 2009-10*, Department of Primary Industry and Fisheries (www.dpif.nt.gov.au)

such as hospitality and accommodation associated with extended fishing trips. Primarily because of the data deficiencies discussed in Section 15.1.1, paired with an absence of funding required to undertake comprehensive research on the issue, it is very difficult to determine the extent of the multiplier associated with recreational fishing expenditure in the Northern Territory. However, the total economic impact of the sector has been estimated to be as much as \$100 million per annum.²⁰⁰

15.1.3. Northern Territory Recreational Fishing Profile

The 2009–10 survey remains the most reliable source of information on recreational fishing in the Northern Territory. Some of the key observations from this survey are summarised in the following subsections.²⁰¹

High Local Participation

It is estimated that approximately 22 percent of the non-Indigenous population of the Northern Territory participate in recreational fishing activity at least once per year. This is coastally oriented, whereby only three percent of inland residents compared to 38 of coastal region residents fish recreationally once a year. Approximately 75 percent of recreational fishers who fish once a year, fished on five days or fewer, 14 percent between six and 10 days, 5 percent between 11 and 15 days and 6 percent fished 16 days or more. Overall, 20 percent of recreational fishers accounted for 60 percent of the total fishing effort.

Boat- and Line-Based Effort

Approximately 85 percent of the recreational fishing effort in the Northern Territory is boat-based, with 81 percent of recreational fishers using a boat at least once. Over 95 percent of the boats used in the recreational fishing sector are privately owned, leading to one of the highest concentrations of private boat ownership in the Nation.

Almost all recreational fishing in the Northern Territory is line-based, with 95 percent of fishing days and 84 percent of total fishing hours being line-based effort. The only other relatively commonly used method is pot/trap-based fishing, which accounted for 15 percent of total fishing hours, with all other methods relatively insignificant.

Temporal Concentration of Fishing Effort

Over 98 percent of the recreational fishing effort in the Greater Darwin Area occurs during the eight-month period between April and November. This corresponds with the dry season when conditions are more pleasant, catches are more predictable and boating conditions are safer. In remote areas, almost all recreational fishing occurs during the April to November period.

Geographical Concentration

The survey indicated that, not surprisingly, the vast majority (79 percent) of recreational fishers reside in the Greater Darwin Area. Darwin Harbour and its surrounds account for approximately 45 percent of the total fishing effort and 48 percent of recreational fishers surveyed fished in Darwin Harbour at least once during the year. The next most popular area is the western coast south of Bynoe Harbour, which accounted for 20 percent of the total fishing effort, followed by

²⁰⁰ Submission to the Productivity Commission Issues Paper for Marine Fisheries and Aquaculture (2013), Amateur Fishermen's Association of the NT (AFANT), available www.afant.com.au

²⁰¹ West, L., et al. (2012), *Survey of Recreational Fishing in the Northern Territory 2009-10*, Department of Primary Industry and Fisheries (www.dpif.nt.gov.au)

the area around the Mary and Alligator Rivers, which accounted for 17 percent. The Arnhem coastline and Gulf of Carpentaria were visited by less than 9 percent of recreational fishers over the year.

Approximately 46 percent of total recreational fishing effort is concentrated in estuarine waters, 27 percent in near coastal waters (less than five kilometres from the coast) and only 8 percent in offshore waters, with the balance (11 percent) in freshwater.

Species Concentration

Finfish accounted for almost half of the species caught by the recreational sector, with Barramundi accounting for 21 percent of all fish caught and snapper 25 percent. A large portion of finfish, particularly Barramundi, are caught on a catch-and-release basis, with 58 percent of all finfish caught released.

Other species that are caught by the recreational sector include crustaceans (comprised of 78 percent of Mud Crabs) and cephalopods (comprised entirely of squid).

15.2. Key Issues and Marine Science Knowledge Needs

The key issues facing the recreational fishing sector in the Northern Territory are understanding the current and future impact of the sector on the fishery resource, more accurately defining the contribution of the sector to the economy and social fabric of the Northern Territory and maintaining the sector's social licence to operate. These issues are discussed in the following subsections and the marine science knowledge needs are detailed in Table 24.

15.2.1. Understanding the Current and Future Impact of the Sector on the Fishery Resource

Because of an absence of mandatory reporting or systems and frameworks that support reporting of recreational catch, it is difficult for the recreational sector to demonstrate with evidence its impact on the fishery resource or argue for an allocation of that resource. Paradoxically, the recreational sector has demonstrated significant historical success in securing allocation of the resource, primarily through rights to fishing areas for key target species at the exclusion of the commercial sector. In accordance with the National Recreational and Indigenous Fishing Survey process, regular repetition of surveying may assist to provide baseline figures; however, the difficulties in carrying out this process, the methodological flaws in landline-based voluntary reporting and the difficulty in fairly accounting for tourist or visitor fishers may complicate interpretation of results. The recreational fishing sector has suggested 5-yearly surveys may be complemented by fish tagging, angler diaries and controlled fine-scale data collection to help alleviate difficulties in this area.

To effectively advocate for maintaining or increasing allocations, the recreational fishing sector will likely increasingly need to be able demonstrate evidence of its use of the resource with a much greater degree of certainty than is currently the case. Furthermore, long-term allocation planning relies on trends in the sector itself. Understanding the growth or otherwise of the recreational sector is an important input to this understanding.

15.2.2. Accurately Defining the Sector's Contribution to the Economy and Social Fabric of the Northern Territory

To effectively advocate for maintaining or increasing allocations, the recreational fishing sector needs to be able to provide evidence of social and economic benefits associated with the sector.

As discussed in Section 15.1.3, recreational fishing is an important pastime for many Northern Territorians. It can be inferred from this that recreational fishing is important to the social fabric and identity of those living in the Northern Territory, an issue which needs to be considered in fishery resource allocation decisions.

Previous attempts to quantify the contribution that the sector makes to the Northern Territory economy suggest it is significant at around \$100 million. However, these estimates are the target of widespread criticism based on the notion they include all ancillary equipment that could be related to a fishing activity, rather than just expenditure that is fundamentally linked to that activity. To a degree this approach is justified as capturing the whole ambit of economic multiplier effects but introduces a degree of imprecision that makes reliance on such a figure problematic. Further, understanding the contribution of the sector to the Northern Territory economy is also an important consideration in fishery resource allocation decisions, however, such figures are not usually directly comparable to GVP measures commonly used in the commercial sector. Suggested means of overcoming this include undertaking standard estimates at regular intervals under controlled conditions and extrapolating from these across the broader sector.

15.2.3. Maintaining the Sector's Social Licence to Operate

Globally, the recreational fishing sector is coming under pressure from both animal welfare activist groups and elements of mainstream society to demonstrate acceptable standards of animal welfare practice. While this has not reached the same intensity of pressure that is the case for many terrestrial hunting practices, there is nevertheless evidence of some pressure.

Even practices designed to sustain the resource such as 'tag-and-release' fishing, which is a common practice in the Northern Territory recreational sector, can come under scrutiny from an animal welfare perspective.

Given the portion of Northern Territorians who fish recreationally on a regular basis, it is unlikely that significant pressure from an animal welfare perspective will come from the local community in the short-term. Nevertheless, as attitudes evolve and respond to external pressures, maintaining animal welfare standards that are acceptable to the wider community will become increasingly important for the sector's social licence to operate.

Key Issue	Description	Specific Marine Science Needs
UNDERSTANDING THE CURRENT AND FUTURE IMPACT OF THE SECTOR ON THE FISHERY RESOURCE		
Population and Stock Structure of Key Target Species	To understand the impact of the recreational fishing sector on the fishery resource, the population and structure of the key species targeted by the recreational sector must first be understood.	Stock structure and distribution of all key species targeted by the recreational sector.
Systems for Measuring and Monitoring the Recreational Sector Catch	The impact of the recreational sector cannot be reliably determined without reasonable quantification of its catch in key species. The recreational sector is generally very resistant to the implementation of a recreational fishing licence, mandatory reporting of catch or boat registration regime, rendering this task politically difficult. Given the advocacy power of the sector, determining a method of measuring the recreational catch with adequate certainty that is acceptable to recreational fishers is in the interests of the sector as well as the regulator. Gaining an understanding of visitor catch and effort is a significant issue for the recreational sector.	<p>Review of frameworks used to determine and monitor recreational fishing catch in other jurisdictions, especially overcoming methodological flaws, reducing reliance on landline contact and accounting for visitor numbers. This should include hybrid survey models using multiple frameworks from which to derive survey participants.</p> <p>Identification of best-practice options that might be acceptable to the Northern Territory recreational sector (or at least that are going to be the least resisted) as the basis for consultation, ideally as part of the forthcoming Northern Territory Code of Practice.</p> <p>Development of a framework for the Northern Territory recreational sector that takes into account best practice and feedback from the consultation.</p>
Trends in Sector Participation	Generally speaking, there is an observable trend that as regional centres grow, local participation in pastimes	Until a more reliable system for measuring sector participation can be established, a

Key Issue	Description	Specific Marine Science Needs
	<p>that are common in rural Australia (such as fishing, hunting, football, etc.) decline as other leisure activities become more readily available. Low cost international travel and the internet further detract from these traditional rural pastimes. Understanding trends in local participation in recreational fishing is an important consideration in fishery resource allocation. However, the absence of recreational fishing licences renders measuring trends difficult.</p>	<p>biannual community survey should be undertaken to determine participation in and attitudes toward recreational fishing among the Northern Territory community.</p>
<p>ACCURATELY DEFINING THE SECTOR'S CONTRIBUTION TO THE ECONOMY AND SOCIAL FABRIC OF THE NORTHERN TERRITORY</p>		
<p>Determination of the Social Value of the Recreational Sector</p>	<p>In making its case for maintained or increased allocation of the fishery resource, and from the regulator's perspective making that allocation, the social values associated with the recreational sector are a very important consideration. However, by the absence of reliable data they are difficult to determine with accuracy or to quantify.</p>	<p>A biannual survey of the community should also assess the value placed on recreational fishing from a social and social identity perspective.</p>
<p>Quantification of the Recreational Sector Contribution to the Northern Territory Economy</p>	<p>Determination of the economic contribution of the sector is an important consideration in resource allocation. An estimate of the economic contribution of the recreational sector should be undertaken based on clearly articulated assumptions and parameters that distinguish between direct contribution, flow-on contribution and economic multipliers associated with that expenditure.</p>	<p>Development of a data collection instrument and target respondents list designed to acquire direct and flow-on expenditure from the recreational fishing sector, as well as the development of reasonable assumptions upon which multipliers can be determined. Reporting of the results should detail data sources and assumptions very clearly. Structure of the reporting model will need to be the subject of further input from the sector.</p>

Key Issue	Description	Specific Marine Science Needs
MAINTAINING THE SECTOR'S SOCIAL LICENCE TO OPERATE		
Trends in Anti-recreational Hunting and Fishing Attitudes and Beliefs and Advocacy Globally	Animal welfare activism targeting terrestrial hunting has accelerated over recent years and wider community attitudes are responding. There is some evidence that this activism is also now targeting the recreational fishing sector, albeit not to the same degree. Understanding these trends is important as the basis for a proactive, rather than reactive response from the Northern Territory recreational fishing sector.	Local implementation of any recommendations from FRDC Recfishing Research review of global animal welfare campaigns targeting recreational hunting and fishing and community responses to those campaigns. Determination in trends in wider community attitudes towards recreational hunting and fishing in Australia, and how those attitudes compare to those of the Northern Territory community.
Trends in Animal Welfare Regulation Pertaining to Recreational Hunting and Fishing Globally	Understanding how animal welfare advocacy and community pressure has translated into regulation of recreational hunting and fishing in other jurisdictions is important information with respect to understanding how Australian regulators may ultimately respond and as a basis for the sector to be proactive.	Review of recreational fishing and hunting regulations in other States of Australia and comparable jurisdictions worldwide, particularly those that have had recent regulatory responses to animal welfare advocacy and community pressure.
Framework for Best Practice and Audit of Northern Territory Recreational Fishing Practices	Understanding how the current normal practices of the Northern Territory recreational fishing sector compare to what is identified as 'best-practice' from an animal welfare perspective in jurisdictions that have come under pressure, will allow the Northern Territory recreational fishing sector to be proactive in response to	Based on the assessment of evolving community attitudes, evaluate forthcoming Northern Territory Code of Practice to determine best-practice, areas where best-practice is exceeded and areas of potential vulnerability that may need to be addressed.

Key Issue	Description	Specific Marine Science Needs
	any future emerging pressure from animal welfare advocates or the community more generally.	

TABLE 24 – RECREATIONAL FISHING SECTOR MARINE SCIENCE KNOWLEDGE NEEDS

16. Northern Territory Marine Science Capacity

The formal marine science capability that is immediately deployable in the Northern Territory Marine environment can be broadly categorised as:

- Commonwealth organisations with operations in the Northern Territory;
- Northern Territory domiciled organisations;
- Formalised, multi-institutional mission-oriented research collaborations with at least some focus on the Northern Territory marine environment; and
- Industry research that is conducted on the Northern Territory marine environment, including that undertaken by private marine environmental and metocean consultancies for industry and government clients.

These are summarised in the following subsections.

16.1. Commonwealth Organisations

16.1.1. Australian Institute of Marine Science

AIMS was established in 1972 by the *Australian Institute of Marine Science Act 1972 (Cth)* as a specialist tropical marine research body, with an initial focus on the Great Barrier Reef. Headquartered in Townsville, AIMS now undertakes a programme of research across northern Australia. AIMS is funded directly by the Commonwealth Government through appropriations from general revenue and has a remit to provide an evidence base to underpin government decision making towards sustainable marine ecosystems and industries across northern Australia.

In the latest 2015–2025 Strategic Plan,²⁰² AIMS identifies three high level outcomes as priorities over the following decade: a healthy, resilient Great Barrier Reef, sustainable coastal ecosystems and industries across tropical Australia, and environmentally sustainable offshore oil and gas. Seven research focus areas are identified as supporting these outcomes, all of which are potentially relevant to the Northern Territory marine estate:

- Documenting the extent and value of marine biodiversity and resources;
- Predicting ecosystem responses to disturbances;
- Predicting cumulative impacts and resilience of reef and associated communities;
- Understanding and predicting environmental risk;
- Developing tools to support effective and equitable resource allocations;
- Developing new technologies and tools for marine monitoring and management; and
- Understanding dynamics and values of iconic and threatened species.

AIMS' research programme in the Territory is based out of the Arafura Timor Research Facility, adjacent to CDU and Australian National University campuses. As an advanced research institute, the focus of AIMS tends to be on specific research questions with an eye towards comprehensive reports or academic publication. Examples of recent research projects

²⁰² AIMS Strategic Plan 2015–2025 (2015), available www.aims.gov.au

undertaken by AIMS that are directly relevant to the Northern Territory marine environment are summarised in Table 25.

Project	Date	Summary
Oceanic Shoals Marine Park Study	Oct 2017	Currently unpublished and due for release mid-2018.
Bioassay using barnacles to assess metals contamination in marine environments	Nov 2016	Lack of appropriate tools to evaluate risk and monitor effects of metals contaminants in marine environments. Study using barnacle larvae to estimate chronic toxicity levels of various metals contaminants.
'StingerCam' monitoring of venomous tropical jellyfish	Oct 2016	High-res temporal resolution data of large venomous jellyfish from 5 years of images provides database of salinity and temperature tolerances, allowing assessment of risk to public and predictive models of distribution.
Spatial prioritisation for remote marine regions	Aug 2016	Review of declared conservation area to balance petroleum industry interests against minimum species conservation targets to address knowledge gaps and optimise spatial areas protected.
Bioassay using marine snails to assess chronic toxicity	Jul 2016	Chronic toxicity growth rate test using marine snail larvae to determine interaction of temperature and metals concentration.
Biological early-warning indicators for multiple metals toxicity impacts in marine sediment	Feb 2016	Biological tools sensitive enough to detect small increases in metals concentration serve as useful predictors of future ecosystem impact. Populations of microfauna present in marine sediment assessed to fill this 'canary' role.
Rio Tinto Gove Refinery – sediment attenuation	Jan 2016	Report commissioned by Rio Tinto—study of the potential for contaminated sediment released by a refinery to be naturally dispersed by oceanographic processes.
Microcontaminants in Darwin Harbour	Dec 2015	Detection of microcontaminants in aquatic environments is difficult. Study investigated anthropogenic impacts (pharmaceuticals, personal care, hormones, pesticides, etc.), concentrations and detection thresholds.
Regional shoals and shelves	Oct 2015	Appendix F to Barossa Area Development Offshore Project Proposal—seabed biodiversity surveys of benthic and associated fish ecosystems.
Sand dynamics and coastal erosion in Darwin Harbour	Sep 2015	Sea level rises may exacerbate natural erosion/deposition processes in Harbour.

Modelling to help assist coastal erosion and shoreline management.

TABLE 25 – RECENT NORTHERN TERRITORY MARINE SCIENCE PROJECTS UNDERTAKEN BY AIMS

Current projects being undertaken in the Northern Territory in furtherance of AIMS' strategic goals include monitoring shark numbers to determine sustainable catch levels and ongoing research into the biodiversity of oceanic shoals and mid-level reefs.

16.1.2. Commonwealth Scientific and Industrial Research Organisation

Originally instituted as the Advisory Council of Science and Industry, CSIRO has existed under several names as an entity of the Commonwealth Government since 1916, settling into its present role of initiating and conducting scientific research to aid development of Australian primary and secondary industry. Since the end of World War II, CSIRO operates under the *Science and Industry Research Act 1949 (Cth)* as an independent statutory body. CSIRO is mostly funded by the Commonwealth; however, it also benefits from significant ongoing investment and co-funding through industry partnerships, research programmes and other joint arrangements. CSIRO is also Australia's largest patent holder and sees significant income from monetising intellectual property. In its *Australia's Innovation Catalyst: CSIRO Strategy 2020*,²⁰³ CSIRO sees its role as fostering greater innovation in Australian businesses and industries through primary research and partnerships.

To deliver this, CSIRO has created six 'Future Science Platforms', including relevantly:

- **Environomics:** utilising knowledge about biodiversity to better manage ecosystems, biosecurity threats, and economically useful species;
- **Deep Earth Imaging:** subsurface geology to discover new minerals, energy and water resources; and
- **Digiscape:** use of sensors, data visualisations and Artificial Intelligence to generate better environmental policy advice.

Marine science undertaken by the CSIRO falls mostly within the Oceans and Atmosphere business unit,²⁰⁴ which aims to foster ocean-based industry through providing information and basic science on the oceans and atmosphere. CSIRO operates a Darwin headquarters in the Territory, which hosts the Tropical Ecosystems Research Centre; however, this mainly focuses on sustainable land management rather than on marine science.

Broad areas of current research for CSIRO that are relevant to the Northern Territory marine environment are summarised in Table 26.

²⁰³ (2015), available www.csiro.au

²⁰⁴ www.cmar.csiro.au/en/research/Oanda

Project area	Description
Australasian ocean currents	Effects and monitoring of major ocean currents, including the ITF and Leeuwin Current.
Oceans and climate change – sea level rise observations and modelling	Improved projections for future sea levels and coastal management.
Marine resources and industry	Supporting commercial development of marine resources, including sustainable harvest levels, marine debris management, fish distribution and primary producer productivity.
BLUElink ocean forecasting	Global ocean forecasting system to help manage maritime operations. Partnership with BOM and the Australian Navy.
ARGO robotic float monitoring	Use of ARGO floats to survey water conditions and depths around coastline.
Coastal management	Primary research into anthropogenic pressures on coastlines and near-shore ecosystems, and strategies to mitigate impact.
Novacq prawn feed	World-leading aquaculture prawn food to increase growth rates and disease resistance.
Sense-T oyster monitor	Real-time animal health monitor to allow oyster farmers to make better management decisions sooner.
Coastal carbon cluster	Wetland and estuarine ecosystems responsible for 50% global carbon transfer to seabed sediment—research into carbon storage potential.
Marine incident responses	Tools for management and monitoring impact of hydrocarbon industry on marine environment (e.g. BLUElink, sensor arrays, PIPEASSURE, Hydrates flow loop, microbial degradation, dispersal, etc)
RV Investigator	Operation of research vessel to allow on-water science.

TABLE 26 – CSIRO MARINE AND ATMOSPHERIC DIVISION RESEARCH PROJECTS IN THE NORTHERN TERRITORY

16.1.3. Integrated Marine Observing System

Since 2006, the Integrated Marine Observing System (IMOS), a collaboration supported by the Commonwealth National Collaborative Research Infrastructure Strategy, has operated a network of ‘nodes’ around Australia to gather marine science data. Funding from IMOS is partly Commonwealth grants; however, a majority of operational funds come from co-investment by regional partners including relevantly CSIRO, BOM, AIMS and the Northern Territory government through the Landbridge (formerly Darwin Port Corporation).

IMOS facilities, operated by different institutions, are funded to deploy equipment and deliver data streams to all Australian marine scientists and international partners. Almost all of these are directly relevant to the Northern Territory marine environment, and include:

- **ARGO floats** – submersible Autonomous Vehicles collecting spatial and temporal data;
- **Ships of Opportunity** – installation of monitoring equipment in vessels sailing through waters of interest;
- **Deep Water Moorings** – tethered observation stations;
- **Ocean Tracking** – tracking network for tagged individual marine animals;
- **Satellite remote sensing** – Earth observation network for surface layer waters;
- **National Mooring Network** – one of seven National Reference Stations in Darwin Harbour, and a shelf mooring array is sited in the Joseph Bonaparte Gulf; and
- **Australian Ocean Data Network** – national repository of Australian marine data.

Due to the size of the commitment and availability of local resources, no specific 'node' (a collaborative planning framework) is in place for the Northern Territory, with Northern Territory interests presently considered through the Western Australian and Queensland nodes as appropriate. IMOS monitoring infrastructure deployed in the Northern Territory marine environment includes a measurement buoy in Darwin Harbour that delivers real-time observations of water quality and ocean conditions, as well as underway observation systems that are deployed on the AIMS vessel RV Solander that spends a significant amount of time in the Northern Territory marine environment.

16.1.4. Commonwealth Department of Environment and Energy

The Commonwealth Government is significantly invested in the Northern Territory marine environment, given the scale of economic activity in Commonwealth waters and EEZ lying offshore, significant conservation estate, heritage listings and near-pristine marine environment. The principal responsibilities of the DoEE include assessments under the EPBC), marine pollution responses, strategic regional planning, and a range of observation and research projects (usually in collaboration with other State, Commonwealth or educational institutions).

In addition to specific partnership work with other organisations and the management of the Commonwealth conservation estate, DoEE undertakes a range of environmental and climate science research. This is delivered through six themed research 'hubs', including relevantly the Marine Biodiversity Hub, the Northern Australia Environmental Resources Hub (NERH) and the Threatened Species Recovery Hub. Recent projects related to the Northern Territory marine environment are summarised in Table 27.

Project area	Description
Sawfish and river sharks	Threatened and endangered estuarine sawfishes and river sharks—partnership with Indigenous communities to deliver research programmes and management plans in poorly studied areas of Territory.
Environmental water needs	Studies of the Daly, Fitzroy and Mitchel Rivers to determine environmental usage and needs from catchment to estuary.
Gulf rivers and coastal productivity	Research programme to better understand links between Gulf of Carpentaria outflowing rivers and ecosystem productivity.
Transitional Environment Program monitoring and management	Development of indices to assess population trends in threatened, endangered and protected species, assessing management techniques for effectiveness.
Indigenous engagement for TEPs protection	Partnerships with Indigenous communities and groups to manage TEPs, benefit from local knowledge and set agreed priorities.
Hotspots for euryhaline (brackish) species biodiversity	Studies of Northern Australian estuarine/brackish species, protection and management
Elasmobranch (shark/rays) research and management	Population and abundance surveys, prioritisation and management needs for Australian species.
Reef ecosystem threats	Continent-scale tracking of threats to shallow water tropical reef marine ecosystems

TABLE 27 – RECENT NORTHERN TERRITORY MARINE PROJECTS UNDERTAKEN BY THE DEPARTMENT OF ENVIRONMENT AND ENERGY

16.1.5. Bureau of Meteorology

As Australia's national weather, climate and water agency, the BOM is concerned with providing observational, meteorological, hydrological and oceanographic services to government, industry and the public, as well as undertaking primary research into environmental sciences. As of 2014 the BOM, operating under the *Meteorology Act 1955* (Cth), became a non-corporate Commonwealth entity under the *Public Governance, Performance and Accountability Act 2013* (Cth) and reports to the Minister for the Environment and Energy. The BOM opened the first Observing Operations Hub in Darwin in 2016, delivering higher quality observational capacity for the northwest of Australia and to join a further seven distributed across Australia.

Services provided by BOM underpin marine and climate science undertaken by almost all other entities. In addition to providing observational data, the BOM also undertakes a limited amount of primary research into atmospheric and climate science, usually in the field of predictive modelling. Examples of work undertaken recently with direct links to the Northern Territory include a two-year tropical cyclone prediction partnership with Shell, Chevron,

Woodside and INPEX, and ongoing broad improvements to on-water observational and prediction data for ocean conditions, as well as coastal storm surge modelling.

16.2. Northern Territory Organisations

16.2.1. Department of Primary Industry and Resources

The Fisheries Division of the Northern Territory Department of Primary Industry and Resources is the primary body concerned with usage of the marine estate, fulfilling research, regulation, enforcement and compliance roles as well as collaborating with multiple other entities both public and private. Under the *Fisheries Act 1988* (NT), Fisheries has responsibility for discharging a number of functions relating to the marine environment.

Some recent research projects undertaken by the Fisheries Division of the Northern Territory Department of Primary Industry and Resources are summarised in Table 28.

Project area	Description
Aquaculture research and development	Through the Darwin Aquaculture Centre, a range of aquaculture research and development programmes are undertaken. Current focus is on sandfish/sea cucumber ranching on Goulburn Island, oyster farming in Indigenous communities and restocking projects.
Aquatic pest eradication	Eradication programmes as required—none known at present.
Shared fisheries resources framework, Harvest strategy policy	Improved management framework for making decisions regarding competing uses of marine estate; contributions to policy debate and plans.
Indigenous Development Unit	Support sustainable and culturally appropriate business and employment opportunities for Aboriginal communities, allow small businesses through more permissive licencing.
Fish stocks reporting	Biannual reporting on stock levels for species of interest as part of Commonwealth Key Australian Fish Stocks report.
Recreational fishing management	Policy and enforcement of recreational fishery, including recreational fishing surveys.

TABLE 28 – RECENT RESEARCH PROJECTS UNDERTAKEN BY THE NORTHERN TERRITORY DEPARTMENT OF PRIMARY INDUSTRY AND RESOURCES

16.2.2. Department of Environment and Natural Resources

The DENR is concerned with environmental protection, monitoring and promoting sustainable usage of natural resources. Unlike Fisheries, this broader remit takes in many other types of activity and usage with potential impact on the marine estate. While an independent statutory body, the Northern Territory Environment Protection Authority (responsible for environmental advice and impact assessments) relies on DENR for staff and facilities to discharge its functions.

Having recently merged with the old Department of Land Resource Management, the status of some previous work and priority areas is in flux. Significant ongoing projects and programmes relevant to the Northern Territory marine environment are summarised in Table 29.

Project area	Description
Darwin Harbour water quality biodiversity monitoring	Ongoing mapping and monitoring of seabed and estuarine habitats in Darwin Harbour, together with seabed meadows important for Dugong populations and coastal dolphins (Snubfin, Humpback and Bottlenose).
RAMSAR wetland monitoring	Ongoing monitoring and protection work relating to the Cobourg Peninsula/Garig Gunak Barlu National Park and the Kakadu National Park RAMSAR listed wetlands.
Aboriginal Ranger grants	Grants process to empower Aboriginal Ranger groups to undertake caring for country activities.
Environmental regulatory reform programme	Ongoing reform to NT environmental protection framework as per election commitments. Currently in Stage 1 of two-stage process, calling for public comment.
Environmental protection grants	Small grants (<\$20k) for community-based projects to prevent environmental harm.
River monitoring	Water resource assessments and stock level monitoring in the Roper, Wildman, Mary and Daly Rivers
Coastal and Marine Management Strategy	Currently under development.

TABLE 29 – RESEARCH PROJECTS AND PROGRAMMES UNDERTAKEN BY THE DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES RELEVANT TO THE NORTHERN TERRITORY MARINE ENVIRONMENT

16.2.3. Charles Darwin University

Formed out of a merger of three other educational institutions in 2003, CDU maintains a range of campuses across the Territory and the rest of Australia. CDU has a reputation for environmental and natural sciences and has a particular focus on the tropical marine environment through the Research Institute for Environment and Livelihoods, the North Australian Centre for Oil and Gas and the Northern Institute.

While CDU has a large and varied research programme, several higher-profile ongoing research efforts are of particular relevance to the Northern Territory marine environment (summarised in Table 30).

Project area	Description
Coastal and marine ecology and management	Ecology and assessment of giant clams, Darwin Harbour sediment assessment, trophic connectivity in tropical fish communities, ecology of mangrove snakes, ecosystems of Daly River catchment area, marine sponges as biomonitors for metals contamination in Darwin Harbour, sewage effluent impact assessments in tropical creeks, ocean remote optics sensing, marine pathogens of public health significance, marine worms as bioanalysis tools for marine ecosystems and freshwater flows in estuarine stability.
Natural resources-based livelihoods	Socio-ecological systems framework to assess impacts of commercial fishing on Indigenous communities, analysis of legislation and policies affecting development of Indigenous wildlife-based enterprises, contemporary measures of success in Indigenous land and sea management, contributions of traditional and non-traditional locally sourced foods to food security of remote communities, integrating measures of Indigenous land and sea management effectiveness, remote sensing for planning and good governance in Northern Australia and effects of climate change on use of intertidal resources by Indigenous women.
River ecology and management	Fine-scale responses of fish to environmental flows, social and cultural values in the planning cycle, population ecology of crocodiles, pressure assessment and reporting on sharks in north marine regions, nutrient monitoring and research in the Daly River catchment, tropic ecology of estuarine sharks and rays, and vegetation dynamics and gully of riparian zone in estuary and catchment areas.
Graduate and post-doc research opportunities	Spatial planning and marine protected areas on Indigenous sea country, quantifying 'blue carbon' stocks in mangrove ecosystems of tropical Australia, novel methods for fish population monitoring in Kakadu National Park, coastal climate change adaption in low-capacity remote Indigenous communities, coastal monitoring through metals-resistant microbes and remote sensing for water quality in Darwin Harbour.
Marine and seafood vocational training	Casuarina campus aquaculture precinct and rehabilitation of marine turtles in partnership with Fisheries and AusTurtle Inc.

TABLE 30 – KEY AREAS OF RESEARCH FOCUS OF CHARLES DARWIN UNIVERSITY THAT ARE RELEVANT TO THE NORTHERN TERRITORY MARINE ENVIRONMENT

16.2.4. North Australian Indigenous Land and Sea Management Alliance Ltd

NAILSMA was established in 2001. NAILSMA provides Indigenous leadership in the delivery of large-scale and complex projects that combine science and research, Indigenous knowledge

and practical support to achieve results that meet cultural, environmental and economic benefits for Indigenous people. NAILSMA's role is to find practical solutions to support Indigenous people in the management of their land and sea resources. To date, NAILSMA has successfully delivered over \$30 million worth of projects across northern Australia.

16.3. Collaborations

16.3.1. Northern Australia Environmental Resources Hub

Growing out of the successes of the National Environmental Research Programme and the earlier TRaCK Consortium, the National Environmental Science Programme's NERH aims to bring together advanced scientific knowledge and decades of on-the-ground observations to manage opportunities for sustainable development of the North.

Funded by the Commonwealth Government and matching contributions from CDU, the University of WA, James Cook University, Griffith University and CSIRO, together with support from NAILSMA and the State Governments of Western Australia, Queensland and the Northern Territory, NERH focuses on a number of issue-driven, regional case studies. Pursuing priorities in landscape-scale studies, land and water planning for urban, agricultural and industrial development, and management of IPAs, the NERH has a six-year project timeframe concluding in 2021.

Research undertaken as part of NERH is set around six key themes: minimising risks of developments, improving management of threats to the environment, pursuing practical approaches to protecting endangered species, new approaches to environmental monitoring, supporting Indigenous management and exploring economic benefits of environmental resources.

Current projects with particular relevance to the Northern Territory marine environment are summarised in Table 31.

Project area	Description
Critical knowledge gaps	Identifying and prioritising crucial knowledge gaps in Northern Australian environmental management to better direct government research investment.
eDNA monitoring for tropical waters	Developing novel monitoring and species survey methods using trace amounts of DNA released into the environment.
River water needs	Collaboration with CDU on ongoing water needs projects regarding catchment areas for major waterways (the Daly, Fitzroy and Mitchell Rivers).
Indigenous land management review	Overcoming barriers to participation by Traditional Owners in land and sea country management (i.e. technological, social and organisational).
Links between Gulf rivers and coastal productivity	Research into significance of inflows of major rivers in the Gulf of Carpentaria (the Flinders, Gilbert and Mitchell Rivers) on coastal productivity, supporting additional economic activity in the area.
Managing threats to riparian savannah	Savannah woodland bordering rivers and estuaries vulnerable to fire, invasive species, overgrazing, development—practical guidelines and monitoring needed to assess impacts.

TABLE 31 – CURRENT NORTHERN AUSTRALIA ENVIRONMENTAL RESOURCES HUB PROJECTS RELEVANT TO THE NORTHERN TERRITORY MARINE ENVIRONMENT

16.3.2. Northern Australia Cooperative Research Centre

As recommended in the Developing Northern Australia White Paper, the Commonwealth Government has provided a \$75 million grant over 10 years to establish a CRC to develop Northern Australia. The CRC will have a remit to assist businesses, government and researchers to identify opportunities for growth and business in the north, initially focusing on areas of perceived comparative advantage such as agriculture, fishery and aquaculture.

To be hosted in Townsville, the Chair and Board have been appointed and an early funding round in advance of formal establishment opened in late February, closing in May 2018. This funding round provided grants of up to \$3 million for tropical health and medicine and agricultural development and was not immediately relevant to the marine estate. Successful applicants have not yet been announced.

16.3.3. Aboriginal Research Practitioners Network

Coordinated and hosted through the Research Institute for Environment and Livelihoods (formerly School of Environmental Research) at CDU, the Aboriginal Research Practitioners Network has been operating since approximately 2008. The Aboriginal Research Practitioners Network employs Aboriginal researcher practitioners on a short-term basis to delivery

participatory research services, engaging and facilitating research activities in their own communities using a range of formal, customary and traditional techniques.

16.3.4. Northern Australia Marine Research Alliance

Commencing work in 2013 at a purpose-built facility upgrade to the Arafura Timor Research Facility at CDU, the Northern Australia Marine Research Alliance (NAMRA) is a collaboration between AIMS, Australian National University, CDU, and the Commonwealth and Northern Territory Governments that focuses on tropical marine science. The focus of NAMRA is on Australian coastal and marine science, including marine biodiversity, estuarine and coastal processes, ocean dynamics and marine and coastal livelihoods and governance.

NAMRA works closely with CDU's Research Institute for Environment and Livelihoods to build marine research capability in northern Australia by investing in post-graduate education and early career researchers, providing funding, post-doctoral stipends, scholarships and operating expenses.

NAMRA has had a strong focus on the Northern Territory marine estate since its inception, with early projects focusing on Darwin Harbour, including mapping, modelling, water quality research and provision of expert advice to the Larrakia Rangers. Current relevant projects are summarised in Table 32.

Project area	Description
Tropical reef fish management	Funded by the FRDC, this project examines the genetic structure and marker traces to assess stock structure and health of commercially relevant species.
Van Diemen Gulf Barramundi populations	Genetic studies to identify regional dispersal of Barramundi subpopulations and connectivity
Metal and nutrient cycling in Darwin Harbour	Comparative study of metal and nutrient cycling in populations in Darwin Harbour compared to more open Van Diemen Gulf, to improve understanding of effects of anthropogenic contamination
Sea sponges in Darwin Harbour	Studying filtering and absorption capabilities of holobionts (sea sponges) in Darwin Harbour
Role of roving apex predators in estuaries	Determining spatial and trophic niche of apex elasmobranches (sharks, skates, rays) in Northern Territory estuarine environments
Ocean remote colour sensing	Due to the remoteness of Northern Territory waters, there is a lack of data on biophysical conditions. Aim to use ocean colour remote sensing from satellite, aerial sources to assess changes in water quality.

TABLE 32 – CURRENT NORTHERN AUSTRALIA MARINE RESEARCH ALLIANCE RESEARCH PROJECTS IN THE NORTHERN TERRITORY

16.4. Industry Marine Research

In addition to commissioning research through some of the organisations discussed in the previous subsections, industry also undertakes applied research to support strategic and operational decision making. Most of this research, which tends to be of an applied nature, is undertaken by operators in the offshore petroleum, commercial fishing and pearling and aquaculture industries.

Industry operators frequently commission this work by engaging various privately operated marine environmental and metocean service providers.

16.4.1. Offshore Petroleum Industry

Operators in the offshore petroleum industry typically have significant internal environmental and engineering scientific capability that pertains to the marine environment. The function of this capability is to give effect to the scientific aspects of project design, approvals, development, commissioning and day-to-day operations. Similarly, there is a large number of technical service providers to the offshore petroleum industry that have similar capabilities.

Furthermore, offshore petroleum companies and their service providers typically possess significant volumes of often (but not always) proprietary sets of physical and biological observational data that pertains to their projects. This is generated through all phases of the project life, particularly during the project design and approvals process.

16.4.2. Commercial Fishing Industry

Some operators in the commercial fishing industry undertake ongoing research, revolving primarily around the nature of their catch and by-catch, as well as distribution of target catch. Operators in the commercial fishing industry also typically have longitudinal records of catch from specific locations.

16.4.3. Pearling and Aquaculture Industries

Because aquaculture in the Northern Territory is a relatively new endeavour, the identification of viable species and development and optimisation of suitable aquaculture facilities is an ongoing endeavour. In both pearling and aquaculture industries, there is ongoing research and innovation designed to improve the productivity of production systems to contain relatively high cost structures.

16.5. A General Comment on Aboriginal Engagement in Marine Research Collaborations

Given limited and often contracting resources in research organisations, it will be important to access local and Indigenous knowledge of marine systems and their dynamics. Accessing and integrating Indigenous and other local knowledge within formal studies will be an essential component of the engagement with Indigenous landowners highlighted as critical in an associated report.

17. Common Marine Science Knowledge Needs

17.1. Schematic of Northern Territory Marine Science Knowledge Needs

The preceding sections of this report articulate a wide range of end user identified marine science knowledge needs that require an almost equally wide range of physical, biological, chemical and social science disciplines to address.

Generally speaking, the collective identified marine science knowledge needs can be broadly categorised according to the framework illustrated in Figure 69 (a higher resolution diagram is contained in Appendix 8).

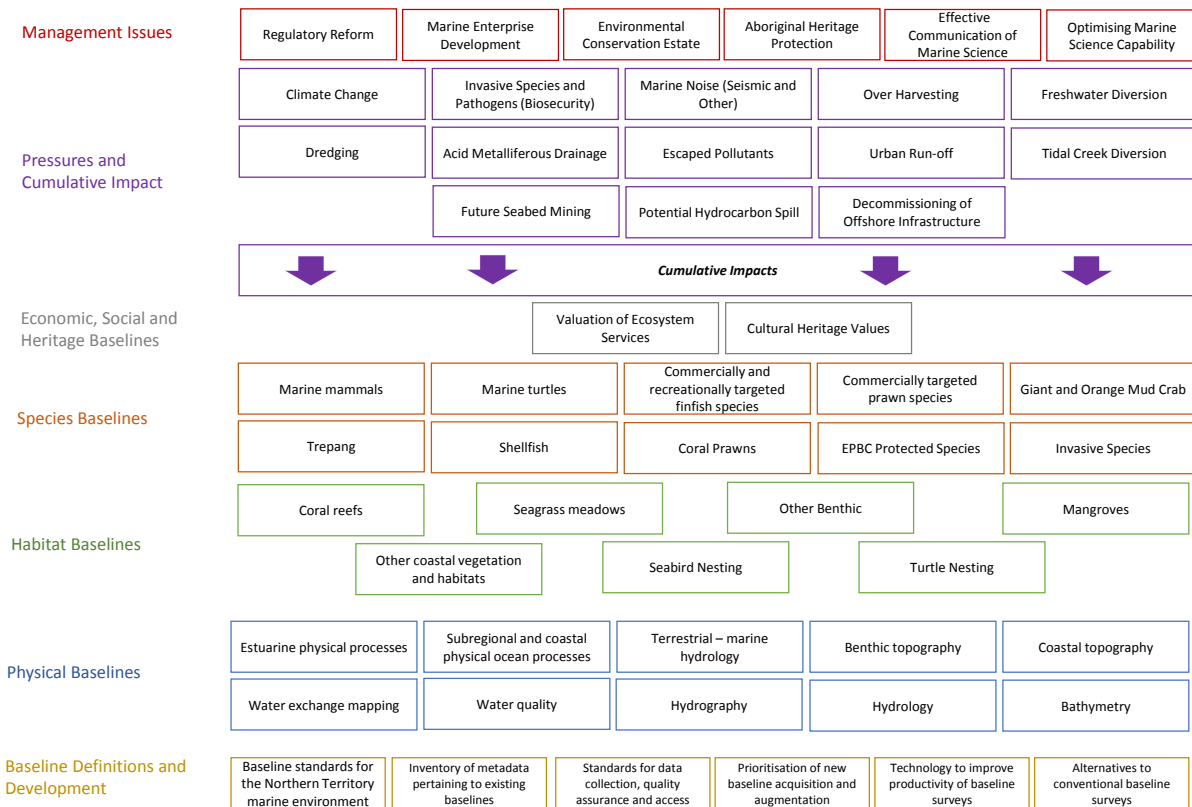


FIGURE 69 – MAIN IDENTIFIED END USER MARINE SCIENCE KNOWLEDGE NEEDS

17.1.1. Baseline Definition and Development

As is the case for most other remote and relatively undeveloped areas of the Australian marine environment, most of the Northern Territory marine environment is void of baseline bio-physical data. In the contemporary framework for environmental approvals and natural resource management, this presents a significant challenge to most, if not all, sectors and interests in the Northern Territory marine environment.

The establishment of bio-physical baselines in the Northern Territory marine environment also faces unique definitional challenges. While there are nationally and internationally recognised

standards for setting baseline parameters, the extraordinarily high natural variation in the Northern Territory marine environment on an intra- and inter-seasonal basis calls into question the relevance of those standards in determining natural baselines in the Northern Territory marine environment. This natural variability means that many baselines may need to be expressed in terms of a very large natural range and implies that, to be meaningful, baseline surveys may need to be taken over a much larger timeframe. This, in turn, risks slowing development and regulatory reform, as well as imposing much higher costs for the collection of biophysical data pertaining to the Northern Territory marine environment.

This dilemma demands a number of priority actions:

- First, while there is relatively limited baseline data pertaining to the Northern Territory marine environment, an inventory of at least existing baseline metadata should be established to ensure that limited resources are not wasted on replicating existing data, and so that existing data can be easily identified by stakeholders and its use negotiated. Such a baseline should be in an open access format to international standards (e.g. ISO 19115.1:2015, ANZLIC metadata profile²⁰⁵ or AGLS/AS5044). Access to data should be implemented through an appropriately resourced portal, likely the Australian Ocean Data Network if arrangements can be made with IMOS.
- Second, once the existing baseline portfolio has been identified, prioritisation of investment of augmentation of existing baseline data and acquisition of new baseline data should be undertaken. The prioritisation of this investment should be based on immediacy of development pressure and common stakeholder interests in the baseline data.
- Third, because of remoteness, challenging physical conditions and dangerous marine life, undertaking particularly biological surveys in the Northern Territory marine environment using conventional survey methods presents economic, technical and OHS challenges. Accessing and, if necessary, developing technology that mitigates these challenges is desirable with respect to improving the efficiency and effectiveness of surveying in the Northern Territory marine environment.
- Finally, even on a prioritised basis, establishing a comprehensive bio-physical baseline for the Northern Territory marine environment using conventional survey methods will be very expensive and time consuming. As such, it is important that the use of methods other than survey to establish baselines, such as sophisticated modelling and inference from similar marine environments are developed to the extent they can be accepted by regulators and other decision makers.

17.1.2. Physical Baselines

Owing to the ITF, Australian Monsoon and, in the case of the Gulf of Carpentaria, the Carpentaria Gyre, being strong and relatively predictable forcing factors, regional level physical oceanic processes pertaining to the Northern Territory marine environment are reasonably well understood. However, sub-regional processes, particularly in many near-shore and coastal environments are poorly understood, as are many estuarine physical processes. This has important implications for understanding ecosystem connectivity, as well as the distribution of pollutants and other contaminants.

A key feature of the Northern Territory marine environment is large seasonal freshwater ingress from the numerous significant rivers that drain from the hinterland, as well as extensive aquifer systems that interface with those rivers and potentially directly with the marine environment through offshore seeps. Understanding the baseline hydrological balance between aquifer and surface water systems and the marine environment is important for determining the

²⁰⁵ www.anzlic.gov.au/resources/anzlic-metadata-profile

resilience of particularly estuarine and coastal ecosystems to changes in freshwater ingress and, therefore, the tolerance of the system to freshwater diversion.

A better understanding of benthic and coastal topography in areas of the Northern Territory coast that are, or because of climate change will become increasingly, vulnerable to storm surge and inundation are required to better inform modelling in this area that is used to generate warnings and inform development.

Water quality studies have been undertaken relatively extensively at specific locations in the Gulf of Carpentaria and particularly Darwin Harbour. However, because of very large daily water exchange volumes and enormous seasonal flushing any contamination tends to be rapidly dispersed. The extent to which the disbursement is effective in reducing any toxic effects, or more importantly, where contaminants may subsequently accumulate is not well understood.

Finally, while there is adequate hydrological, hydrographic and bathymetric data to inform navigation and pilotage in most areas of Darwin Harbour, as well as for other commercial port operations along the Northern Territory coast, this data is limited in other areas. As commercial and recreational vessel traffic increases in the Northern Territory, this information will be increasingly required.

17.1.3. Habitat Baselines

Fundamental to the ecosystem function in the Northern Territory marine environment are the habitats that support ecosystems. Climate change and increased anthropogenic activity obviously place increased pressures on these habitats. The natural physical variability in the Northern Territory marine environment results in a degree of natural variability in the extent and health of these habitats. Mapping the extent and biodiversity of coral, seagrass, other benthic habitats, mangroves and other coastal habitats and assessing their health and function over a suitable period is important for determining the cumulative impact of climate change and various other pressures on those habitats, as well as their resilience to those cumulative pressures.

Habitats need to be considered in terms of permanent and periodic feeding, breeding and nursery areas and, to this extent, naturally extend to the terrestrial environment in the case of species such as turtles and seabirds (i.e. nesting areas).

17.1.4. Species Baseline

Understanding the abundance, distribution and structure of stocks of key species is important in ensuring optimised sustainable harvest and for determining impact. Comparatively speaking, there is considerable data pertaining to these variables for marine mammals such as Dugong, dolphin and whale species, as well as the main species of marine turtle such as Green, Olive Ridley, Hawksbill, Leatherback, Flatback and Loggerhead Turtles, albeit much of this data is not easily accessible and in some cases is only raw data still being analysed as part of current PhD projects.

Apart from perhaps Banana Prawns and Tiger Prawns, there is limited empirical data pertaining to the abundance, distribution and stock structure of most species that are targeted by the commercial, recreational and customary fishing sectors. To ensure optimal sustainable catch and support resource allocation decisions, this information is required for key species such as Giant and Orange Mud Crabs; Barramundi; Black Jewfish, Red Snapper, Goldband Snapper,

Sweetlip Snapper and various Emperor Species; Grey Mackerel, Spanish Mackerel, Threadfin Salmon, Blue Threadfin Salmon and King Threadfin Salmon; Black-tip Sharks, Hammerhead Sharks and Spot-tailed Sharks; Trepan and harvested coral species. Abundance, distribution and stock structure data is also required for species that play key roles in the food chain such as zooplankton and coral prawns.

Understanding baseline abundance, distribution and stock structure data is also important with respect to devolution of Commonwealth powers with respect to the management of species listed under the EPBC, such as various species of freshwater sawfish.

As biosecurity pressures increase in the Northern Territory marine environment, understanding the current baseline in terms of abundance and distribution of invasive species, particularly in proximity to current and future ports is important for managing and controlling invasive species.

17.1.5. Economic and Heritage Baselines

Valuation of Ecosystems Services

As discussed in Section 1.1.2, the Northern Territory marine environment is the source of critically important marine ecosystem services. For example, the Northern Territory marine environment:

- Underpins or facilitates the majority of industry in the Northern Territory, which in turn provides employment to the growing Northern Territory community;
- Is a source of key social, cultural and leisure values that define both Aboriginal and non-Aboriginal culture in the Northern Territory;
- Is a critical contributor to the customary economy for many Aboriginal communities;
- Provides food for humans and animals;
- Performs biological regulation, nutrient cycling and climate regulation functions;
- While being a vector for potential invasive species and pathogens, it also acts as a barrier to entry for exotic human, animal and plant disease; and
- Provides storm and erosion protection to coastal communities and industry.

International trends toward more holistic approaches to managing the marine environment based on preserving ecosystems services require a sophisticated understanding of the value of those ecosystems services (particularly the value of socially oriented services) and frameworks for measuring that value.

Cultural Heritage Values

As discussed in Section 5.4.5, recorded Aboriginal cultural values in the Northern Territory marine environment are extensive and are not fully formally identified. Effective management of cultural heritage values by both regulators and operators in the Northern Territory marine environment requires descriptive and spatial data pertaining to specific Aboriginal cultural values.

17.1.6. Cumulative Pressures

With the exception perhaps of the immediate Darwin Harbour Area, the various habitats that support the Northern Territory marine environment and the biodiversity that they support have endured relatively limited pressures from anthropogenic activity. However, as discussed throughout this report, this is changing. Understanding the current and likely future cumulative impact of a range of anthropogenic pressures as well as climate change, and the resilience of habitats and species to those pressures is key in informing a wide range of policy, regulatory, strategic and operational decisions.

Climate Change

Understanding the impact of climate change on marine habitats and the species they support, and the resilience of those ecosystems to climate change impacts, is important not only from the perspective of mitigating detrimental impacts, but also with respect to understanding the degree to which observable degradation is the result of climate change, as opposed to generally more manageable anthropogenic impacts.

Invasive Species and Pathogens

Invasive species and pathogens can have devastating impacts on the natural marine environment, on commercially, recreationally and culturally significant marine species and on commercial operations such as pearling, aquaculture and crocodile farms. Early identification of emerging pathogens in the region and invasive pathogens and species is critical in managing this very significant risk. An evidence-based risk framework for identifying likely vectors for the introduction of foreign species and pathogens and practical and effective monitoring systems is essential in maintaining the biosecure marine environment that underpins the competitive advantage of the Northern Territory marine environment as a production base.

Marine Noise

The marine noise profile of the Northern Territory marine environment is increasing as a result of increased vessel traffic, seismic survey activity and intensive use of sonar during regular maritime military exercises. Research in other jurisdictions indicates that seismic survey activity can potentially affect the abundance and distribution of some commercially, recreationally and culturally important species, although further research is required to enhance understanding of the cause-effect pathways and the extent, severity and persistence of potential impacts (see Section 10.3.4). Given that the opportunity cost of not proceeding with seismic surveys can be very significant for the Northern Territory, it is important that research into the impacts of seismic that has been undertaken in other relevant regions be contextualised for the Northern Territory marine environment, so that evidence-based operational and regulatory decisions can be made.

Over Harvesting

The absence of baseline abundance, distribution and stock structure data for most fish species in most locations, together with the absence of systems that provides a basis to determine a reliable estimate of the volume of the recreational catch in most species, means that assessments of sustainable harvest have limited reliability. This extends beyond marine species to the harvesting of seabird eggs. Without this information, it is difficult to determine whether any identified stress on stocks is the result of over-harvesting or other pressures. Indeed, in some cases, current catch limits may be well below sustainable harvest levels.

Freshwater Diversion

Irrigated agriculture and forestry in the Northern Territory is currently based exclusively on groundwater resources. While the connectivity between aquifers and surface water resources and the marine environment directly is not well understood, the impact of this activity is likely to be minimal. Any significant expansion of irrigated agriculture or forestry in the Northern Territory is likely to be based on limited harvesting of peak-season flows from some rivers. Again, the volume of water required would only ever be a very small portion of the total flow. Nevertheless, given the importance of estuarine ecosystems to the productivity of species

targeted by commercial, recreational and customary sectors, understanding the impact of freshwater diversion on these ecosystems and the resilience of those ecosystems to changes in freshwater ingress is important for determining maximum levels of diversion in specific locations.

Dredging and Port Development

To date, dredging in the Northern Territory marine environment has been limited primarily to Darwin Harbour and a few discrete locations in the Gulf of Carpentaria. Understanding the distribution and impact of dredge plumes and dredge spoil is necessary to optimally design dredging programmes and avoid the imposition of potentially costly requirements to dispose of dredge spoil on land.

Acid Metalliferous Drainage

The leaching of naturally occurring heavy metals that are concentrated in mining operations tailings into the water table and nearby waterways is a problem that confronts many mining operations worldwide. Relatively recent recognition of this issue has resulted in stringent tailings dam design requirements that substantially reduce this risk. However, as with other mining regions around the world, the Northern Territory is characterised by a number of older mining operations that have legacy or current leaching issues. Understanding the extent to which groundwater and surface water resources are contaminated as a result of AMD, the distribution of any contamination, where contamination has been concentrated in habitats and the presence of heavy metals in the food chain is important to understand the pressure AMD may be placing on key habitats and species.

Other Pollutants and Contaminants

In addition to naturally occurring heavy metals, other contaminants from industry such as escaped inorganics and organics used in minerals processing or fertilisers used in agriculture can also leach into groundwater and surface water resources, ultimately entering the marine environment and potentially becoming concentrated in key habitats. They can also be directly introduced through the discharge of process water into the marine environment. Understanding the extent to which other escaped pollutants are introduced to the Northern Territory marine environment, how they are disbursed and where, if at all, they are concentrated is important to understanding the extent of this pressure.

Urban Run-off

Any meaningful level of urban run-off is currently confined to Darwin Harbour and is sourced from the Darwin-Palmerston Area. Introduced from secondary treated sewerage disposal and stormwater run-off, urban flows can contain a range of household and light industrial sourced pollutants. Understanding the extent to which urban sewerage and run-off into Darwin Harbour contains pollutants, how they are disbursed and where, if at all, they are concentrated is important for determining the extent to which any existing toxicity is historical and the extent to which any current toxicity has an impact on key ecosystems.

Tidal Creek Diversion

As coastal development in the Darwin Harbour Area continues and is contemplated for other settlements along the Northern Territory coastline, some of the many tidal creeks will necessarily be destroyed or diverted. Understanding the impact of the loss of flow from tidal creeks on

ecosystems in the immediate vicinity of those creeks is necessary to understand the impact of coastal development.

Potential Future Seabed Mining

While it is probably sometime before commodity markets and technology development converges to render large-scale seabed mining commercially viable in the Northern Territory, such potential presents a significant disturbance to the natural environment. It is highly probable that, before such an activity proceeds, comprehensive understanding of its impact on the immediate and regional marine environment will be required.

Potential Hydrocarbon Spill

Hydrocarbon spills, particularly uncontained spills, are a relatively rare event. However, large uncontained spills can have an extensive and dramatic impact on key environmental and cultural values. The key information required to effectively design and implement a response to an uncontained spill is to know where the hydrocarbon will travel to and what it will impact on. Key environmental values are identifiable through baseline surveys and an understanding of ecosystem connectivity, and cultural values derived through databases managed by the AAPA and, most importantly, through consultation and dialogue with Aboriginal people.

Operators of offshore petroleum assets and Darwin Port have detailed data and modelling pertaining to physical ocean processes in the immediate vicinity of assets, and regional scale physical ocean processes are reasonably simple and well understood. However, there is limited understanding of sub-regional scale processes, particularly in near-shore and coastal environments. A better understanding of these near-shore and coastal physical ocean environments is important to predicting, through modelling, what coastal environmental and cultural values might be affected by a spill.

Decommissioning of Offshore Infrastructure

Decommissioning of offshore infrastructure is not an immediate issue for the Northern Territory. However, the region only has experience in decommissioning a single FPSO operation to date. As offshore infrastructure approaches end of useful life, questions around whether complete removal of infrastructure is necessary and whether offshore infrastructure can serve as Fish Attraction Devices for recreational and commercial sectors, or refugia for threatened species will need to be explored.

17.1.7. Management Issues

Regulatory Reform

There are a number of key regulatory reform issues in the Northern Territory that require marine scientific input, namely:

- Improved integration of Aboriginal people and IEK in decisions pertaining to the management of the marine resource and conservation estate;
- Frameworks for certainty and transparency around conditions of access to Aboriginal controlled waters;
- Transition to a scientific evidence base for fishery resource allocation decisions;
- Transition to a total resource management approach for fishery resource allocation, rather than a geographical based management;
- Development of frameworks for a certain pathway for equitable Aboriginal participation in commercial fishing rights;

- Development of a politically acceptable methodology and framework for obtaining more reliable data on the recreational fishery catch; and
- A greater understanding of regulatory reform that better facilitates marine oriented enterprise development in remote communities, without compromising human health and safety and important environment protection criteria, and which ensures benefits are captured locally.

Marine Enterprise Development

There is a range of areas where marine science is required to support the development of technology and innovative business models to support marine-oriented enterprise development and growth. This includes:

- Improving the predictability, efficiency and efficacy of port dredging cycles;
- Developing new markets for commercial fishing by-catch that is otherwise disposed of;
- Development of technology that automates animal husbandry and downstream processing of aquaculture and pearling product; and
- New business models that render marine enterprise ranging in size from small, locally oriented businesses designed to support livelihoods to larger-scale export businesses based in remote coastal communities viable, and which ensure benefits are captured locally.

Environmental Conservation Estate

The declaration of large areas of the marine estate as conservation reserves is a relatively new phenomenon for the Northern Territory, particularly with respect to Commonwealth waters. An absence of finalisation of the boundaries of these reserves, their management plans and subsequently zoning of allowable activity within the boundaries of the reserves is creating significant uncertainty for industry, particularly offshore petroleum and commercial fishing.

It is also of concern to Aboriginal interests as to whether the conservation estate adequately protects species and ecosystems that are of cultural significance.

Aboriginal Heritage Protection

As there are a large number of sacred sites present in the Northern Territory marine environment, distributed across the entirety of the marine estate, the impact of on-water activities on these sacred sites is a key concern to all stakeholders. While declared conservation areas such as Marine Parks or IPAs can perform some role in protecting sacred sites, it is unrealistic to expect that the declaration of reserves will provide comprehensive protection, as there are more sacred sites outside of the conservation estate than within.

Key issues and knowledge needs identified relate to the less than adequate record of marine sacred sites, mostly as a result of the high cost in identifying and assessing marine-based sacred sites. Further, the current regulatory regime under the *Aboriginal Sacred Sites Act* (NT) may no longer be adequate to protect sacred sites from the secondary impacts of development and industry, including siltation, pollution, disturbance to currents and biosecurity threats.

Marine science that advances the efficacy of the marine conservation estate from both an environment and heritage protection perspective is desired, especially in respect to the ability of that science being able to accelerate decisions pertaining to boundaries and zoning with certainty.

Effective Communication of Science

Almost all the sectors of industry and many community interests that intersect with the Northern Territory marine environment currently face, or will likely face in the future, social licence to operate challenges. The application of marine science to demonstrate the impact of activities on the marine environment and the efficacy of impact mitigation measures from an evidence basis is an important tool in ensuring that the community understand the impact of specific sectors or interests, as a basis for maintaining social licence to operate.

However, effectively communicating scientific evidence to the community is increasingly complicated. Navigating cultural differences in interpretation and relevance of traditional science, a much wider range of communication mediums and proliferation of misinformation that can be designed to appeal to entrenched beliefs and attitudes is a constant challenge.

Social science research that leads to more effective communication of marine science knowledge pertaining to industry, government and community activities in the Northern Territory marine environment to a diverse community is desirable from the perspective of maintaining social licence to operate.

Developing frameworks for the up-front identification of pathways to research adoption, defining the form of research outputs that are needed for efficient and effective application to management problems, peer review as a means of establishing defensible science and its application, and promoting public availability of science so it can be applied and used by a range of users and stakeholders will prove key in ensuring science maintains an important role in supporting decision making in certain areas.

Optimising Marine Science Capability

As a relatively small state (territory), developers, regulators and other users of marine science knowledge have become adept at leveraging marine science capability and resources that exist outside of the Northern Territory, in collaboration with local capability, to address important marine science questions. Unfortunately, this lack of domestic capacity and limited ability to reciprocate or contribute to joint projects has restricted the ability of the Northern Territory to engage with national marine science programmes such as IMOS.

As the forces discussed in Section 2 drive a need for greater investment in marine science, both the capacity of local marine science-oriented research organisations and the depth and reach of external collaborations will need to grow.

17.2. Priority Regions

Given the relatively limited anthropogenic activity outside the Darwin Harbour Area, prioritising investment in marine science on a regional basis is difficult. However, given the significant concentration of Northern Territory industrial and urban activity in proximity to the Darwin Harbour Area, addressing gaps in relevant marine science knowledge in this area and its immediate surrounds remains the priority.

The Gulf of Carpentaria is characterised by significantly less industrial and urban activity. However, it is characterised by several large mining operations that have a marine environment interface and increased commercial and recreational fishing activity. This, combined with significant Aboriginal community interests render it the second regional priority.

Except for an altered environment that has occurred because of the diversion of the Ord River and the proposed Project Sea Dragon prawn farm, the Joseph Bonaparte Gulf is the focus of

limited development. The northern coast of Arnhem Land faces very limited immediate development pressures and is relatively intensively managed by Aboriginal Ranger Groups.

17.3. Common Marine Science Knowledge Needs

A synthesis of the marine science knowledge needs discussed in preceding sections clearly identifies areas of marine science knowledge needs that are common to multiple sectors and interests. This section identifies that common interests at a high level. To understand the commonality to a greater degree of specificity, the reader should revert to the relevant specific sections of the report.

17.3.1. Baseline Definition and Development

Figure 70 summarises areas of baseline definition and development in which different sectors and interests in the Northern Territory marine environment have common high-level interests (a higher resolution diagram is contained in Appendix 8).

	Aboriginal Interests	Regulators	Australian Defence Force	Darwin Port	Commercial Fishing	Pearling, Aquaculture & Crocodiles	Offshore Petroleum	Minerals	Irrigated Agriculture & Forestry	Coastal Communities & Urban Development	Recreational Fishing
Baseline standards for the Northern Territory marine environment	■	■	■	■	■	■	■	■	■	■	■
Inventory of metadata pertaining to existing baselines	■	■	■	■	■	■	■	■	■	■	■
Standards for data collection, quality assurance and access	■	■	■	■	■	■	■	■	■	■	■
Prioritisation of new baseline acquisition and augmentation	■	■	■	■	■	■	■	■	■	■	■
Technology to improve productivity of baseline surveys	■	■	■	■	■	■	■	■	■	■	■
Alternatives to conventional baseline surveys	■	■	■	■	■	■	■	■	■	■	■

FIGURE 70 – COMMON INTERESTS IN BASELINE DEFINITION AND DEVELOPMENT

17.3.2. Physical Baselines

Figure 71 summarises areas of physical baseline in which different sectors and interests in the Northern Territory marine environment have common high-level interests (a higher resolution diagram is contained in Appendix 8).

	Aboriginal Interests	Regulators	Australian Defence Force	Darwin Port	Commercial Fishing	Pearling, Aquaculture & Crocodiles	Offshore Petroleum	Minerals	Irrigated Agriculture & Forestry	Coastal Communities & Urban Development	Recreational Fishing
Estuarine physical processes	Blue	Blue			Blue	Blue	Blue	Blue	Blue	Blue	Blue
Subregional and coastal physical ocean processes	Blue	Blue	Blue	Blue			Blue		Blue	Blue	
Terrestrial – marine hydrology	Blue	Blue			Blue		Blue		Blue	Blue	Blue
Water exchange mapping		Blue		Blue			Blue	Blue			
Benthic topography	Blue	Blue	Blue				Blue			Blue	
Coastal topography		Blue	Blue				Blue			Blue	
Hydrography		Blue	Blue				Blue			Blue	
Water quality	Blue	Blue		Blue			Blue	Blue		Blue	
Hydrology		Blue	Blue				Blue				
Bathymetry		Blue	Blue				Blue				

FIGURE 71 – COMMON INTERESTS IN PHYSICAL MARINE BASELINES

17.3.3. Habitat Baselines

Figure 72 summarises areas of habitat baseline in which different sectors and interests in the Northern Territory marine environment have common high-level interests (a higher resolution diagram is contained in Appendix 8).

	Aboriginal Interests	Regulators	Australian Defence Force	Darwin Port	Commercial Fishing	Pearling, Aquaculture & Crocodiles	Offshore Petroleum	Minerals	Irrigated Agriculture & Forestry	Coastal Communities & Urban Development	Recreational Fishing
Coral reefs	Green	Green			Green		Green	Green			
Seagrass meadows	Green	Green			Green		Green	Green			
Benthic	Green	Green			Green		Green	Green			
Mangroves	Green	Green			Green		Green	Green			
Other coastal vegetation and habitats	Green	Green			Green		Green	Green			
Seabird Nesting	Green	Green			Green		Green	Green			
Turtle Nesting	Green	Green			Green		Green	Green			

FIGURE 72 – COMMON INTERESTS IN MARINE HABITAT BASELINES

17.3.4. Species Baselines

Figure 73 summarises areas of species baseline in which different sectors and interests in the Northern Territory marine environment have common high-level interests (a higher resolution diagram is contained in Appendix 8).

	Aboriginal Interests	Regulators	Australian Defence Force	Darwin Port	Commercial Fishing	Pearling, Aquaculture & Crocodiles	Offshore Petroleum	Minerals	Irrigated Agriculture & Forestry	Coastal Communities & Urban Development	Recreational Fishing
Marine mammals	■	■			■		■	■			
Marine turtles	■	■			■		■	■			
Commercially and recreationally targeted finfish species	■	■			■		■	■			■
Commercially targeted prawn species					■		■	■			
Giant and Orange Mud Crab	■	■			■						
Trepang		■			■						
Shellfish	■	■									
Seahorse	■	■									
Coral Prawns							■				
Invasive Species		■		■	■	■	■	■			■

FIGURE 73 – COMMON INTERESTS IN SPECIES BASELINE

17.3.5. Economic, Social and Heritage Baselines

Figure 74 summarises high economic, social and heritage baseline issues in which individual sectors and interests have common interests (a higher resolution diagram is contained in Appendix 8)

	Aboriginal Interests	Regulators	Australian Defence Force	Darwin Port	Commercial Fishing	Pearling, Aquaculture & Crocodiles	Offshore Petroleum	Minerals	Irrigated Agriculture & Forestry	Coastal Communities & Urban Development	Recreational Fishing
Valuation of Ecosystem Services	■	■		■	■						
Cultural Heritage Values	■	■	■	■	■	■	■	■	■	■	■

FIGURE 74 – COMMON INTERESTS IN ECONOMIC, SOCIAL AND HERITAGE BASELINES

17.3.6. Cumulative Pressures

Figure 75 summarises specific pressures in which different sectors and interests in the Northern Territory marine environment have common high-level interests in understanding the relative impact of specific pressures and the resilience of species and ecosystems to these pressures, both individually and cumulatively (a higher resolution diagram is contained in Appendix 8).

	Aboriginal Interests	Regulators	Australian Defence Force	Darwin Port	Commercial Fishing	Pearling, Aquaculture & Crocodiles	Offshore Petroleum	Minerals	Irrigated Agriculture & Forestry	Coastal Communities & Urban Development	Recreational Fishing
Climate Change											
Invasive Species and Pathogens (Biosecurity)											
Marine Noise (Seismic and Other)											
Over Harvesting											
Freshwater Diversion											
Dredging											
Acid Metalliferous Drainage											
Escaped Pollutants											
Urban Run-off											
Tidal Creek Diversion											
Future Seabed Mining											
Potential Hydrocarbon Spill											
Decommissioning of Offshore Infrastructure											

FIGURE 75 – COMMON INTERESTS IN SPECIFIC PRESSURES

17.3.7. Management Issues

Figure 76 summarises high-level management issues in which individual sectors and interests have common interests (a higher resolution diagram is contained in Appendix 8).

	Aboriginal Interests	Regulators	Australian Defence Force	Darwin Port	Commercial Fishing	Pearling, Aquaculture & Crocodiles	Offshore Petroleum	Minerals	Irrigated Agriculture & Forestry	Coastal Communities & Urban Development	Recreational Fishing
Regulatory Reform											
Marine Enterprise Development											
Environmental Conservation Estate											
Aboriginal Heritage Protection											
Effective Communication of Marine Science											
Optimising Marine Science Capability											

Common Interests in Management Issues

FIGURE 76 – COMMON INTERESTS IN MANAGEMENT ISSUES

18. Toward a Comprehensive Northern Territory Marine Science Strategy and Implementation Plan

Key issues and insights that have emerged from the NTMSEUNA that any strategy and implementation plan must address include:

- Critical knowledge gaps exist in various biophysical, social, cultural, economic and related policy dimensions regarding decisions pertaining to the use of the Northern Territory marine environment;
- There is significant commonality of interest in addressing specific marine science knowledge gaps across various custodians of and stakeholders in the Northern Territory marine environment;
- Given the mismatch between the extent of the stated marine science knowledge needs and the regional marine science capacity, research agencies and other providers require active engagement with the users of that knowledge so that they can accurately and efficiently address the most important marine science knowledge needs; and
- The multiplicity of identified marine science knowledge needs and the complex ways in which various sources of uncertainty interact means that the system that addresses those knowledge needs requires:
 - Improved approaches to comprehensive stakeholder participation in all aspects of the research challenge, from problem framing through project design to on-ground activity;
 - Recognition of the specific difficulties faced by Aboriginal land and rights holders in the marine estate in examining options and setting priorities; and
 - A well supported framework for review and re-assessment of marine science knowledge needs that keeps pace with changing circumstances.

18.1. What this Report has Addressed

While this report is not comprehensive in certain areas, it does cover in detail a number of fundamental pillars from which a comprehensive, end user oriented marine science strategy and implementation plan for the Northern Territory can be developed. The full array of objectives of such a strategy would be further developed during its framing.

The most significant contributions of this report are discussed in the following subsections.

18.1.1. Advancing Recognition of Aboriginal Interests in the Northern Territory Marine Environment

Arguably, one of the most important contributions that this report makes is a detailed description of the extent and range of Aboriginal interests in the Northern Territory marine environment, as well as the legal basis for those interests. This extends to an identification of some marine science knowledge needs identified by some Aboriginal owners of and stakeholders in the Northern Territory marine environment.

These specific knowledge needs must be central to the development of any comprehensive marine science strategy for the Northern Territory and any such plan cannot be effectively implemented without genuine engagement with Aboriginal interests with respect to both undertaking field work and incorporating Aboriginal values and traditional knowledge into scientific investigation.

Timely, high-quality research designed explicitly to meet Aboriginal needs as well as those of other stakeholders in the Northern Territory marine environment will be essential to ensuring that Aboriginal owners and managers are able to meet their obligations with respect to influencing development and management decisions pertaining to the Northern Territory marine environment.

The need to effectively engage with Aboriginal interests extends beyond engaging once other sectoral needs have been framed, research questions determined and projects designed. For Aboriginal owners and managers to endorse research and its outcomes, they must be involved in shaping priorities and programmes wherever there is an expectation that research will be conducted on or applied to Aboriginal estates. This is discussed further in Section 18.3.

18.1.2. Detailed Overview of Key Stakeholder Interactions with the Northern Territory Marine Environment

The study acknowledges and describes the relatively intact tropical marine ecosystem that is the Northern Territory marine environment and discusses the uniqueness of this characterisation. It identifies key forces that will shape the nature of new marine science knowledge required to optimally inform decisions pertaining to interactions with the Northern Territory marine environment now and into the future. These forces are:

- Industrialisation and population growth;
- Aboriginal economic and social participation;
- Increased defence interests;
- Increased conservation advocacy;
- Climate change;
- Evolving regulatory framework; and
- Evolving multi-jurisdictional framework.

The report also provides a data and consultation driven discussion on the status and trends in interaction with the Northern Territory marine environment of all key stakeholders, namely:

- Northern Territory marine conservation estate;
- Regulators of the Northern Territory marine environment;
- ADF;
- Darwin Port;
- Commercial fishing industry;
- Pearling, aquaculture and crocodile industries;
- Offshore petroleum industry;
- Marine tourism industry;
- Minerals industry;
- Irrigated agriculture and forestry industry;
- Coastal communities;
- Marine tourism;
- Recreational fishing sector; and
- Environmental services industry.

18.1.3. Identification of the Main Marine Science Knowledge Needs of Key Stakeholders in the Northern Territory Marine Environment and Areas of Common Interest

Through consultation with key decision makers, the study has identified marine science knowledge needs of each of the key stakeholders in the Northern Territory marine environment as they presently identify them, with some limitations (see Section 18.2.2).

The study has also identified marine science knowledge needs that are, at least at a general level, of interest to multiple stakeholders in the Northern Territory marine environment, as a basis for the development of potential collaboration in and co-funding of marine science endeavours in the Northern Territory.

18.1.4. Identification of Northern Territory Sources of Marine Science Capacity

The report provides a high level overview of the marine science capacity of a range of organisations operating in the Northern Territory including AIMS, CSIRO, IMOS, Commonwealth DoEE, BOM, Northern Territory DENR, CDU, NAILSMA, NERH, Northern Australia CRC, Aboriginal Research Practitioners Network, NAMRA and the marine research capacity of industry.

While a much more in-depth analysis is required to truly assess resident marine science capability and match that capability with the identified needs to address gaps, the key sources of this capability have at least been identified in this report.

18.2. The Key Limitations of this Report

While this report represents significant progress toward a comprehensive end user driven marine science strategy and implementation plan for the Northern Territory, it does demonstrate some important limitations.

18.2.1. Limitations of the Consultation

This study is in part based on consultation via 55 direct one-on-one interviews with decision makers and a range of workshops across the various stakeholders in the Northern Territory marine environment. While this has been a considerable endeavour, it cannot be categorised as exhaustive. In particular, a statement of Aboriginal research needs provided by NAILSMA in Appendix 9 presents a number of important marine science knowledge needs, but the authors of that statement acknowledge that their report could not be considered as an authoritative statement of all Aboriginal knowledge needs with respect to the Northern Territory marine environment. Within the project's resource limitations, it was not possible to reach more than a handful of communities. They and most other communities have not had the opportunity to work through the detail of many issues confronting them and articulate properly considered and shared positions.

This acknowledgement highlights the fact that interviewees and participants in the consultation process varied in their capacity and interest in contributing to identification and justification of marine science knowledge needs. For example, well-established industry organisations and larger companies are well placed to articulate needs based on long and direct experience analysing the knowledge they require to optimise operations in the marine environment. Whereas others, particularly those representing community interests, may have had limited direct exposure to the full array of issues likely to arise under development and other drivers of change, or to consider the utility of basic and applied scientific research designed to address their interests in and care for the marine environment.

Finally, some of the consultation emphasised the unavoidable overlap and linkage among questions of bio-physical science and related social issues. For example, many of the discussions around the marine environment more generally with Aboriginal landowners and communities prompted responses around compatibility of commercial use and customary obligations and ways of influencing interactions to minimise environmental and cultural costs

and capture development benefits locally. This obviously complicates problem-framing and articulation of research questions in ways that allow (usually) single-disciplined researchers to engage productively.

18.2.2. Prioritisation and Basis for Prioritisation

The list of marine science knowledge needs espoused by each of the key stakeholder groups consulted for the purposes of this study represents marine science knowledge acquisition priorities for those groups to the extent that they are the needs that have been identified directly by those stakeholders. However, this prioritisation has two immediate limitations.

First, the espoused marine science knowledge needs identified by each stakeholder group have not been ranked by that group, nor have the criteria by which identified needs should be prioritised established. Second, while some marine science knowledge needs that are common to multiple stakeholders in the Northern Territory marine environment have been identified, those needs have not been ranked across sectors according to the overarching priorities of the Northern Territory or the Nation as political jurisdictions, nor have criteria for establishing such a prioritisation been established.

Establishing the criteria on which prioritisation can be based is a significant exercise and can include factors such as:

- Variation in the source and quality of understanding of need and the obligation to pursue better understanding;
- Economic, cultural and/or social impact if the knowledge need is addressed;
- Number of stakeholders positively affected by research that successfully addresses the knowledge need;
- Cost of research that is necessary to address the knowledge need;
- Whether the marine science capacity required to address that knowledge need is immediately available and accessible;
- Likelihood of a successful outcome from the research designed to address the knowledge need; and
- Time required to undertake the research designed to address the knowledge need and whether this adequately coincides with when that knowledge is needed.

18.2.3. Strategy and Implementation

In addition to not providing adequate prioritisation of the marine science knowledge needs, the report does not present a science plan that describes the multidisciplinary scientific research projects that will be required to deliver on identified needs. Furthermore, while the study identifies local marine science capability at a high level, it does not describe these capabilities in the detail that is necessary for the purposes of identifying gaps in that capacity with respect to addressing the identified marine science knowledge needs.

Finally, in the absence of a resulting detailed marine science plan that is derived from the identified needs and a subsequent prioritisation process, it is not possible to identify a suitable governance structure and resourcing plan for implementing that strategy.

18.3. Toward a Comprehensive Northern Territory Marine Science Strategy and Implementation Plan

Formalised mission-oriented, multi-disciplinary, multi-institutional and multi-sectorial scientific research collaborations have become an important part of the Australian research

landscape. If structured well, these arrangements focus on the knowledge needs of the end users they serve, result in the more efficient use of scientific capacity and resourcing and inevitably result in better scientific outcomes. This has been recognised by the Commonwealth Government's Cooperative Research Centre Program that has now been operating for almost 30 years, involving approximately 120 CRCs across the Nation creating products and processes estimated to have a direct economic, social and environmental value of approximately A\$14.5 billion.²⁰⁶ Various state governments across the Nation have implemented policy that has seen the development of similar structures designed to strategically coordinate research effort and investment around issues of strategic importance to the state, including administratively 'light' structures that perform a strategic planning, coordination and resourcing role.

Historically, Aboriginal landowners and managers have not been easily accommodated by such arrangements. Interests can be generalised to some extent such as shared concerns such as pollution, physical disturbance of valued sites and specific interests in shaping resource allocation policies and related livelihoods. However, local land-use histories and experience vary too much from community to community to permit the construction of a set of research activities likely to be regarded by most as genuinely satisfying local needs.

Indigenous people from across northern Australia have worked together to identify a preferred approach to analysis and presentation of their socio-economic aspirations and opportunities and the best pathway to them.²⁰⁷ That approach can itself be characterised as a substantial research programme, under which Traditional Owners work with external experts to consider systematically their land-use options, prepare associated land use and management plans, and present their views to potential partners and investors. This process will inevitably highlight specific marine science knowledge needs.

In this context, effectively meeting community needs for knowledge will be as much about how research is designed and conducted, as it will be about pursuing identified priorities.

18.3.1. A Call to Arms

If nothing else, the detailed analysis contained in this study should leave the reader acutely aware of the sheer volume and range of marine science that is necessary to ensure marine ecosystem services are adequately preserved and economic, social and cultural interactions with the marine environment can continue and do not face unnecessary obstacles or productivity penalties. It should also leave the reader excited with respect to the opportunity to set a new standard of world's best practice with respect to marine stewardship, which must be informed by a competent and comprehensive marine science effort. This can only be achieved through a collaborative strategic approach based on coordinated co-investment in end user driven marine science.

This report should be used as a basis for promoting enthusiasm from key decision makers in government, industry and community to embark on a process to give effect to this approach. This should involve:

²⁰⁶ The Allen Consulting Group (2017), *The Economic, Social and Environmental Impacts of the Cooperative Research Centres Program*, Cooperative Research Centres Association

²⁰⁷ NAIEP (2013), *An Indigenous Prospectus for Participating in the Sustainable Development of North Australia*, North Australian Indigenous Experts Forum on Sustainable Development, Kakadu National Park, Northern Territory

- Wide circulation of the report to decision makers in key government, industry and community organisation;
- Simple public online access to the report potentially through a government website, one or both of the project sponsor's websites or an independent website dedicated to the NTMSEUNA project, as well as functionality that allows the wider public to provide feedback on the report and discuss through online forums; and
- A series of targeted debriefing sessions for key government, industry and community stakeholders.

18.3.2. Creating a Level Playing Field for Engagement

As discussed in Section 18.2.1, the capacity to adequately engage with a process designed to prioritise marine science knowledge needs and create a strategic framework and structure for resourcing and undertaking the marine science necessary to address those priorities is variable across stakeholders.

Establishing improved processes and structures for industry and government engagement with Aboriginal interests is critical to establishing a deeper understanding of Aboriginal marine science knowledge needs and therefore a key part of, and condition precedent for, developing and implementing an end user driven marine science strategy for the Northern Territory.

An improved process for engagement in this regard is likely to include the following elements:

- Respect for the need for free, prior and informed participation in decision making;
- Discussing and managing participant expectations;
- Working directly with relevant Land Councils and representative bodies and being respectful of their respective engagement protocols;
- Valuing and incorporating local experience and skills in research design and conduct;
- Understanding emerging needs and building relevant capabilities into community stakeholders and other sectors;
- Building capability into research projects to recognise and respect other knowledge systems and to take opportunities to collaborate and maximise mutual benefits;
- Ensuring that research is additive to previous and related research activities;
- Acknowledge obvious limitations to all research ensuring that the research is funded for proper engagement and *bona fide* outcomes;
- Where appropriate, the utilisation of different models for research execution such as including direction of local activity by skilled non-researchers supervised by a competent researcher or panel of researchers;
- Utilisation of advisory structures to guide the development and management of projects; and
- Protocols that ensure that useable outputs from research are provided to the communities on whose country that research took place in a form that those communities can utilise.

Establishing processes and structures for improved engagement with Aboriginal interests in the marine environment should be a priority and be implemented in conjunction with the wider 'call to arms' process discussed in Section 18.3.1 above. This will require resourcing for culturally appropriate communication tools as well as to ensure that the engagement is comprehensively reaching all key Aboriginal communities with interests in the Northern Territory marine environment.

18.3.3. Establishing, Resourcing and Implementing an End user Driven Marine Science Strategy for the Northern Territory

Acknowledging that the process described in Section 18.3.2 is a critical priority, a series of multi-stakeholder round table discussions should be held with the intention of:

- Critiquing and validating this report;
- Giving consideration to any additional public feedback on the report;
- Establishing criteria and supporting framework for relative ranking of marine science knowledge needs that are common to multiple stakeholders, as well as important individual knowledge needs;
- Establishing a set of priorities for acquiring marine science knowledge pertaining to the Northern Territory marine environment that is subject to regular review;
- Commissioning the development of a marine science strategy for the Northern Territory marine environment that incorporate systems for review; and
- Giving consideration to whether a formal structure is required to resource and govern that strategy and if so, the nature of that structure.

The round table process should include representation from all key end users of marine science knowledge pertaining to the Northern Territory marine environment including Aboriginal community leadership, regulators, industry and other community interests. This process should run concomitantly with an urgent effort to address the process discussed in Section 18.3.2.

The proposed pathway to a universally owned, end user driven Northern Territory marine science strategy and implementation plan is summarised in Figure 77.

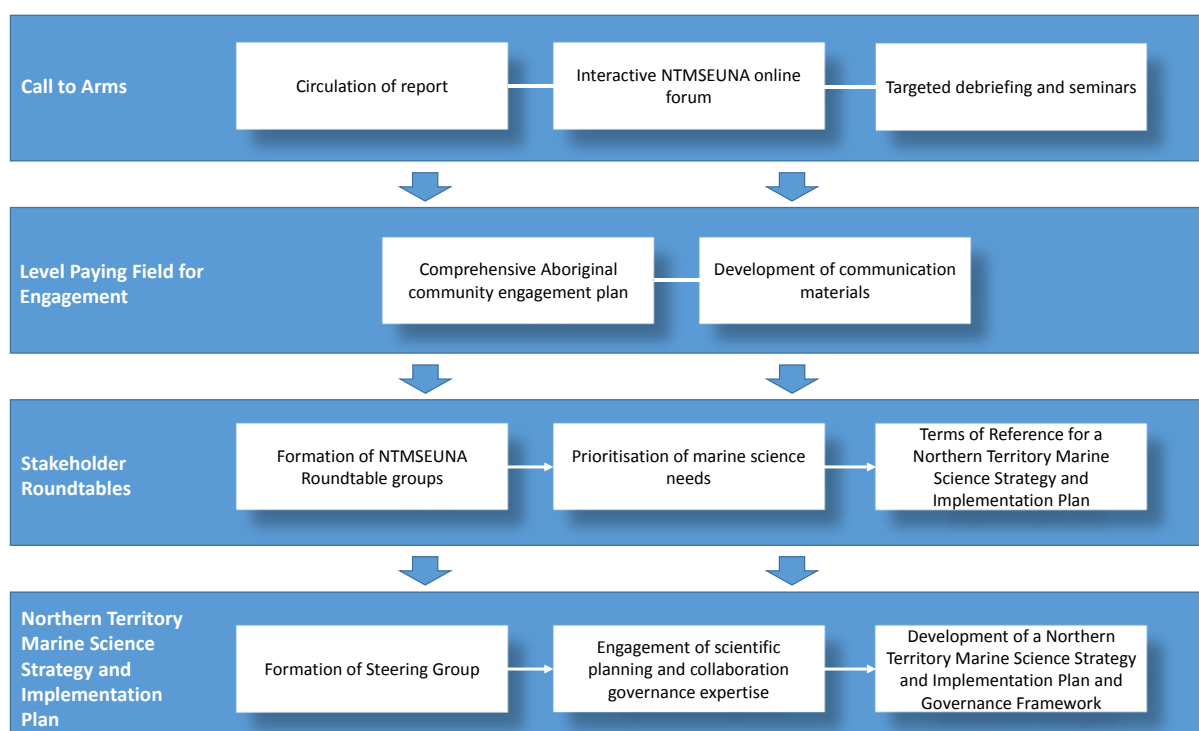


FIGURE 77 – PATHWAY TO A NORTHERN TERRITORY MARINE SCIENCE STRATEGY

Appendix 1: Interviewees

Interviewee	Position	Organisation
Northern Territory Government		
Annie Andrews	Senior Environment Officer	Power and Water Corporation
Mike Butler	Senior Development Manager	Land Development Corporation
Lorraine Corowa	Major Agribusiness Projects	Department of Primary Industry and Resources
Alaric Fisher	Executive Director – Flora and Fauna	Department of Environment and Natural Resources
Tony Griffiths	Executive Director – Marine Ecosystems	Department of Environment and Natural Resources
Victoria Jackson	Executive Director – Energy Division	Department of Primary Industry and Resources
Bryan McDonald	Fisheries Group	Department of Primary Industry and Resources
Mac Moyses	Director – Park Development	Parks and Wildlife Commission of the Northern Territory
Tony O'Malley	Regional Harbour Master and Director of Marine Safety	Department of Infrastructure, Planning and Logistics
Matt Osborne	Fisheries Group	Department of Primary Industry and Resources
Benedict Scambary	Chief Executive Officer	Aboriginal Areas Protection Authority
Joanne Townsend	Acting Chief Executive Officer	Department of Environment and Natural Resources
Skefos Tsoukalis	Senior Engineer Water and Waste Water Treatment	Power and Water Corporation
Paul Vogel	Chair	Environmental Protection Authority
Commonwealth Government		
James Findlay	Chief Executive Officer	Australian Fisheries Management Authority (AFMA)
Nick Rayns	Executive Manager – Fisheries Management Branch	Australian Fisheries Management Authority (AFMA)
Cameron Sim	Environmental Specialist	National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA)

Interviewee	Position	Organisation
Stuart Smith	Chief Executive Officer	National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA)
Todd Smith	Regional Director – Northern Territory	Australian Bureau of Meteorology (BOM)
Commercial Fishing Industry		
Chris Calogeras	Chair	Mud Crab Licensing Committee and Offshore Net and Line Fishing Association
David Carter	Chief Executive Officer	Austral Fisheries
Chauncey Hammond	Commercial Advisor	Tasmanian Seafoods
Annie Jarrett	Chief Executive Officer	Northern Prawn Fishery Industry Association
Daniel Kimberley	Proprietor	Monsoon Aquatics
Jeff Newman	Chair	Barramundi Licence Committee
Bruce Wildcard	Proprietor	Wildcard Professional Fishing
Katherine Winchester	Chief Executive Officer	Northern Territory Seafood Council
Pearling, Aquaculture and Crocodile Industries		
Mick Burns	President	Northern Territory Crocodile Farmers Association
Chris Mitchell	Executive Director	Seafarms
Heidi Mumme	QHSE Manager	Paspaley Group
James Paspaley	Chief Executive Officer	Paspaley Group
Bob Richards	Managing Director	Humpty Doo Barramundi
Irrigated Agriculture		
Greg Owens	Chief Executive Officer	NT Farmers
Minerals Industry		
Jeremy Barnett	Environmental Specialist	South 32
Ryan Pascoe	Environment, Safety and People	Glencore
Benn Prowse	Health, Safety and Environment	Rio Tinto
Offshore Petroleum		
Brenton Chatfield	Environmental Lead	ConocoPhillips Australia

Interviewee	Position	Organisation
Greg Oliver	Environmental Manager	Inpex
Daniel Thompson	Environmental Manager	ConocoPhillips Australia
Tom Baddeley	Manager, Government and Community Relations – WA and NT	Santos
Maritime Logistics Industry		
Terry O'Connor	Chief Executive Officer	Darwin Port
Defence Sector		
CMDR Viktor Pilicic	Commanding Officer	HMAS Coonawarra
Recreational Fishing Sector		
David Ciaravolo	Executive Officer	Amateur Fishermen's Association Northern Territory (AFANT)
Environmental Conservation Sector		
Adele Pedder	Campaign Manger	Australian Marine Conservation Society
Scientific Sector		
Allan Dale	Professor of Tropical Regional Development	James Cook University
Crispian Ashby	Programs Manager	Fisheries Research and Development Corporation
Peter Baylis	Principal Research Scientist –Oceans and Atmosphere	CSIRO
Rik Buckworth	University Fellow	Charles Darwin University
Edward Buttler	Science Leader – Northern Territory	Australian Institute of Marine Science
Karen Gibb	Director – Research Institute for the Environment and Livelihoods	Charles Darwin University
Jackie Gould	Charles Darwin University – Australian Institute of Marine Science Fellow	Charles Darwin University
Patrick Hone	Chief Executive Officer	Fisheries Research and Development Corporation
Tim Moltmann	Chief Executive Officer	Integrated Marine Observation System
Eva Plaganyi	Principal Research Scientist – Oceans and Atmosphere	CSIRO

Interviewee	Position	Organisation
David Williams	Coastal Oceanography	Australian Institute of Marine Science

Appendix 2: Main Northern Territory Bays and Rias and Notable Environmental Values

Bay	Migratory and Waterbirds	Important Marine Fauna
Joseph Bonaparte Gulf ²⁰⁸	Legune Floodplain Important Bird Area	
Hyland Bay ²⁰⁹	Magpie Geese, Pied Heron and Great Knot	Flatback Turtle and breeding area for Salt Water Crocodile
Anson Bay ²¹⁰	Magpie Geese, Wandering Whistling Duck and Pied Heron	
Fog Bay ²¹¹	Greater Sand Plover, Grey-tailed Tattler, Great Knot, Terek Sandpiper, Black-tailed Godwit and Australian Bustard	Green Turtle, Flatback Turtle and Hawksbill Turtle
Bynoe Harbour		
Darwin Harbour		
Shoal Bay ²¹²		
Adam Bay		
Chambers Bay ²¹³		Flatback Turtle, Blue Whale, Speartooth Shark and Northern River Shark
Finke Bay		
Eastern Van Diemen ²¹⁴	Australian Bustard, Whiskered Tern, Marsh Sandpiper, Sharp-tailed Sandpiper, Little Curlew, Common Sandpiper, Australian Pratincole, Magpie Geese and Wandering Whistling Duck	Flatback Turtle, Green Turtle, Loggerhead Turtle, Olive Ridley Turtle, Speartooth Shark, Freshwater Sawfish, Dwarf Sawfish and Northern River Shark

²⁰⁸ Department of Natural Resources and Environment, Legune Coastal Floodplain – Site of Conservation Significance, Northern Territory Government

²⁰⁹ Department of Natural Resources and Environment, Hyland Bay and Associated Coastal Floodplains – Site of Conservation Significance, Northern Territory Government

²¹⁰ Department of Natural Resources and Environment, Anson Bay and Associated Floodplains – Site of Conservation Significance, Northern Territory Government

²¹¹ Department of Natural Resources and Environment, Fog Bay– Site of Conservation Significance, Northern Territory Government

²¹² Department of Natural Resources and Environment, Shoal Bay and Associated Floodplains– Site of Conservation Significance, Northern Territory Government

²¹³ Department of Natural Resources and Environment, Chambers Bay– Site of Conservation Significance, Northern Territory Government

²¹⁴ Department of Natural Resources and Environment, Alligator Rivers Coastal Floodplains– Site of Conservation Significance, Northern Territory Government

Bay	Migratory and Waterbirds	Important Marine Fauna
Maningrida Bay ²¹⁵	Brolga, Roseate Tern, Bridled Tern, Pied Heron and Black-tailed Godwit	Flatback Turtle, Olive Ridley Turtle and Leatherback Turtle
Boucaut Bay ²¹⁶	Black-tailed Godwit, Great Knot and Pied Oystercatcher	Flatback Turtle and Olive Ridley
Castlereagh Bay ²¹⁷	Bar-tailed Godwit, Terek Sandpiper, Great Knot, Far Eastern Curlew, Ruddy Turnstone, Grey-tailed Tattler and Pied Oyster Catcher	
Buckingham Bay	Blacktailed Godwit, Eastern Curlew, Great Knot, Brolga, Magpie Geese and Pied Heron	
Melville Bay ²¹⁸		Flatback Turtle, Hawksbill Turtle, Olive Ridley Turtle and Green Turtle
Rocky Bay ²¹⁹		Green Turtle
White Rock Bay ²²⁰	Bridled Terns	Green Turtle, Flatback Turtle, Hawksbill Turtle and Olive Ridley Turtle
Caledon Bay and Surrounds ²²¹	Brolga, Roseate, Black-naped Terns and Bridled Terns	Hawksbill Turtle
Limmen Bight ²²²	Roseate Terns, Crested Terns and Lesser Crested Tern	Dugong, pipefish and sharks

²¹⁵ Department of Natural Resources and Environment, Maningrida Coastal Habitats - Site of Conservation Significance, Northern Territory Government

²¹⁶ Department of Natural Resources and Environment, Boucaut Bay Coastal Habitats- Site of Conservation Significance, Northern Territory Government

²¹⁷ Department of Natural Resources and Environment, Castlereagh Bay and Associated Islands- Site of Conservation Significance, Northern Territory Government

²¹⁸ Department of Natural Resources and Environment, Gove Peninsula and North East Arnhem Coast- Site of Conservation Significance, Northern Territory Government

²¹⁹ Department of Natural Resources and Environment, Gove Peninsula and North East Arnhem Coast- Site of Conservation Significance, Northern Territory Government

²²⁰ Department of Natural Resources and Environment, Gove Peninsula and North East Arnhem Coast- Site of Conservation Significance, Northern Territory Government

²²¹ Department of Natural Resources and Environment, Gove Peninsula and North East Arnhem Coast- Site of Conservation Significance, Northern Territory Government

²²² Department of Natural Resources and Environment, Limmen Bight and Associated Coastal Floodplains- Site of Conservation Significance, Northern Territory Government

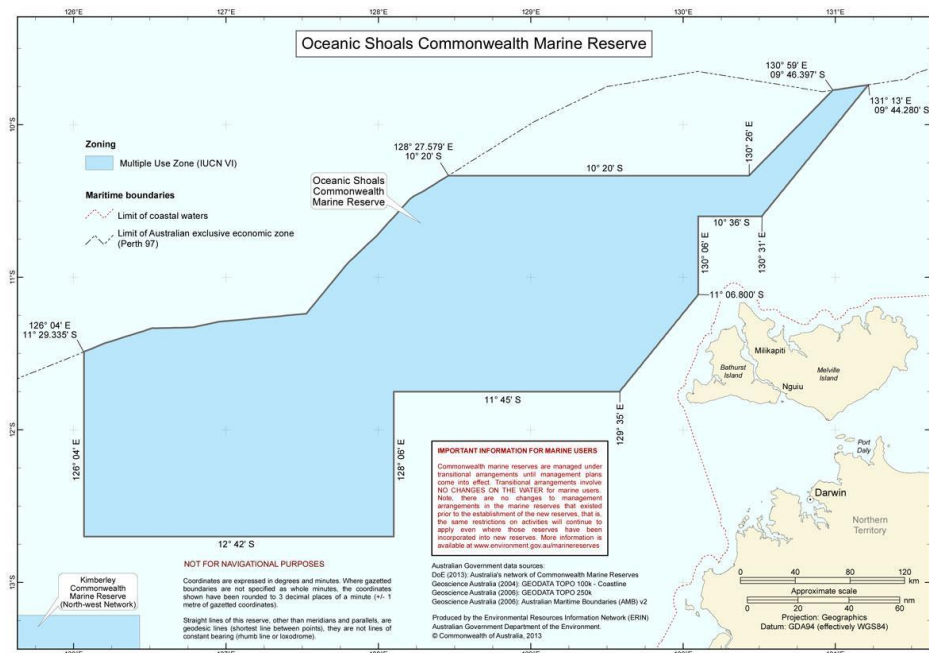
Appendix 3: Major Northern Territory Island Groups and Notable Environmental Values

Island Group	Migratory and Waterbirds	Other Important Fauna
Peron Islands (northern edge of Anson Bay) ²²³	White-winged Black Terns and Australian Pelicans	Flatback Turtles
Indian Island Group (north of Dundee and Fog Bay)	Black-naped Tern, Little Tern, Greater Sand Plover, Grey-tailed Tattler, Great Knot, Terek Sandpiper and Black-tailed Godwit,	Flatback Turtles
Gunn Peninsula/Glyde Point/Vernon Islands (40 km north east of Darwin)		Extensive seagrass meadows hosting significant marine biodiversity
Tiwi Islands		
Cobourg Peninsula and Surrounding Islands	RAMSAR Wetland	Extensive seagrass meadows hosting significant marine biodiversity
Croker Island Group (immediately east of Cobourg Peninsula)	Black-naped Terns and Bridle Terns	Flatback Turtle, Green Turtle and Olive Ridley Turtle
Goulburn Islands (off the coast of Arla Bay)		
Crocodile Islands	Crested Terns and Bridled Terns	Flatback Turtle, Green Turtle and Olive Ridley Turtle
Elcho, Wessel and English Company Islands	Bar-tailed Godwits, Roseate Tern, Black-naped Tern and Little Tern	Flatback Turtle, Hawksbill Turtle Green Turtle and Olive Ridley Turtle
Bremer Island	Bridled Tern and Roseate Tern	Green Turtle, Olive Ridley Turtle and Flatback Turtle
Isle Woodah and surrounding islets	Little Tern, Bridled Tern and Black-naped Tern	Flatback Turtle
Groote Eylandt, Bickerton and surrounding islands	Roseate Terns	Green Turtle and Hawksbill Turtle

²²³ Department of Natural Resources and Environment, Anson Bay and Associated Coastal Floodplains- Site of Conservation Significance, Northern Territory Government

Appendix 4: Commonwealth Marine Reserves

Oceanic Shoals²²⁴



Area (approximate) 71,744 sq km (total including WA marine waters)

Location – Darwin reference (approximate) 100 km NW

Zoning Multiple Use Zone (IUCN Category VI)

Management Plan N/A – transitional arrangements apply

Ecological features

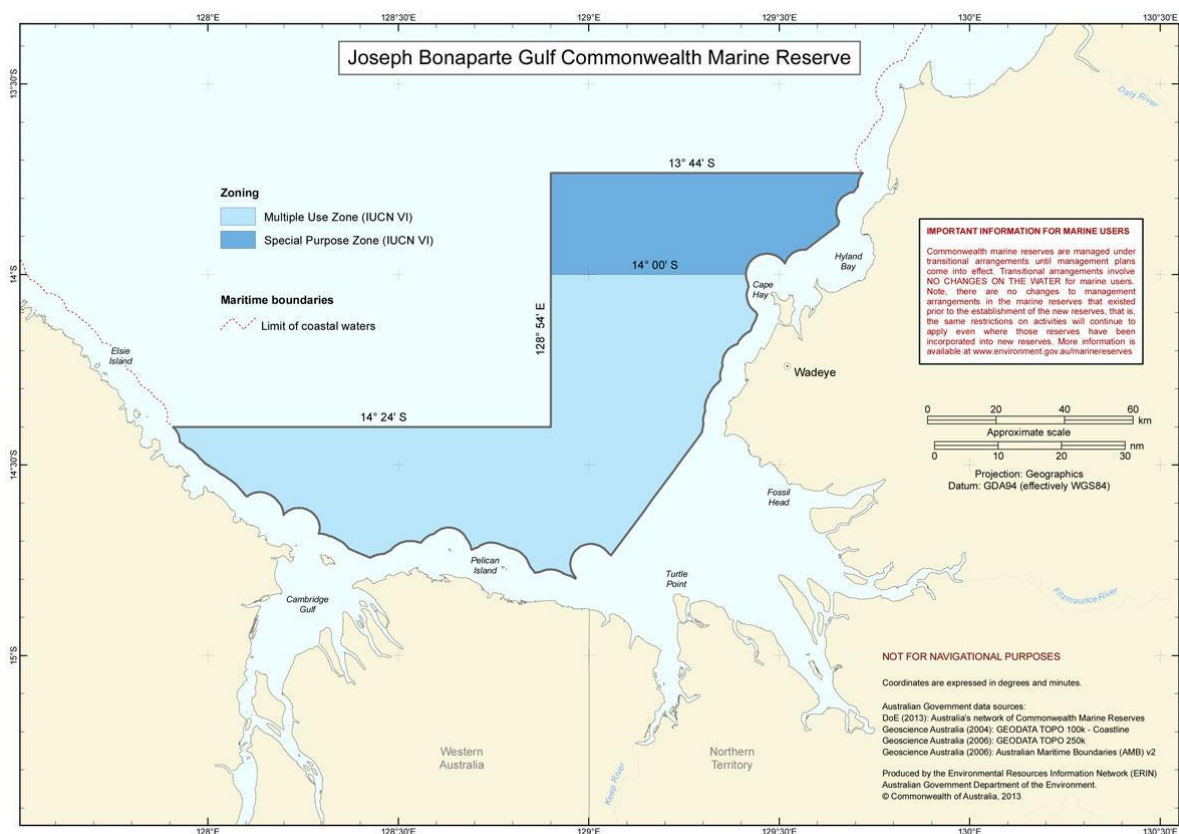
- Carbonate bank and terraces of Van Diemen rise
- Carbonate banks of Joseph Bonaparte Gulf
- Pinnacles of Bonaparte Basin
- Shelf break and slopes of Arafura Shelf

Conservation values

- Important resting area for Flatback Turtle and Olive Ridley Turtle
- Important foraging area for Loggerhead Turtle and Olive Ridley Turtle
- Relatively intact example of ecosystems from two bioregions – Northwest Shelf Transition Province and Timor Transition Province

²²⁴ *Oceanic Shoals*, in *Australian Marine Parks (Commonwealth Marine Reserves)*, published Cth DoEE, available www.environment.gov.au

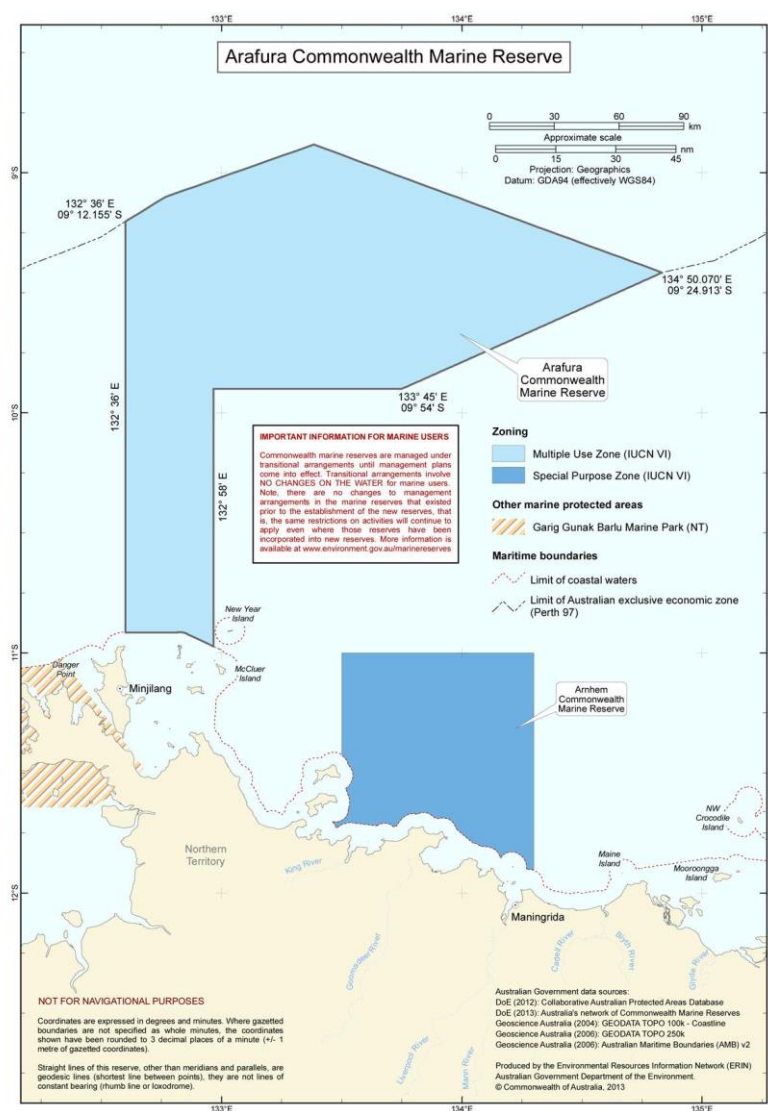
Joseph Bonaparte Gulf²²⁵



Area (approximate)	8,597 sq km (total including WA marine waters)
Location – Darwin reference (approximate)	300 km SW
Zoning	Northern portion: Special Purpose Zone (IUCN Category VI) Southern Portion: Multiple Use Zone (IUCN Category VI)
Management Plan	N/A – transitional arrangements apply
Ecological features	Carbonate banks of Joseph Bonaparte Gulf
Conservation values	<ul style="list-style-type: none"> - Important foraging area for Green and Olive Ridley Turtles - Important foraging area for Australian Snubfin Dolphin - Relatively intact examples of shallow water ecosystems of Northwest Shelf Transition Province – Cambridge-Bonaparte, Anson, Beagle and Bonaparte meso-scale regions

²²⁵ Joseph Bonaparte Gulf, in *Australian Marine Parks (Commonwealth Marine Reserves)*, published Cth DoEE, available www.environment.gov.au

Arafura²²⁶

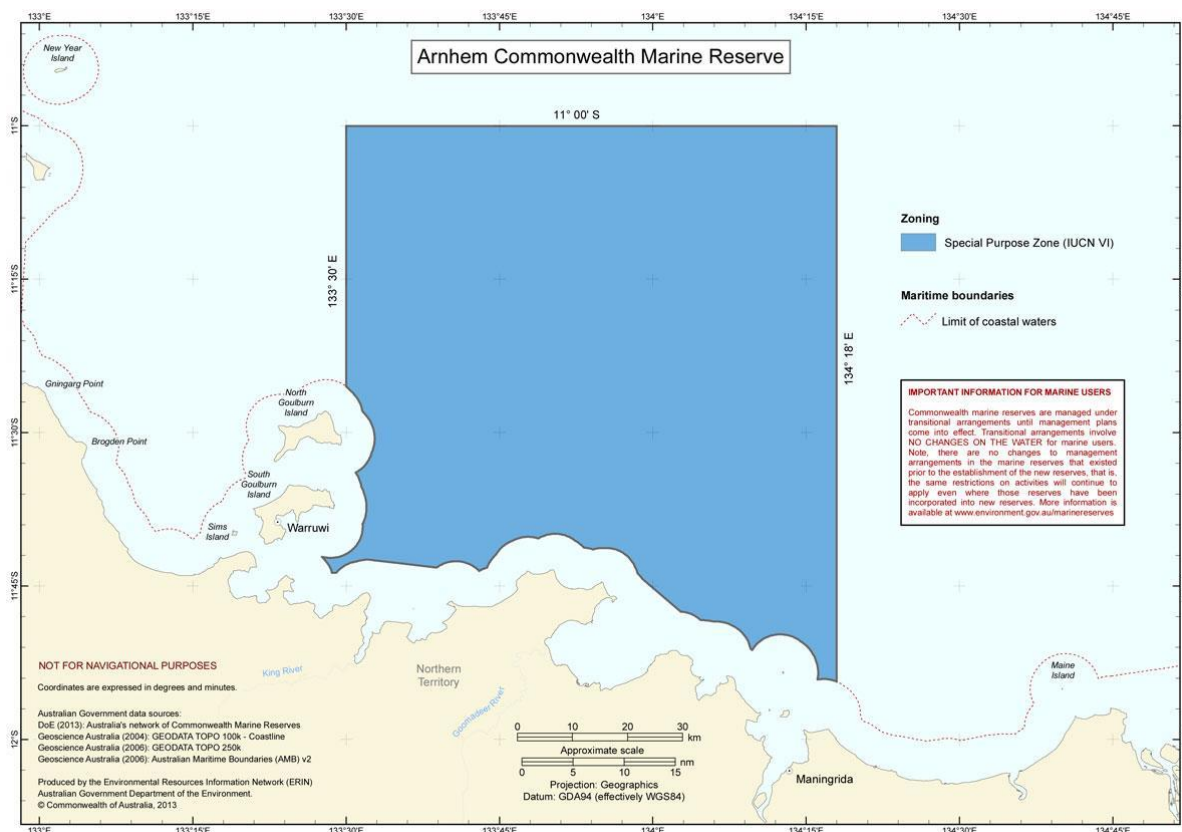


Area (approximate)	22,924 sq km
Location – Darwin reference (approximate)	300 km NE
Zoning	Multiple Use Zone (IUCN Category VI)
Management Plan	N/A – transitional arrangements apply
Ecological features	Tributary canyons of Arafura Depression
Conservation values	<ul style="list-style-type: none"> - Important resting area for turtles in egg-laying season (Flatback, Green, Hawksbill and Olive Ridley) - Important foraging area for breeding aggregations of Roseate Tern

²²⁶ Arafura, in *Australian Marine Parks (Commonwealth Marine Reserves)*, published Cth DoEE, available www.environment.gov.au

- Good example of ecosystems of two provincial bioregions—Northern Shelf Province and Timor Transition Province

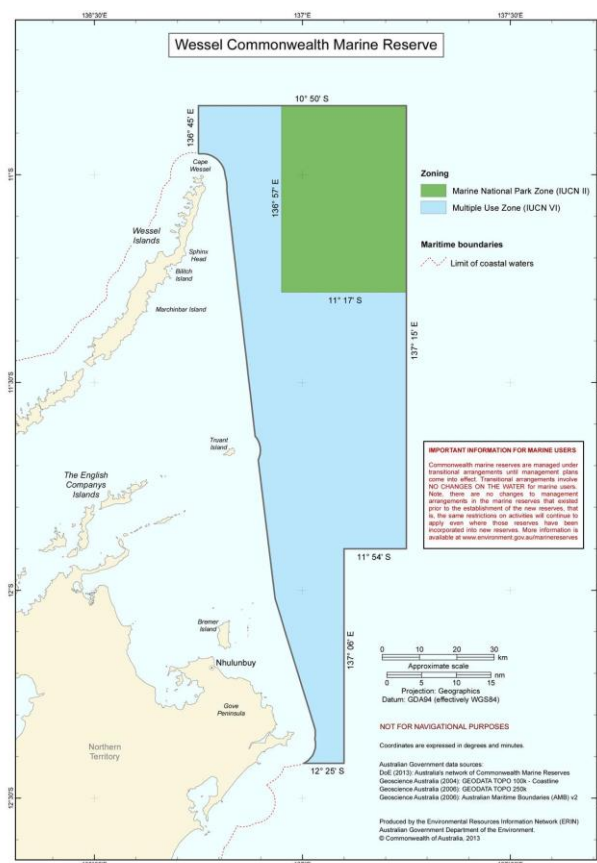
Arnhem²²⁷



Area (approximate)	7,125 sq km
Location – Darwin reference (approximate)	320 km ENE
Zoning	Special Purpose Zone (IUCN Category VI)
Management Plan	N/A – transitional arrangements apply
Ecological features	- Shallow water examples of Arnhem/Wessel mesoscale bioregion
Conservation values	- Important resting area for Flatback Turtle - Important foraging habitat for breeding aggregations of migratory waterbirds (Bridled Tern, Roseate Tern and Marine Crested Tern)

²²⁷ Arnhem, in *Australian Marine Parks (Commonwealth Marine Reserves)*, published Cth DoEE, available www.environment.gov.au

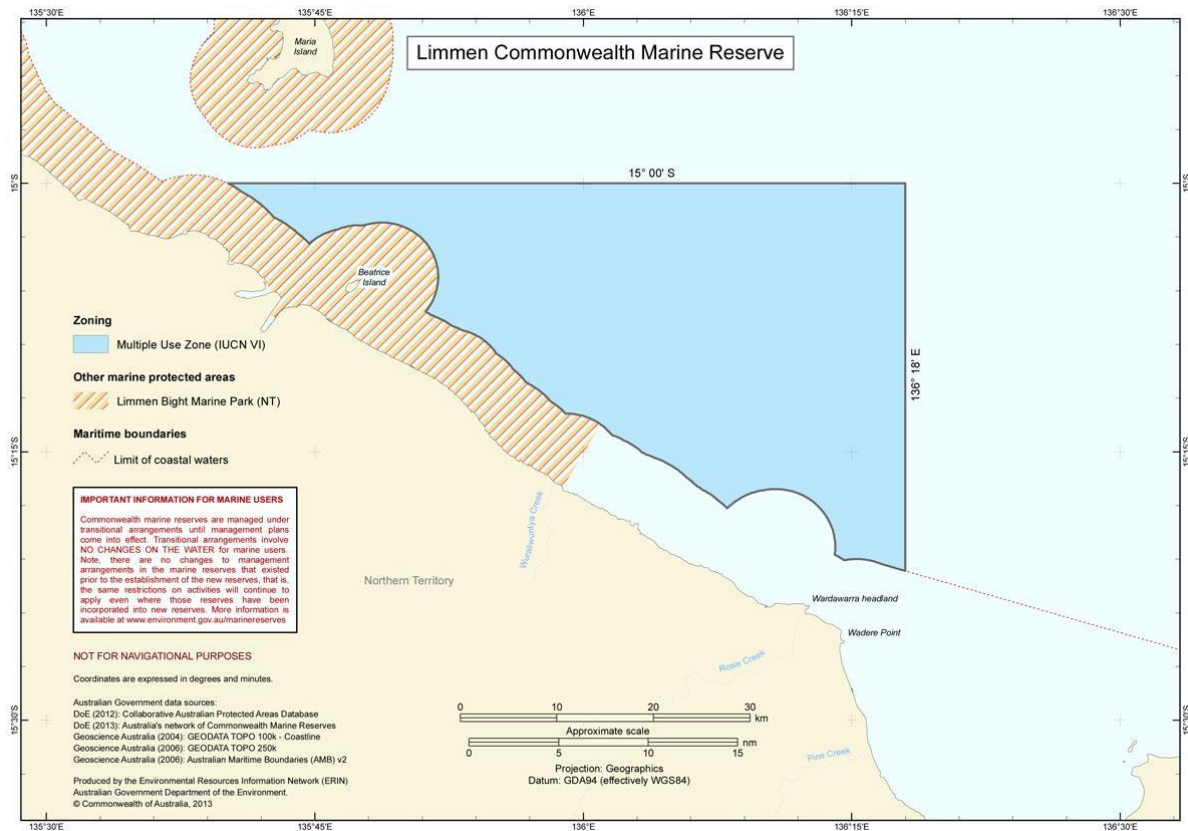
Wessel²²⁸



Area (approximate)	5,908 sq km
Location – Darwin reference (approximate)	700 km ENE
Zoning	Northeastern portion: Marine National Park (IUCN Category II) Southern portion: Multiple Use Zone (IUCN Category VI)
Management Plan	N/A – transitional arrangements apply
Ecological features	Gulf of Carpentaria Basin
Conservation values	<ul style="list-style-type: none"> - Important resting area for nesting turtles (Flatback, Green, Hawksbill and Olive Ridley) - Important foraging area for breeding aggregations of marine waterbirds (Common Noddy, Roseate Tern and Marine Crested Tern) - Good example of Arafura, Arnhem-Wessel and Carpentaria mesoscale bioregions

²²⁸ Wessel, in *Australian Marine Parks (Commonwealth Marine Reserves)*, published Cth DoEE, available www.environment.gov.au

Limmen²²⁹

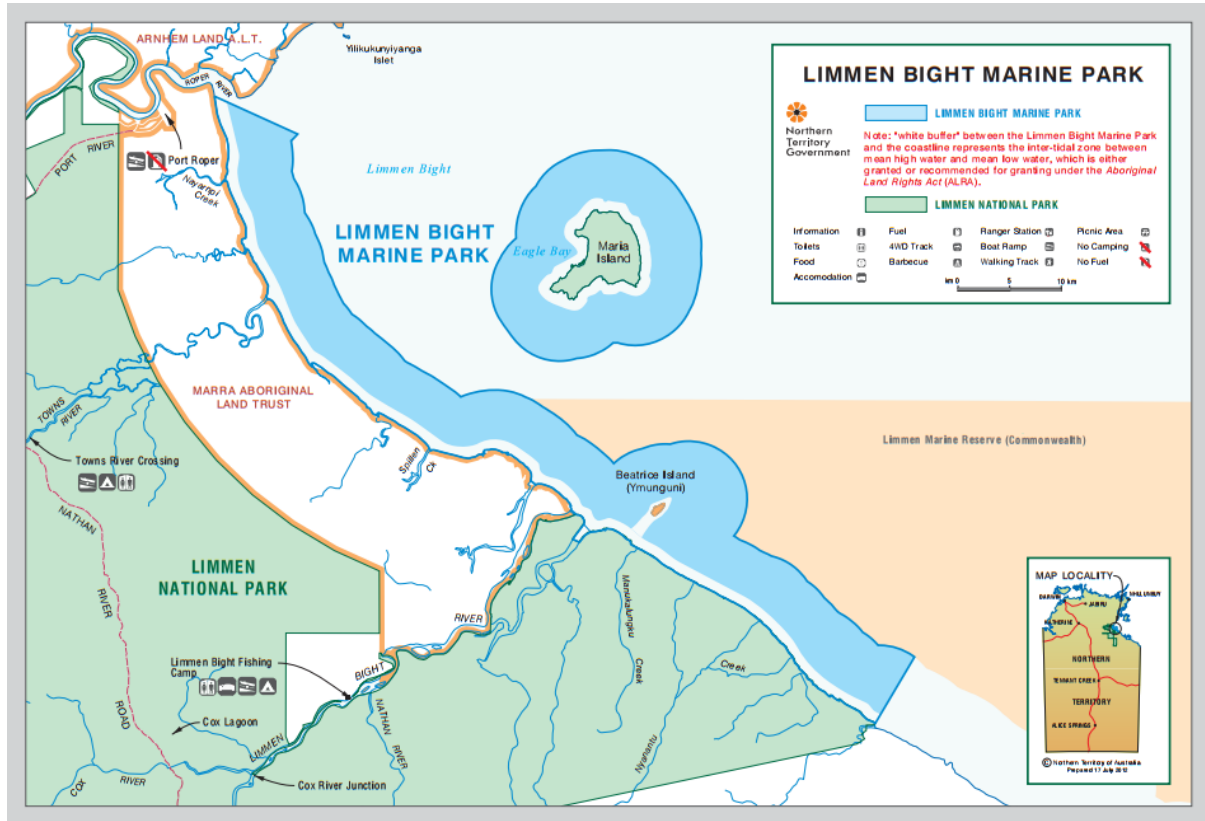


Area (approximate)	1,399 sq km
Location – Darwin reference (approximate)	600 km SE
Zoning	Multiple Use Zone (IUCN Category VI)
Management Plan	N/A – transitional arrangements apply
Ecological features	Gulf of Carpentaria coastal zone
Conservation values	<ul style="list-style-type: none"> - Important resting area for Flatback Turtle - Relatively intact example of Northern Shelf Province bioregion

²²⁹ *Limmen*, in *Australian Marine Parks (Commonwealth Marine Reserves)*, published Cth DoEE, available www.environment.gov.au

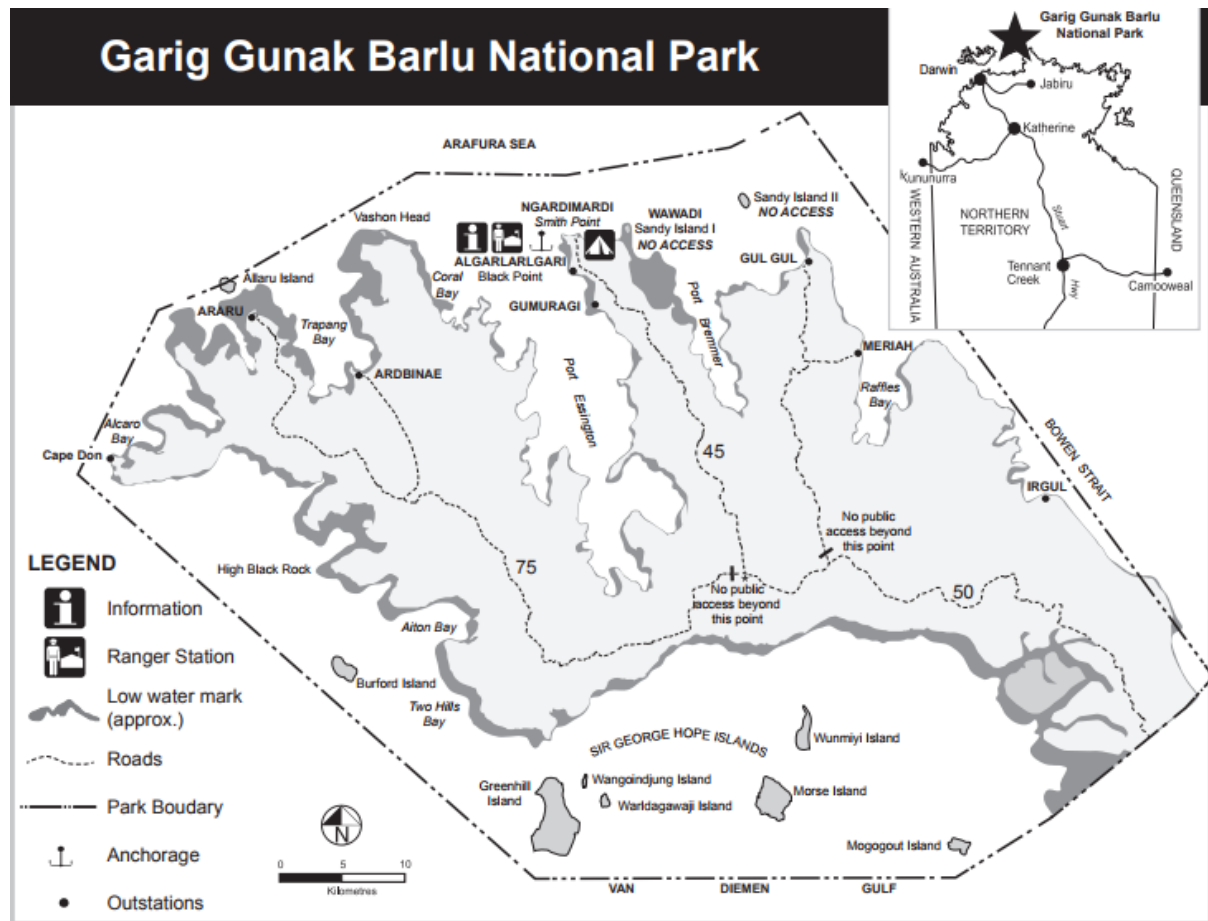
Appendix 5: Northern Territory Marine Parks and Coastal Reserves

Limmen Bight Marine Park²³⁰



²³⁰ Adapted from *Limmen Bight Marine Park – Park Guide and Map*, in *Limmen Bight Marine Park*, published Northern Territory Department of Parks and Wildlife, available www.nt.gov.au

Garig Gunag Barlu / Cobourg Peninsula National Park²³¹

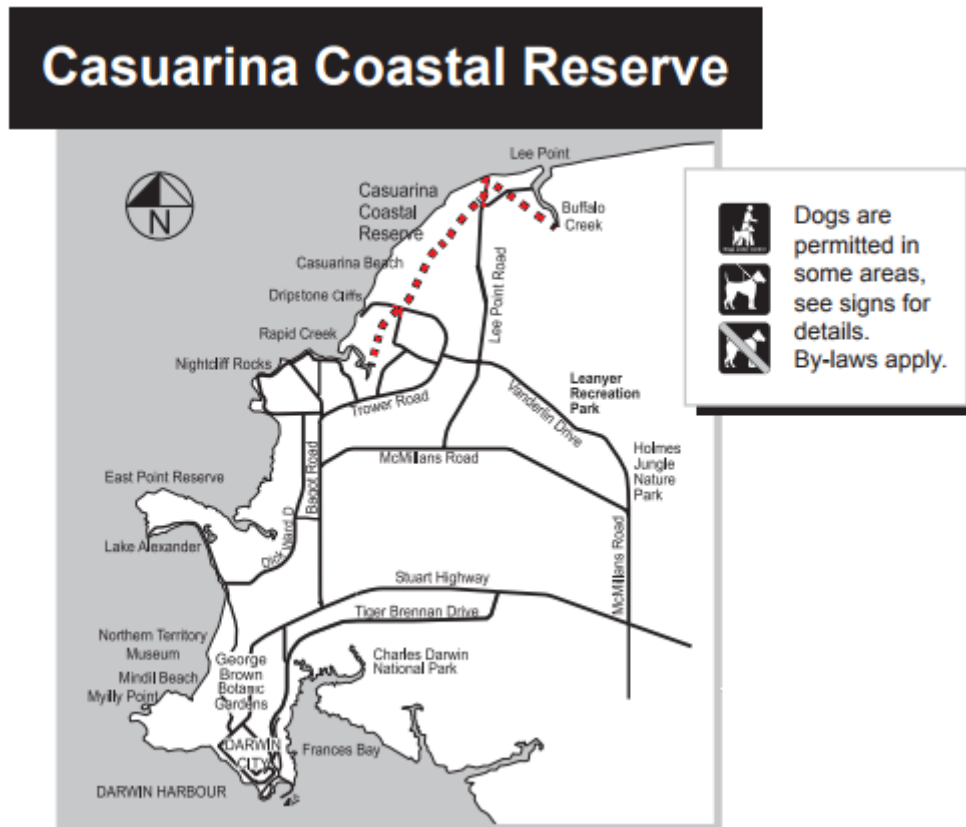


Proposed additional marine parks

Wessel, Arafura, Arnhem

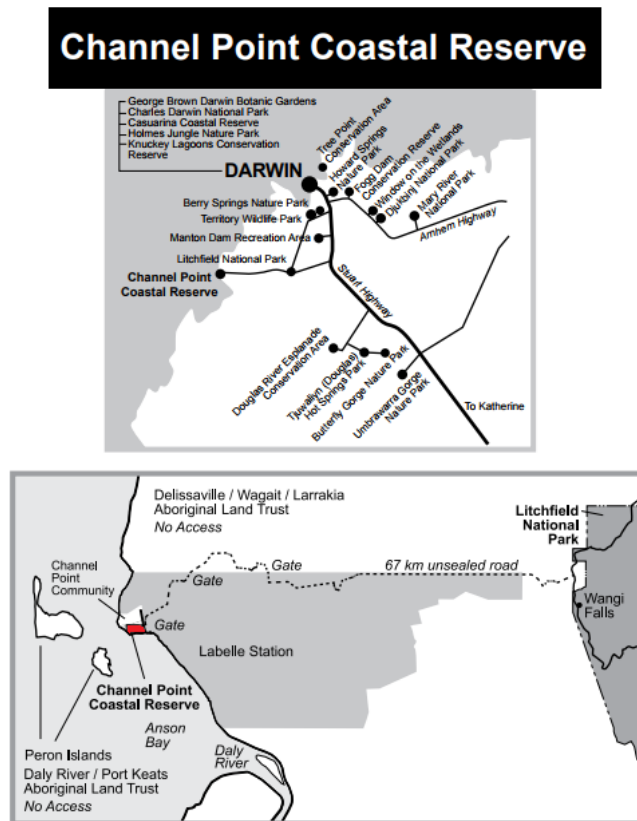
²³¹ Adapted from *Garig Gunag Barlu Marine Park – Park Guide and Map*, in *Garig Gunag Barlu Marine Park*, published Northern Territory Department of Parks and Wildlife, available www.nt.gov.au

Casuarina Coastal Reserve²³²



²³² Adapted from *Casuarina – Park Guide and Map*, in *Casuarina Coastal Reserve*, published Northern Territory Department of Parks and Wildlife, available www.nt.gov.au

Channel Point Coastal Reserve²³³



²³³ Adapted from *Channel Point Coastal Reserve – Park Guide and Map*, in *Channel Point Coastal Reserve*, published Northern Territory Department of Parks and Wildlife, available www.nt.gov.au

Shoal Bay Coastal Reserve²³⁴



Other Northern Territory Marine Parks and Coastal Reserves

Other Northern Territory Marine Parks and Coastal Reserves include:

- Indian Island Conservation Area
- Charles Darwin National Park
- Tree Point Conservation Area
- Vernon Islands Conservation Reserve
- Melacca Swamp Conservation Area
- Djukbinj National Park
- Mary River National Park
- Kakadu National Park
- Barranyi National Park
- Finucane Island National Park

²³⁴ No official NT publications showing area publicly available following 2016 nt.gov website restructure. Placeholder image reproduced and adapted from Google Maps.

Appendix 6: Indigenous Protected Areas

Marri-Jabin (Thamurrurr) (Stage 1) Indigenous Protected Area²³⁵



Area (approximate)	712 sq km
Further expansion	Thamurrurr Stage 2 – mooted expansion of area of sea country covered, no formal proposal yet
Location – Darwin reference (approximate)	200 km SW
Zoning	Declared IPA (IUCN Category VI)
Managing body	Thamarrurr Rangers
Ecological features	<ul style="list-style-type: none"> - Moyle and Little Moyle River floodplains - Mudflats and estuarine waters
Conservation values	<ul style="list-style-type: none"> - Important nesting and foraging site for Red Goshawk

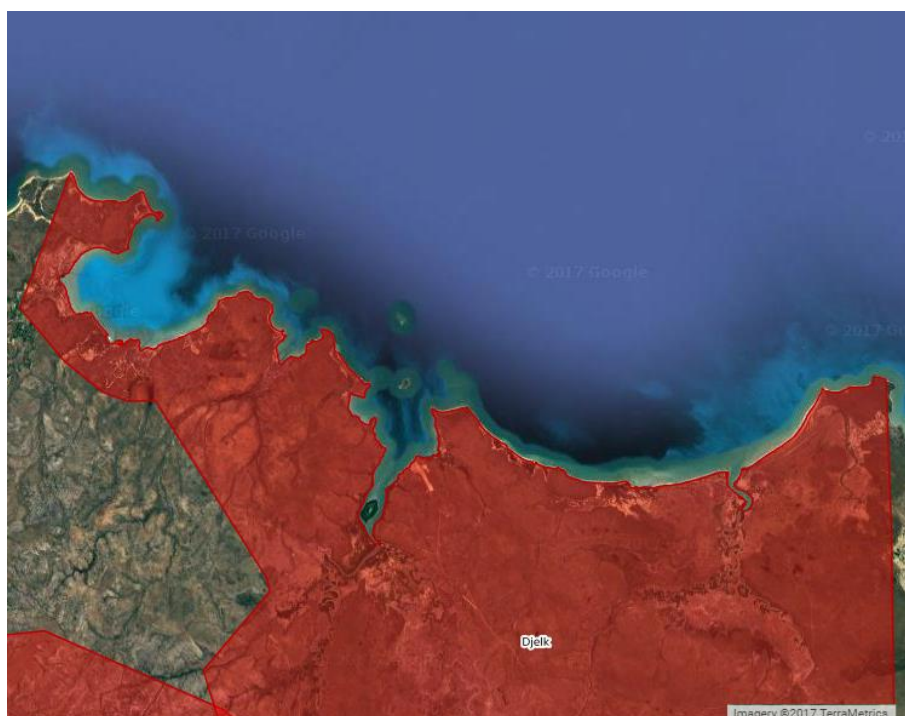
²³⁵ Imagery produced from *Indigenous Protected Areas (IPA) – Declared metadata and data (2015)*, published Commonwealth Department of the Environment, available www.environment.gov.au/about-us/environmental-information-data/open-data

- Northern Quoll and Water Mouse habitat
- Wetlands support approximately 500,000 Magpie Geese
- Beaches known nesting sites for Flatback and Olive Ridley Turtles

Activities

- Thamarrurr Rangers one of largest Indigenous employers in the Wadeye community
- Traditional Owners exploring feral animal hunting safaris, fishing and ecotourism

Djelk Indigenous Protected Area²³⁶



Area (approximate)	6,732 sq km
Further expansion	None known
Location – Darwin reference (approximate)	350 km ENE
Zoning	Declared IPA (IUCN Category VI)
Managing body	Djelk Rangers
Ecological features	<ul style="list-style-type: none"> - Sub-coastal Central and West Arnhem sandstone plateaus - Tropical savannah woodlands

²³⁶ Imagery produced from *Indigenous Protected Areas (IPA) – Declared metadata and data (2015)*, published Commonwealth Department of the Environment, available www.environment.gov.au/about-us/environmental-information-data/open-data

- Monsoonal rainforest and estuarine flats surrounding Goomadeer, Mann and Blythe Rivers
- Beaches and islands bordering Arafura Sea

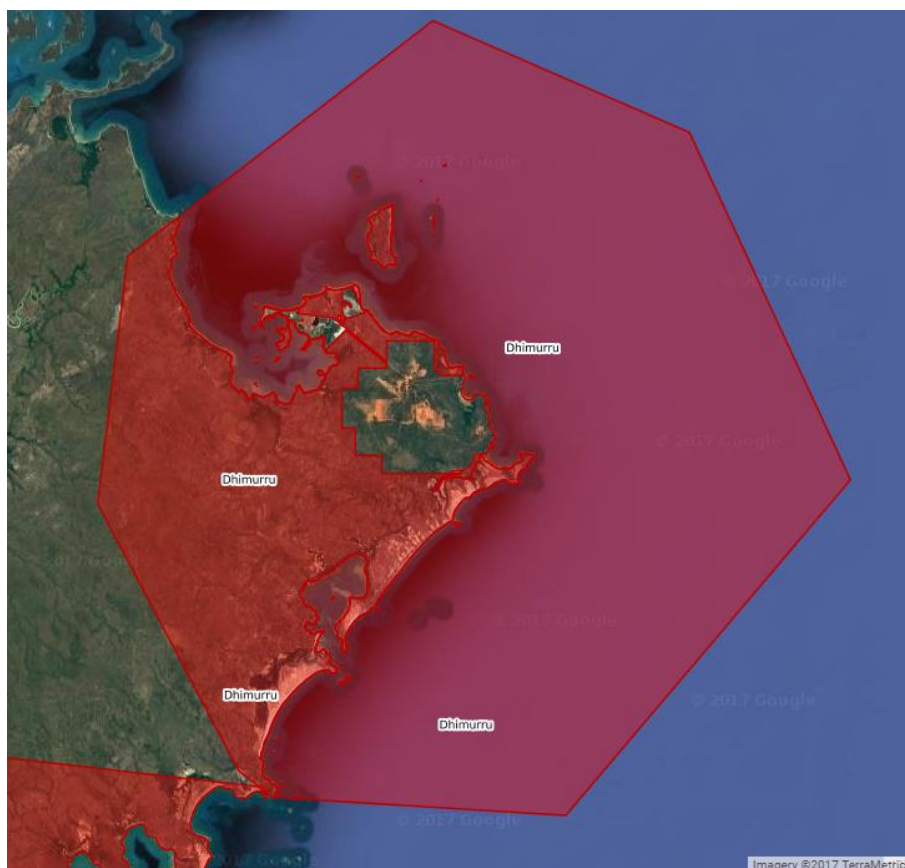
Conservation values

- Tropical savannah woodland provides habitat for Australian Bustard, Frill neck Lizard and Yellow-spotted Goanna
- Sandstone plateaus highest diversity of reptile species in world, as well as threatened species of Arnhem Land Rock Rat, Black Wallaroo and White-throated Grasswren
- Arafura beaches nesting habitat for marine turtles (Flatback, Olive Ridley and Green)
- Seasonal floodplains habitat and breeding area for Arafuran File Snake, Water Mouse, Mangrove Monitor and Saltwater Crocodile

Activities

- Djelk Rangers undertake variety of fee-for-service reporting and monitoring for NT Department of Primary Industries and Fisheries (DPIF), Australian Customs and Australian Quarantine and Inspection Service (AQIS)

Dhimurru Indigenous Protected Area²³⁷



Area (approximate)	5,500 sq km
Further expansion	None known
Location – Darwin reference (approximate)	650 km E
Zoning	Declared IPA (IUCN Category VI)
Managing body	Dhimurru Rangers
Ecological features	<ul style="list-style-type: none"> - Rocky coastlines of northeast Arafura, interspersed with dune fields and lateral beach ridge plains - Open coastal eucalypt forest over bauxite plains, patches of monsoonal forest and paperbark swampland - Most extensive and diverse shallow water coral reefs in the Northern Territory
Conservation values	<ul style="list-style-type: none"> - Important breeding and foraging area for Snubfin Dolphin, Dugong, Saltwater Crocodile and Green and Olive Ridley Turtles

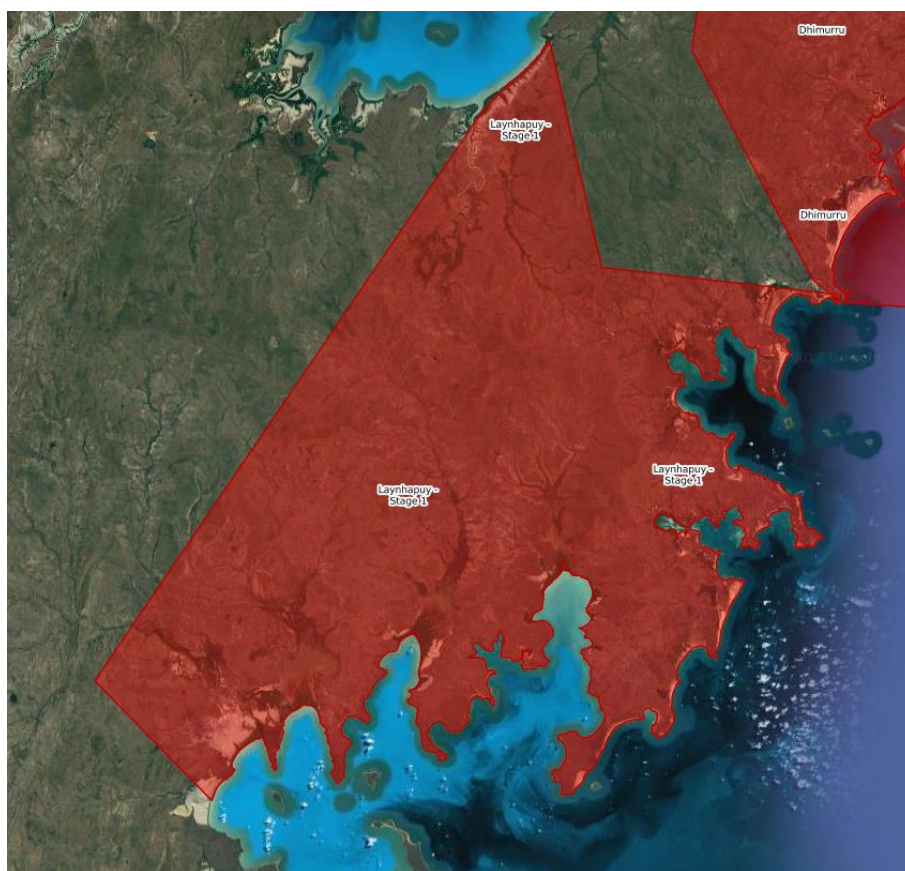
²³⁷ Imagery produced from *Indigenous Protected Areas (IPA) – Declared metadata and data (2015)*, published Commonwealth Department of the Environment, available www.environment.gov.au/about-us/environmental-information-data/open-data

- Regionally significant breeding colony of Roseate Tern
- Highly endangered endemic population of Gove Crow Butterfly

Activities

- Dhimmuru Rangers undertake variety of fee-for-service reporting and monitoring for NT DPIF, Australian Customs and AQIS
- Small-scale guided tours and recreational fishing, feral animal eradication services
- Well-established Learning on Country programme linking to in-school work and curriculum outcomes

Laynhapuy (Stage 1) Indigenous Protected Area²³⁸



Area (approximate)

4,500 sq km

Further expansion

Laynhapuy Stage 2 – significant expansion to south and west, with additional sea country – total 17,000 sq km

Location – Darwin reference (approximate)

650 km E

²³⁸ Imagery produced from *Indigenous Protected Areas (IPA) – Declared metadata and data (2015)*, published Commonwealth Department of the Environment, available www.environment.gov.au/about-us/environmental-information-data/open-data

Zoning	Declared IPA (IUCN Category VI)
Managing body	Yirralka Rangers – Dirramu (men's) and Miyalk (women's) groups
Ecological features	<ul style="list-style-type: none"> - Open coastal eucalypts and savannah woodlands, occasional monsoonal vine forest - Large number of rias, embayments and estuarine floodplains - River systems and seasonal creeks, swamps and floodplains
Conservation values	<ul style="list-style-type: none"> - Important breeding and foraging area for Snubfin Dolphin, Dugong, Saltwater Crocodile and Green and Olive Ridley turtles - Marine and coastal environments virtually untouched
Activities	<ul style="list-style-type: none"> - Small-scale sustainable tourism - Laynhapuy Homelands Association primarily manages area to allow traditional sustainable hunting practices for subsistence purposes

Anindilyakwa Indigenous Protected Area²³⁹



²³⁹ Imagery produced from *Indigenous Protected Areas (IPA) – Declared metadata and data* (2015), published Commonwealth Department of the Environment, available www.environment.gov.au/about-us/environmental-information-data/open-data

Area (approximate)	3,000 sq km
Further expansion	None known
Location – Darwin reference (approximate)	650 km ESE
Zoning	Declared IPA (IUCN Category VI)
Managing body	Anindilyakwa Land and Sea Management Unit – Anindilyakwa Rangers
Ecological features	Island archipelago of Groote Eylandt
Conservation values	<ul style="list-style-type: none"> - Densest marine turtle nesting site in NT - Large populations of species endangered elsewhere in NT (Northern Quoll and Hopping Mouse) - No introduced or feral grazing animals, no Cane Toads
Activities	<ul style="list-style-type: none"> - Very limited tourist permits - Fee-for-service arrangement with several government departments (AQIS and Cth Department of Agriculture)

Yanyuwa (Barni-Wardimantha Awara) Indigenous Protected Area²⁴⁰



Area (approximate) 1,300 sq km

²⁴⁰ Imagery produced from *Indigenous Protected Areas (IPA) – Declared metadata and data* (2015), published Commonwealth Department of the Environment, available www.environment.gov.au/about-us/environmental-information-data/open-data

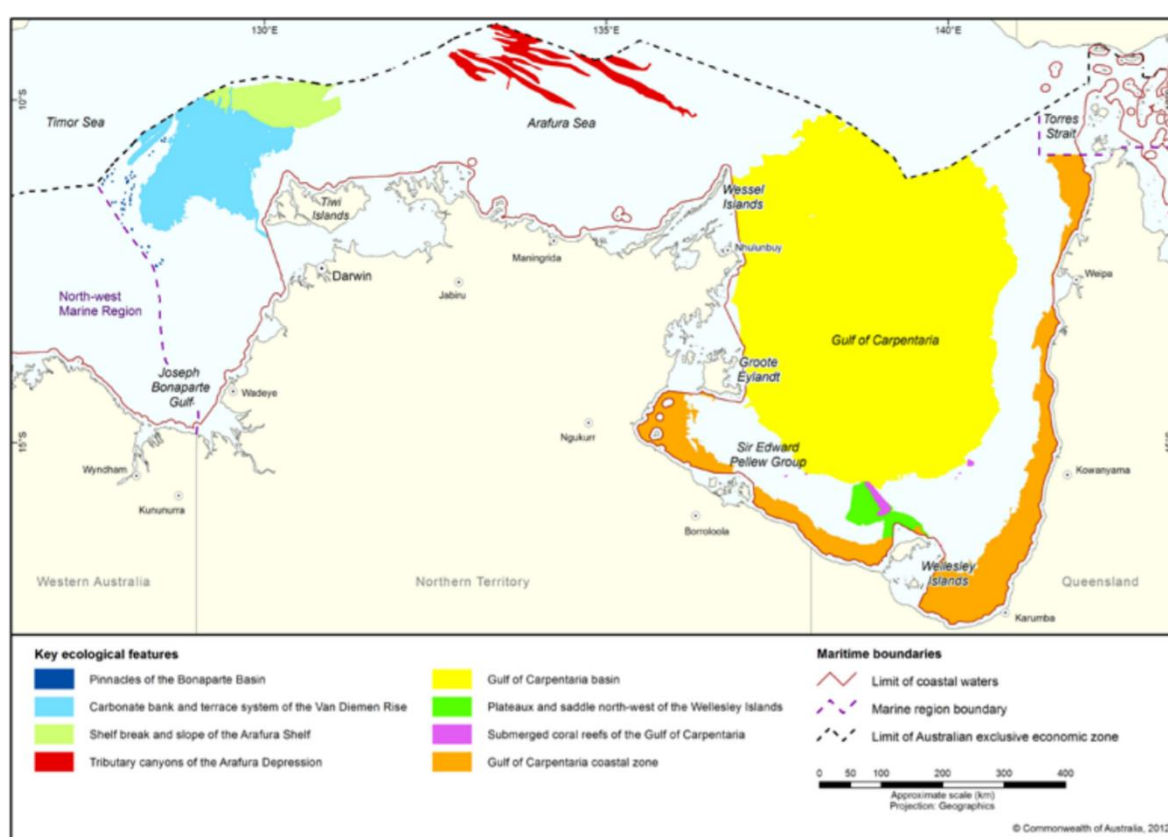
Further expansion	None known
Location – Darwin reference (approximate)	730 km SE
Zoning	Declared IPA (IUCN Category VI)
Managing body	li-Anthawirriyarra Sea Ranger Unit
Ecological features	<ul style="list-style-type: none"> - Floodplains and swamps of McArthur River and estuaries - Sir Edward Pellew Island group
Conservation values	<ul style="list-style-type: none"> - McArthur River, swamps and floodplains important habitat for Barramundi, Black Bream, Saltwater Crocodiles and Long-neck Turtles, as well as a range of native flora - Islands important refuge for animals threatened on mainland, with range of ecosystems represented (vine forest, open eucalypt, scrub, sandstone heath, mangrove, sandy dunes) - Sea turtle and Dugong grazing and aggregation area
Activities	<ul style="list-style-type: none"> - Very limited tourist permits - Fee-for-service arrangements relating to turtle conservation and feral animal eradication - Management of marine resources for sustainable usage by Yanyuwa Traditional Owners - Annual Maabayi sea turtle camp (high-value eco- and voluntourism to assist turtle conservation efforts)

Appendix 7: Key Ecological Features

Regulatory framework

Key ecological features (KEFs) are elements of the Commonwealth marine environment that are of importance at regional-scales for the proper function and integrity of a bioregion and its ecosystems. While they have no legal framework or protection, the marine environment as a whole is considered to be a matter of national environmental significance under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) and impacts on areas declared as KEFs will attract particular attention from regulators.

Six distinct KEFs appear within the Northern Territory marine environment, shown in the figure below and discussed in further detail in the following subsections.



Pinnacles of the Bonaparte Basin²⁴¹

National and/or regional importance

The deep ocean limestone pinnacles in the Bonaparte Basin support a diverse community in an otherwise oligotrophic system and represent 40 per cent of all pinnacles that exist in the

²⁴¹ Adapted from *Species Profile and Threats Database – Key Ecological Features – Pinnacles of the Bonaparte Basin*, published Cth Department of the Environment and Energy, available www.environment.gov.au

North Marine Region. Occurring adjacent to the carbonate banks of the Bonaparte Depression, they form part of the Oceanic Shoals meso-scale bioregion.

Values description

These pinnacles (up to 50 metres high and 100 kilometres long) lie on the mid-outer shelf, which has few other seabed structures. As the hard substrate of the pinnacles is surrounded by a relatively featureless environment the pinnacles are presumed to support relatively high numbers of species; however, there are significant gaps in understanding about the species richness and diversity of these structures.

The Indonesian Throughflow (ITF) brings warm, low-salinity water into the Bonaparte Basin and nutrients may be transported into the area through storm and cyclone events. Primary productivity is largely from phytoplankton and zooxanthellae within the hard corals on the limestone pinnacles and through sporadic upwelling across the Sahul Shelf. Generally, the processes associated with the presumed enhanced productivity of the limestone pinnacles are not well understood.

Communities associated with the limestone pinnacles are thought to include sessile benthic invertebrates such as hard and soft corals and sponges, and aggregations of demersal fish species such as snapper, emperor and grouper. Marine turtles including Flatback, Olive Ridley and Loggerhead Turtles are known to forage around the pinnacles, and Flatback Turtles feed on squid eggs laid on the hard substrate of the pinnacles. The pinnacles are considered a 'general use' area for sawfishes (Green and Freshwater Sawfishes), although the functioning of the pinnacles ecosystem is not thought to depend on these species.

Carbonate bank and terrace system of the Van Diemen Rise²⁴²

National and/or regional importance

The Van Diemen Rise—part of the larger system associated with the Sahul Banks to the north and Londonderry Rise to the east—enhances biodiversity and local productivity relative to its surrounds and supports a relatively high species diversity. The carbonate banks and shoals found within the Van Diemen Rise make up 80 per cent of the banks and shoals, 79 per cent of the channels and valleys, and 63 per cent of the terrace found across the North Marine Region. Channels between the banks vary in depth from shallow (10–40m) to quite deep (60–150m) and are thought to relate to hydrocarbon seepage from the Bonaparte Basin.

Values description

The variability in water depth and substrate composition across the feature may contribute to the presence of unique ecosystems in the channels: however, the causes, composition and history of channel fill sediment is not well understood. The ITF transports warmer oligotrophic waters of lower salinity into the area from the tropical western Pacific Ocean, however, the extent to which this supports ecological functioning and biodiversity in the area is largely unknown.

Species present in this key ecological feature include sponges, soft corals and other sessile filter feeders associated with hard substrate sediments of the deep channels. Biodiversity mapping

²⁴² Adapted from *Species Profile and Threats Database – Key Ecological Features – Carbonate bank and terrace system of the Van Diemen Rise*, published Cth Department of the Environment and Energy, available www.environment.gov.au

indicates a higher degree of variability than in many other areas of the North Marine Region, i.e. rich sponge gardens and octocorals have been identified on the eastern banks, ridges and some terraces, while deep valleys are characterised by scattered epifauna and infauna that include polychaetes (worms) and ascidians (filter feeders). Epibenthic communities such as sponges found in the channels are likely to support first and second-order consumers.

Pelagic fish such as mackerel, red snapper and a distinct gene pool of Gold Band Snapper are found in the Van Diemen Rise. Olive Ridley turtles and sea snakes, including the Olive Sea snake and Turtle headed Sea snake, occur in the area. Sharks are also found, although not as frequently as they once were, with the reason for this decline unknown.

Shelf break and slope of the Arafura Shelf²⁴³

National and/or regional importance

The shelf break and slope of the Arafura Shelf has ecological significance associated with productivity emanating from the slope and forms part of a unique biogeographic province. It is characterised by patch reefs and hard substrate pinnacles trending up along the continental slope, at a depth of about 120–180 metres. Outer and upper shelf slope sediments are largely associated with clay deposits from Indonesian rivers.

Values description

Ecosystem processes operating within this key ecological feature are largely unknown. Oceanographic processes, possibly associated with the ITF and surface winds from the northwest monsoon are likely to be strong influencers on pelagic dispersal of nutrients, species and biological productivity. Pelagic dispersal in turn drives long-term patterns of transport and dispersal of larvae, juvenile and migrating adult organisms across the region. Localised seasonal influences of the ITF are likely to occur between the northwest monsoon and southeast trade winds, although during the monsoon period (December to March) surface currents are weak and have no distinct direction.

The shelf break and slope of the Arafura Shelf is situated in a major biogeographic crossroad where biota is largely affiliated with the Timor–Indonesian–Malay Region. Primary production of phytoplankton is thought to form the basis for offshore food webs. Fish communities that occur in this key ecological feature represent the break between the Timor Province provincial bioregion and the Timor Transition provincial bioregion, with at least 284 demersal fish species found in the area including commercially fished species. The area is also likely to support whale sharks, sharks and marine turtles, although little data is available.

Tributary canyons of the Arafura Depression²⁴⁴

National and/or regional importance

The tributary canyons of the Arafura Depression are associated with productivity and species biodiversity. Almost all canyons found in the North Marine Region are located in this key ecological feature and endemic benthic species are believed to occur there, although little

²⁴³ Adapted from *Species Profile and Threats Database – Key Ecological Features – Shelf break and slope of the Arafura shelf*, published Cth Department of the Environment and Energy, available www.environment.gov.au

²⁴⁴ Adapted from *Species Profile and Threats Database – Key Ecological Features – Tributary canyons of the Arafura Depression*, published Cth Department of the Environment and Energy, available www.environment.gov.au

concrete data is available. The canyons are approximately 100 metres deep and 20 kilometres wide, with the largest extending 400 kilometres from Cape Wessel seaward, and are thought to be the remnants of prehistoric drowned river systems.

Values description

Because of the history and geography of the Arafura Sea, sea-floor sediments are calcium carbonate rich with substantial but varying fractions of carbonate sand and subfossil shell fragments, with scattered calcareous sand and gravel or sandy mud.

While the ITF has some effect, the strongest influence on water flows at the sea floor is thought to be tidal ranges that can exceed five metres vertically, with high seafloor currents, particularly across ridges on Pillar Bank and hard grounds. This leads to diverse populations of large sessile filter-feeding biota such as sponges, octocorals and comatulacean crinoids. Primary productivity is believed to be associated with movements of water through the canyons and surface water circulation driven by seasonal northwest monsoon winds. The steep topography of the canyons, their diverse current regimes, nutrient enrichment and entrapment, detritus funnelling and diverse substrate types form widely divergent ecosystems, which strongly influence biodiversity.

A survey conducted in the area has identified at least 245 macroscopic species, including a diverse variety of invertebrates (e.g. sponges, corals, sea anemones, tunicates, worms, crustaceans, brittle stars, feather stars) and small fish species. It is estimated that a further 500 species could be identified from post-survey analysis of grab and dredge samples marine turtles (most likely Olive Ridley Turtles) have been reported to feed near the canyons.

Gulf of Carpentaria Basin

National and/or regional importance

The Gulf of Carpentaria Basin is of important conservation value due to the aggregations of marine life and biodiversity found there, with high levels of endemism. It is believed to be one of the few remaining near-pristine marine environments in the world. Seafloor environment is characterised by gently sloping soft sediments and water varying in depth up to approximately 80 metres. Sediment types differ across the basin—muddy sands (50–80 per cent sand) dominate the eastern and southern portions in Northern Territory waters, trending to sandy muds further to the west in Queensland. Waters in the Gulf mix little with those of the Arafura and Coral Seas, instead forming a distinct semi-enclosed system with limited inputs from either oceanographic or terrestrial sources.

Values description

Primary productivity in the Gulf of Carpentaria Basin is driven mainly by nitrogen-fixing cyanobacteria but is also strongly influenced by seasonal processes. During the monsoon, Gulf waters become stratified, resulting in the development of high concentrations of chlorophyll at depths of approximately 40 metres. In the dry season (April–October), strong southeast trade winds mix Gulf waters and resuspend nutrients generated from benthic microbial processes high in the euphotic zone, resulting in high primary productivity throughout the water table. Higher-order species including cetaceans and large pelagic fish prey on pelagic species that benefit from this seasonal boost in productivity. Detritus washed into the Gulf by terrestrial rivers is also an important source of nutrients consumed by epifauna and invertebrate infauna. Snapper and other detritus-feeding fish consume the epifauna, in turn feeding higher-order predators.

The soft sediments of the Gulf of Carpentaria Basin are characterised by benthic invertebrates including echinoids (e.g. Heart Urchins and Sand Dollars), sponges, solitary corals, molluscs, decapods, bryozoans, sea cucumbers and sessile tunicates. These deposit-feeding epifauna in the soft sediments are more abundant than suspension-feeding epifauna. The Gulf of Carpentaria Basin also supports assemblages of pelagic fish species including planktivorous and schooling fish, and top predators such as shark, snapper, tuna and mackerel. The Gulf is also an important migratory route for seabirds, shore birds and marine turtles.

Gulf of Carpentaria coastal waters

National and/or regional importance

The Gulf of Carpentaria coastal zone, like the basin, is important due to high productivity, presence of large aggregations of marine life (including several endemic species) and comparatively high biodiversity. The Gulf of Carpentaria coastal zone stretches from west Cape York Peninsula to Limmen Bight in the southwest Gulf, spanning both Northern Territory and Queensland waters.

Values description

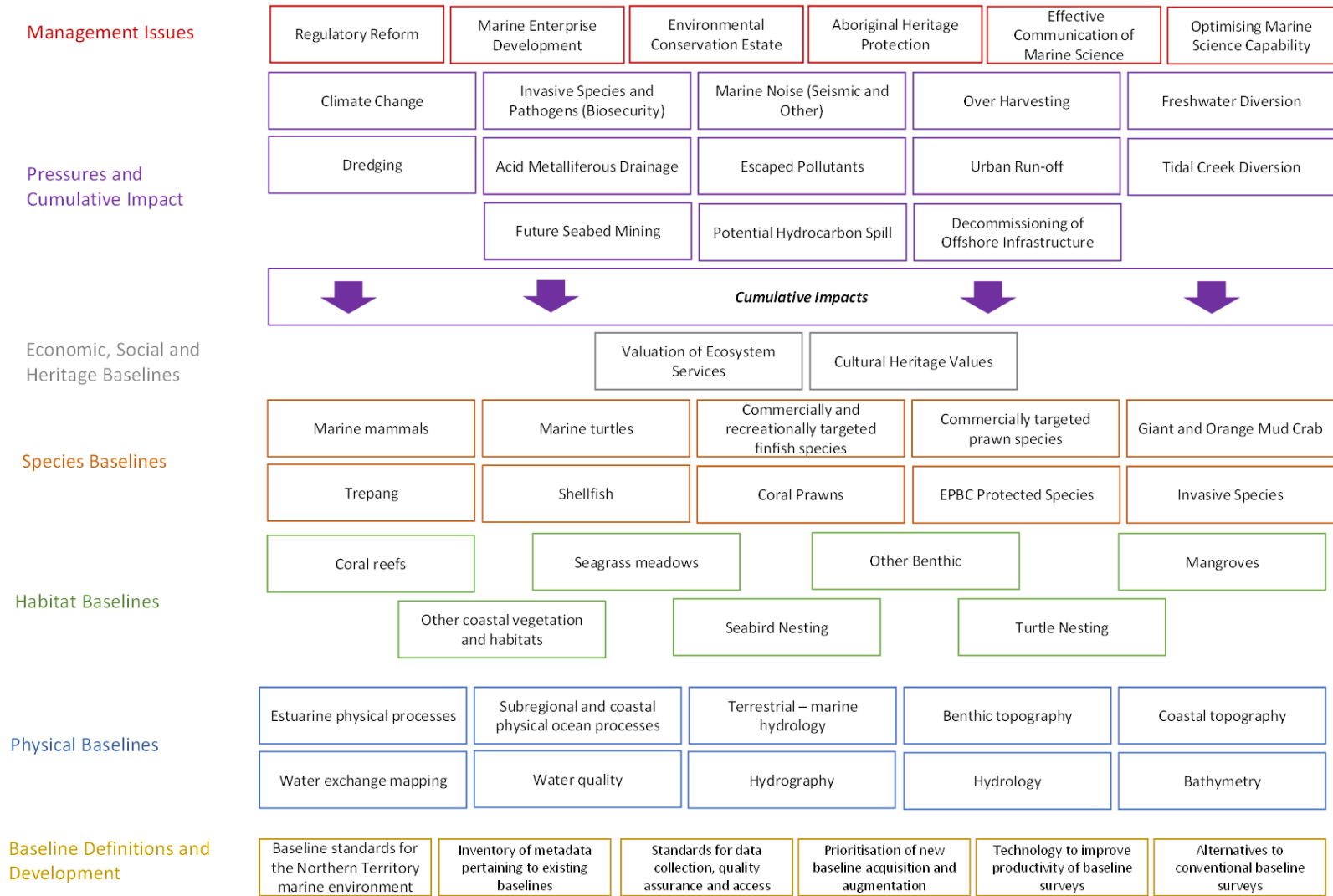
Nutrient inflow from rivers adjacent to the North Marine Region generates higher productivity and more diverse and abundant biota within the Gulf of Carpentaria coastal zone than elsewhere in the region. The coastal zone is near pristine and supports many protected species such as marine turtles, Dugongs and sawfish. Ecosystem processes and connectivity remain intact; river flows are mostly uninterrupted by artificial barriers, and healthy, diverse estuarine and coastal ecosystems support many species that move between shallow coastal and offshore waters.

Sediments in the feature are relatively fine muddy sands and sandy muds. Waters are well mixed throughout the year but are more heavily influenced by freshwater flows during the monsoon, which tends to trap nutrients within the coastal zone resulting in the high productivity and diverse marine life of the area. Inshore waters support mangroves, seagrasses and coral reefs, which help to drive primary production and diversity in contiguous offshore Commonwealth waters, providing source organic matter found in Commonwealth waters that is transported through migration of fish and crustaceans.

Species found in this key ecological feature include marine turtles (Olive Ridley, Green, Hawksbill and Loggerhead), 16 species of sea snake, colonial and solitary seabirds (e.g. terns, frigatebirds, White Bellied Sea Eagles, osprey, Brown Boobies), Dugongs and aggregations of fish and sharks. Small whales (False Pilot Whales) and bottlenose dolphins are numerous, and sawfishes (Freshwater and Green), syngnathids, rare rays and other elasmobranchs are also present.

Appendix 8: Main Identified End User Marine Science Knowledge Needs and Common Interests

Main Identified End User Marine Science Knowledge Needs



Common Interests in Baseline Definition and Development

	Aboriginal Interests	Regulators	Australian Defence Force	Darwin Port	Commercial Fishing	Pearling, Aquaculture & Crocodiles	Offshore Petroleum	Minerals	Irrigated Agriculture & Forestry	Coastal Communities & Urban Development	Recreational Fishing
Baseline standards for the Northern Territory marine environment											
Inventory of metadata pertaining to existing baselines											
Standards for data collection, quality assurance and access											
Prioritisation of new baseline acquisition and augmentation											
Technology to improve productivity of baseline surveys											
Alternatives to conventional baseline surveys											

Common Interests in Physical Marine Baselines

	Aboriginal Interests	Regulators	Australian Defence Force	Darwin Port	Commercial Fishing	Pearling, Aquaculture & Crocodiles	Offshore Petroleum	Minerals	Irrigated Agriculture & Forestry	Coastal Communities & Urban Development	Recreational Fishing
Estuarine physical processes	Blue	Blue	White	White	Blue	Blue	Blue	Blue	Blue	Blue	Blue
Subregional and coastal physical ocean processes	Blue	Blue	Dark Blue	Blue	White	White	Blue	White	Blue	Blue	White
Terrestrial – marine hydrology	Blue	Blue	White	White	Blue	White	Blue	White	Blue	Blue	Blue
Water exchange mapping	White	Blue	White	Blue	White	White	Blue	Blue	White	White	White
Benthic topography	Blue	Blue	Blue	White	White	White	Blue	White	White	Blue	White
Coastal topography	White	Blue	Blue	White	White	White	Blue	White	White	Blue	White
Hydrography	White	Blue	Blue	White	White	White	Blue	White	White	Blue	White
Water quality	Blue	Blue	White	Blue	White	White	Blue	Blue	White	Blue	White
Hydrology	White	Blue	Dark Blue	White	White	White	Blue	White	White	White	White
Bathymetry	White	Blue	Dark Blue	White	White	White	Blue	White	White	White	White

Common Interests in Marine Habitat Baselines

	Aboriginal Interests	Regulators	Australian Defence Force	Darwin Port	Commercial Fishing	Pearling, Aquaculture & Crocodiles	Offshore Petroleum	Minerals	Irrigated Agriculture & Forestry	Coastal Communities & Urban Development	Recreational Fishing
Coral reefs	Green	Green			Green		Green	Green			
Seagrass meadows	Green	Green			Green		Green	Green			
Benthic	Green	Green			Green		Green	Green			
Mangroves	Green	Green			Green		Green	Green			
Other coastal vegetation and habitats	Green	Green			Green		Green	Green			
Seabird Nesting	Green	Green			Green		Green	Green			
Turtle Nesting	Green	Green			Green		Green	Green			

Common Interests in Species Baselines

	Aboriginal Interests	Regulators	Australian Defence Force	Darwin Port	Commercial Fishing	Pearling, Aquaculture & Crocodiles	Offshore Petroleum	Minerals	Irrigated Agriculture & Forestry	Coastal Communities & Urban Development	Recreational Fishing
Marine mammals	■	■			■		■	■			
Marine turtles	■	■			■		■	■			
Commercially and recreationally targeted finfish species	■	■			■		■	■			■
Commercially targeted prawn species					■		■	■			
Giant and Orange Mud Crab	■	■			■						
Trepang		■			■						
Shellfish	■	■									
Seahorse	■	■									
Coral Prawns							■				
Invasive Species		■		■	■	■	■	■			■

Common Interests in Economic, Social and Heritage Baselines

	Aboriginal Interests	Regulators	Australian Defence Force	Darwin Port	Commercial Fishing	Pearling, Aquaculture & Crocodiles	Offshore Petroleum	Minerals	Irrigated Agriculture & Forestry	Coastal Communities & Urban Development	Recreational Fishing
Valuation of Ecosystem Services											
Cultural Heritage Values											

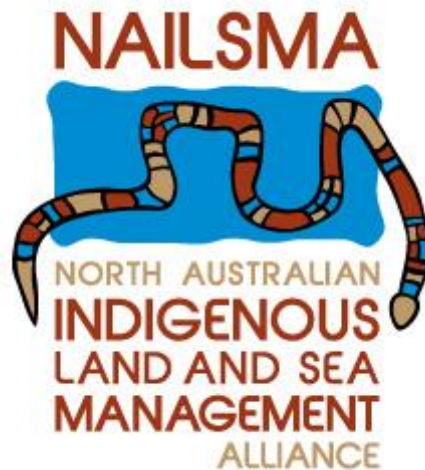
Common Interests in Cumulative Pressures

	Aboriginal Interests	Regulators	Australian Defence Force	Darwin Port	Commercial Fishing	Pearling, Aquaculture & Crocodiles	Offshore Petroleum	Minerals	Irrigated Agriculture & Forestry	Coastal Communities & Urban Development	Recreational Fishing
Climate Change											
Invasive Species and Pathogens (Biosecurity)											
Marine Noise (Seismic and Other)											
Over Harvesting											
Freshwater Diversion											
Dredging											
Acid Metalliferous Drainage											
Escaped Pollutants											
Urban Run-off											
Tidal Creek Diversion											
Future Seabed Mining											
Potential Hydrocarbon Spill											
Decommissioning of Offshore Infrastructure											

Common Interests in Management Issues

	Aboriginal Interests	Regulators	Australian Defence Force	Darwin Port	Commercial Fishing	Pearling, Aquaculture & Crocodiles	Offshore Petroleum	Minerals	Irrigated Agriculture & Forestry	Coastal Communities & Urban Development	Recreational Fishing
Regulatory Reform	Red	Red	White	Red	Red	Red	Red	Red	White	White	Red
Marine Enterprise Development	Red	Red	White	Red	Red	Red	White	White	White	Red	White
Environmental Conservation Estate	Red	Red	White	White	Red	White	Red	White	White	White	Red
Aboriginal Heritage Protection	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
Effective Communication of Marine Science	Red	Red	Red	Red	Red	White	Red	Red	Red	Red	Red
Optimising Marine Science Capability	Red	Red	Red	Red	Red	White	Red	White	White	White	White

Appendix 9: NAILSMA Indigenous Engagement Report



Northern Territory Marine and Coastal Science End User Knowledge Needs Assessment

Indigenous Engagement Report Part B - Consultation and Synthesis

Final Report by NAILSMA Ltd

December 2017

Executive Summary

The Australian Institute of Marine Science (**AIMS**) and Charles Darwin University (**CDU**) are co-sponsoring a survey of needs for better information for users of the Northern Territory's marine and coastal environments, titled 'Northern Territory Marine and Coastal Science End-user Knowledge Needs Analysis' (**NTMSEUNA**). The main report surveyed a number of sectors (e.g. mining, commercial and amateur fishers, pastoral, tourism and others) for their issues and research interests.

An important component of the study is to understand Indigenous peoples' needs, aspirations and concerns; and ways of securing appropriate engagement in marine research. This has been clearly identified by the research sponsors (Australia Institute of Marine Science and Charles Darwin University – AIMS and CDU) and others as critical for achieving more effective research outcomes in the future and particularly significant as Indigenous people have inalienable freehold title to around 85% of the NT coastline including the intertidal zone (to the mean low tide mark) and native title interests in other parts of the marine environment. The North Australian Indigenous Land and Sea Management Alliance Limited (**NAILSMA**) has undertaken this component of the study. The work reported here was informed by a desktop review of relevant literature relating to north Australian Indigenous interests in marine research (**Appendix 1 – Indigenous Engagement Report – Part A Desktop Review**) and, direct consultations with 'sea country' custodians with active management interests in marine environments in four broad areas generally associated with the communities: Maningrida (west Arnhem Land), Borroloola (Gulf of Carpentaria), Galiwin'ku (east Arnhem Land), and Darwin (**Appendix 2 – Consultations**). The desktop review identified key issues and interests from published management plans and strategies framed by various Indigenous groups involved in caring for sea country in the Northern Territory. Consistent with the resources available, a targeted approach to consultations was needed - specifically, to engage across a reasonably broad geography, focus on areas where known interests and concerns are shared by groups who have had recent experience and opportunity to reflect on them, to capture a diversity of historical and other circumstance (e.g. built up areas, areas with IPAs, different land tenure contexts, places with local research capability and initiatives, places effected by significant environmental impact).

Given a range of factors, such as the very limited engagement with Aboriginal land owners on this topic in the past and culturally discreet traditional owner estate interests, the project cannot offer comprehensive statements of priority. Themes emerging from the desktop review and initial discussions were confirmed during face to face consultations/workshops held with customary estate owners and managers in respective communities. This study highlights these as a snap-shot of interests, some indicative, some unique, and with important directives as to how research in this environment may be designed and carried out more effectively than in the past. This study is not intended as a base for a full, detailed and clearly prioritised research agenda across the Top End. However, the level of consistency in the information gathered can be used to inform an early stage research agenda and engagement process, including for example:

Biophysical/environmental interests

- Research to understand the impacts and threats (and opportunities) from damaging natural and anthropogenic sources such as climate change across all sectors.
- Independent information and monitoring of potential and actual impacts of mining (and related activities e.g. ports, roads) on ecosystems and human health. Examples raised include individual projects like McArthur River Mine, Redbank Copper Mine, Western Desert

Resources Mine, Inpex LNG project; and types of resource extraction activities including fracking and seabed mining.

- Research on the sustainability of commercial harvests of managed species (including consideration of causes for any decline in fish populations).
- Population studies to examine the potential for Indigenous participation in wild harvest/aquaculture of commercial species such as pearl, trepang (beche-de-mer), and also species such as trochus and oysters for which there is no or limited commercial harvest.
- Baseline information and monitoring systems for key species and marine habitats.
- Managing invasive species and improving biosecurity.
- Information on impacts (and opportunities) arising from tourism.
- Research on the impacts of offshore seismic surveys on marine species and environments.
- Information to guide management of marine pollutants (including marine debris/rubbish; their point of origin and how to influence them, recycling, transport and disposal options; opportunities for large scale collaborations/experience sharing amongst ranger groups).²⁴⁵

Beyond the biophysical

Because Indigenous people see themselves and their land / sea as inseparable their research interests extend beyond biophysical marine science narrowly defined, to include social science, citizen science and (arguably scientifically equivalent) Indigenous Ecological Knowledge. The practical research lens includes legal, policy, social, economic and IEK issues;

- Research contributing to understanding and asserting legal rights and interests and influences on policy in relation to sea country/resource management, access, allocation and use, including increasing Aboriginal engagement in fisheries management through appropriate governance frameworks and capacity building.
- Approaches to devolution of enforcement powers to locals/rangers to respond to commercial and amateur fisher issues, including development of management models and support systems.
- Responses to sea country management (e.g. access and use agreements) that balance local management aspirations and capabilities with the need for regional consistency to reduce confusion and complexity regarding fisher and other access.
- Research to understand the need for and potential impacts of introducing recreational fishing licencing and boat registration and their interaction with management and compliance regimes.
- Improving documentation, management and protection of sacred sites and other places of value in the sea and coast.
- Improving understanding of options under relevant laws and regulations to make greater use of geographically differentiated management zoning (e.g. take/no take areas).
- Socio-economically oriented research needs including pathways to realising economic/enterprise development opportunities, encompassing development planning, governance (including options for Aboriginal cooperatives) and capability building.
- Small-scale and low-impact enterprise development opportunities including land and sea management/provision of environmental services, Aboriginal participation in commercial fisheries and aquaculture, wild-harvest, and tourism.

²⁴⁵ North Australian Indigenous Land and Sea Management Alliance Limited (2017) Remote recycling, rubbish and marine debris management in north Australia needs strong helping hands: Summary of Cape York Peninsular community case studies. Report by Regional Advisory & Innovation Network (RAIN) Pty Ltd, Mena Creek.

- Improving governance structures, policy redesign and mechanisms for promoting access to opportunity (e.g. government procurement).
- Research to help reinvigorate and enhance recognition and application of Traditional Knowledge systems around marine and coastal environments.

Engagement in research

- Employing and supporting Aboriginal community-based researchers.
- Ensuring local needs influence research programs, projects and methods.
- Establishing better engagement processes and protocols for how research is designed and carried out.
- Recognition of local context, values and Indigenous perspectives when conducting research and development activities e.g. human health, customary obligations, livelihoods.
- Respectful, strong and equitable partnerships underpin successful research projects – engagement principles and processes / protocols (incorporating free, prior and informed consent; intellectual property; compensation; appropriate use of Indigenous knowledge; data collection and storage; and governance).
- Relevant and accessible information and educational resources for rangers, Traditional Owners, and the broader community (including schools).

Nature of apparent knowledge gaps

Apparent knowledge gaps sometimes relate to information about issues of interest not being available at a fine enough (or local) scale to be useful to Indigenous communities. In other cases, they arise as a result of knowledge derived from research being poorly communicated. Often, research outcomes are not accessible. For example, peer reviewed journal articles are largely inaccessible outside academic or institutional networks and invariably in language forms that are not useful locally. Respondents in this project identified a significant gap in non-Indigenous researchers and agencies understanding them, their co-dependent relationship with 'country' and even the practical import of their legal status under ALRA, Native Title and other instruments.

Conclusions

A key conclusion from this work is that needs and interests include, but encompass much more than the availability or quality of biophysical information relevant to the use, management and conservation of marine environments. Pressing needs include better understanding of opportunities and constraints on Aboriginal participation in use and management, and roles in shaping the wider social and economic life of the Territory, drawing on rights and obligations to sea country and its resources.

The depth and breadth of Aboriginal legal and cultural interests, including ownership of most of the coast require effective engagement with Aboriginal landowners and their communities. Improved engagement by government, industry, universities and relevant NGOs is essential on all fronts, including marine research. Well-designed research on any of the topics identified here, conducted to sound protocols for full Aboriginal participation, offers one useful pathway for fostering the necessary improvements in engagement contributing to a more comprehensive understanding of research priorities.

This report provides an overview of some presently recognised Indigenous (research) needs for sea country in the Northern Territory, together with engagement principles for building stronger relationships between research institutions and Aboriginal land and sea owners and managers. These relationships could inform more comprehensive and nuanced understanding of Aboriginal

interests, leading to more effective research project prioritisation, design, operation and use in future.

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Introduction

Background and purpose

The AIMS and CDU co-sponsored Northern Territory Marine and Coastal Science End-user Knowledge Needs Analysis (**NTMSE UNA**) aims to understand the marine science knowledge required to support policy, regulatory, strategic and operational decisions made by government, industry and communities with respect to their interaction with the Northern Territory marine and coastal environment. Among other things, a key objective of the NTMSE UNA project is to identify knowledge needs that are common to multiple stakeholders and consider priorities for research investment in the Territory marine environment.

Another important objective of the study is to understand Indigenous peoples' needs, aspirations and concerns; and ways of securing appropriate engagement in marine research. The North Australian Indigenous Land and Sea Management Ltd (**NAILSMA**) has undertaken this part of the study. However, given the limited engagement with Aboriginal people that has occurred to date and the scope of this study, it is not possible to arrive at a comprehensive set of research needs; or of clearly articulated "sectoral" overlaps in needs that might be useful in assigning priorities. Instead, a longer-term properly supported engagement strategy is needed to get a valid sense of Indigenous priorities on a place-by-place basis, as culturally prescribed, rather than by generalisation from limited samples.

Accordingly, this report provides an overview of some presently recognised Indigenous (research) needs for sea country in the Northern Territory, together with engagement principles for building stronger relationships between research institutions and Aboriginal land and sea owners and managers. These relationships could inform a more comprehensive and nuanced understanding of Aboriginal interests, leading to more effective research project prioritisation, design, operation and application in future.

Legal and customary rights and interests

Aboriginal people hold inalienable freehold title over most of the Northern Territory coast and have rights to control access to that coast, to significant closed seas in the Arnhem region and are important end users of marine resources under native title (Brennan 2008). Further, although not properly recognised, Aboriginal peoples' traditional economies and customary rights to lands and waters extend well beyond the low water mark – commonly beyond the horizon. It follows that they seek, and will increasingly assert a central role in decisions about use and management of the Territory's near-coastal marine environment.

Finding better ways to foster Aboriginal interests in and benefits from the marine systems, while respecting existing interests and promoting socio-economic development are critical issues for the Northern Territory and Australia.

Indigenous interests in marine science research

Under the Aboriginal Land Rights (NT) Act 1976 (ALRA) developers, governments and other parties wishing to undertake activities (including researchers) or build infrastructure, require an agreement with the Land Trust. Prescriptions under ALRA (as with other relevant instruments) demand processes for Traditional Owner consultation and informed consent, for land and sea country owners and (ceremonial) managers - to understand the nature and purpose of proposed activities, the effects the activities will have on their lands and seas, and methods proposed to minimise adverse impacts and promote benefits. Without relevant and accessible information on benefits and risks, especially potential impacts on country, Traditional Owners cannot make fully informed

decisions or give free, prior and informed consent to proposed projects. Facilitating engagement and informed decision-making is a necessary precursor to governments' push for accelerated northern development, as set out in statements like the 2015 White Paper on Developing Northern Australia. In addition, relevant and accessible research would be useful to inform Indigenous-led local area planning processes, such as with Indigenous Protected Areas and multiple use planning.

It is therefore essential that Traditional Owners have opportunity to influence the direction of research and the manner in which results are presented, as key end-users of science. Like all other land owners, Traditional Owners seek access to the best information available to foster and take up rewarding livelihoods and inform care for country. Better and more accessible information will facilitate sound and timely decision-making.

While Indigenous and non-Indigenous people share interests in, and needs for, high quality marine science information, the premise underlying these interests and needs may be different. This means the basis of all collaboration must be an awareness of different systems of knowledge and avoiding simplistic assumptions about shared understandings that may exist between groups. All collaboration must be grounded in a mutual respect for the different knowledge systems and values that coexist in this context.

Engagement with Aboriginal people

Aboriginal people have a clear interest in research relating to their land and seas. Present systems for gathering, interpreting, reporting and applying science to management of sea country have generally been built around the interests and needs of government and industries. As a consequence, many research providers have little practical awareness of Indigenous rights, interests or research priorities.

Past and present weaknesses in engagement practice and performance compromise capacity and confidence to articulate Aboriginal interests clearly. Better engagement by government, industry, other NGOs and researchers with Aboriginal people must precede and inform attempts to prioritise Indigenous research and development needs.

Fortunately, well-designed and properly conducted marine research can itself offer a useful vehicle for helping to drive improvements in engagement. Best practice collaborative research around shared goals for improved livelihoods and better land, sea and resource management will, by definition, be built on close, respectful interactions with high levels of Indigenous participation. These interactions help build the familiarity and confidence to underpin cross-cultural understanding and fruitful collaboration.

Research in cross-cultural environments requires that underlying partnerships and processes to be treated as critically important to quality outcomes. Broader issues of communication, access, consent, intellectual property, scale and context, compensation, appropriate use of Indigenous knowledge and governance need to be considered in exploring what is best practice collaborative research.

In this report, we present views from Indigenous respondents that inform inclusive participatory research strategies and espouse the value gained in achieving strategic goals, a shared understanding of Aboriginal research interests and practical means for achieving mutual benefit.

Scope and Limitations

The study consisted of a desktop review of Indigenous sea country plans and other relevant published materials (**Appendix 1 – Indigenous Engagement Report Part A - Desktop Review**), together with targeted consultations in several coastal communities (**Appendix 2 – Consultations**). This report presents the findings of the consultations, building on the desktop review.

Given the potential breadth and depth of issues, achieving more representative engagement would require a comprehensive set of consultations involving many dozens of coastal groups, relating to discrete customary estates. However, with limited resources, a more targeted approach was taken consisting of engagement in four areas proximal to the communities: Maningrida (west Arnhem Land), Borroloola (Gulf of Carpentaria), Galiwin'ku/Elcho Island (east Arnhem Land), and Darwin. These focal areas are only a sample of the larger Indigenous interests across the Northern Territory coastline and even within the local communities from which responses were drawn, cannot represent the breadth or diversity of interests within those complex mixed towns.

Another important limitation arising from the scope of the consultations (as with the report on sector interests) is that, although some key overarching themes and interests were identified and explored, it was not possible to prioritise or assign relative rankings to those interests.

Methodology

Desktop review

The key issues and interests in the desktop review were identified primarily from published management plans and strategies framed by various Indigenous groups involved in caring for sea country in the Northern Territory, together with Indigenous- led economic development plans (**Annexure 1 – Indigenous Engagement Report Part A - Desktop Review**).

Further information was gathered directly from Traditional Owners in the consultation phase of the project, to compare issues and interests with those documented in plans etc and to widen the net to capture other and possibly more diverse issues that may translate into research interests. (**Annexure 2 – Consultations**).

Initial consultations

Telephone and face to face discussions were conducted with Traditional Owners/Custodians, rangers and coordinators, Indigenous researchers, and other people with relevant experience to help identify issues and interest in further participation. These preliminary consultations included discussions with Indigenous land and sea managers/Traditional Owners from both the Kimberley and Torres Strait to obtain broader perspectives and to compare experiences in neighbouring jurisdictions with sea country research and management issues, initiatives and priorities in the NT.

Indigenous working group

An Indigenous reference group comprised of four (4) Indigenous land and sea managers from different regions across northern Australia was initiated to provide advice and feedback to the researchers. In particular, members reviewed and commented on materials prepared by the project team (e.g. draft reports, communications products) and, in the case of NT members, acted as a conduit for communicating with community.

Selection of focal areas / communities

Locations for targeted consultations were selected using several criteria:

1. known interest in the general topic area;
2. capturing a diversity of experiences and contexts;
3. presence of operating ranger groups, and some familiarity with NAILSMA;
4. active projects through which consultations could be undertaken more efficiently; and,
5. logistical considerations.

In addition, the characteristics of each area were taken into consideration (see below) to ensure the project covered different environments, economic and legal contexts.

1. **Maningrida (west Arnhem Land)** – existence of an Indigenous Protected Area (IPA), Healthy Country Plan, ranger group, experience with small aquaculture ventures, exposure to illegal fishing, indiscriminate fisheries bycatch discard, conflict between fishing tours and commercial fishers, sacred sites issues, potential mining, historical engagement with fishing industry, connections to Croker Island (native title claim) and Goulburn Island.
2. **Borroloola (Gulf of Carpentaria)** including sea country estates held by Yanyuwa and Garawa groups – existence of an IPA, sea country management plan, ranger groups, agreement with NTG on open intertidal access, mangrove die back, McArthur River Mine impacts, high fishing activity, tourism impacts, native title issues and significant determination, Bing Bong wharf development, concern with stretch of unmanaged/researched coast (Garawa people) and keenness to engage.
3. **Galiwin'ku/Elcho Island (east Arnhem Land)** – experience in crabbing and tourism opportunities; history with 'mission era' fishing industry; Island environment with significant amateur and commercial fisher activity; strong sea country culture; sea country closures; keenness to rebuild sea country knowledge; recent 'two way' collaborative science project on shellfish.
4. **Darwin (Cox Peninsular to Gunn Point including Bynoe Harbour and Port Darwin)** – primary area of development in the study area; intensive industrial, urban and port development; mining and spills issues; clearing of mangroves; Traditional Owners heavily impacted by city and other development; some engagement with harbour research; keenness to use research to strengthen culture and improve recognition of Traditional Owner; many potential enterprise and contract opportunities; many active sectors and research needs.

Consultations/participatory workshops with focal communities

Themes emerging from the desktop review and initial consultations were confirmed during face to face consultations/workshops held with individuals and small groups in focal communities. Specific local issues and interests were identified, and local engagement principles /processes were explored. The small group consultations were co-facilitated by a NAILSMA project staff member/consultant working alongside a local Indigenous person from each of the respective communities engaged.

A number of consultations had to be postponed or cancelled due to sorry business. Other constraints on consultations included consultation fatigue from other projects/issues, transport difficulties, and participant availability due to conflicts with employment responsibilities and other commitments. It was additionally difficult to get enthusiastic participation from many because benefits to them or their community from this project were not obvious. The project team was unable to say what the ultimate purpose, outcomes or sponsors planned next steps would be, that

may benefit and therefore encourage participation from TOs. This protracted the initial engagement stage.

The consultations ranged from semi-structured interviews to open-ended and informal discussions depending on the context. As we sought to avoid leading the direction of interviews when the project goals had been explained, we were sometimes required to infer research questions rather than cite verbatim questions articulated directly by informants. We did this only where the frequency of responses on such issues and related discussions permitted reasonably robust inference.

Further details of the consultations are included in Annexure 2.

Collation and analysis of results of consultations

Synthesised results of the consultations are set out in the table in the 'Results' section. Themes and research questions emerging from the consultations are set out and elaborated upon in the 'Discussion' section.

Results

A summary of the results of the consultations and workshops is set out in Table 1. The particular interest/concern to which the issue relates is identified as either biophysical, cultural, social, or economic/enterprise development depending on the particular disciplinary focus of the issue identified. The table also identifies wider connections and context for the interest or concern such as, for example, human health, customary obligations, or livelihoods to illustrate the relevance of the issue to the informants.

Table 1. Consultation Results

Value of interest/concern	Pressure/issue	known or potential impact	Research question(s)	wider connections and context	location
Biophysical values					
Coral reefs	Changing water temperatures	Climate change	Extent and impact of change	Customary economy Livelihoods	Maningrida Darwin
Marine carbon dynamics	Mangrove dieback Seagrass decline	Climate change Sedimentation Boat damage Other pollution	Extent and severity of change Causes of change Change in carbon stocks – PES opportunities	Ecosystem health Customary economy Livelihoods	Darwin Borrooloola
Coastal environs	Mangrove and Paperbark/melaleuca dieback Coastal erosion & inundation	Sea level rise	Extent and severity of change Saltwater intrusion, cause of change	Landscape health Future utility of land	Borrooloola Darwin
Sea bird nesting	Increased access to islands leading to overharvest	Reduced numbers/diversity. Breakdown of local protocols for access to resource	Extent and sustainability of harvest. Efficacy of hybrid forms of control - customary and scientific.	Customary economy Obligations to country	Maningrida
Dugong and other marine mammal populations	Port development and operations Commercial fishing Increased and unregulated boat traffic Defence operations / acoustic devices	Dredging Boat strike Pollution/ghost nets Bycatch	Extent and significance of change	Ecosystem health Obligations to country	Darwin Ngukurr
Marine turtle populations	Commercial fishing Increased and unregulated boat traffic	Boat strike Bycatch Pollution/ghost nets	Incidence of mortalities	Customary economy Obligations to country	south-western Gulf of Carpentaria
Benthic topography	Interactions with development	Sea level change	Mapping present features as baseline	Cultural heritage	Darwin

Value of interest/concern	Pressure/issue	known or potential impact	Research question(s)	wider connections and context	location
				Understanding impacts of change	
Shellfish status	Toxicology Mud muscle population decline	Pollution Feral pig predation Loss of diversity	Current status and significance of change	Customary economy Human health Obligations to country Food sources	Darwin
Beach stone curlew status	Apparent decline	Disturbance	Current status, significance of decline and potential influences	Obligations to country	Darwin
Hermit crab status	Potential impacts of shell collection	Reduced availability of shells	Extent of shell collection and impacts	Obligations to country	Darwin
Atlas Moth	Decline in distribution and abundance	Loss of habitat	Continuation of revegetation work at Tree Point	Obligations to country Livelihoods	Darwin
Water quality	River borne mining Pollutants and sediments affecting estuarine systems	Decline in habitat quality Contamination of wildlife	Risks of chronic and catastrophic pollution Options for reducing risks Monitoring and reporting systems	Human health Customary economy Ecosystem health	Borrooloola Darwin
	Concentrate and other pollutant spills and dust at port loading facilities				
	Agricultural sedimentation and pollution				
	Urban development				
	Dust problems associated with road transport of ores and concentrates	Decline in habitat quality Contamination of wildlife	Risks of chronic and catastrophic pollution Options for reducing risks	Human health Customary economy Ecosystem health	Borrooloola
Shale oil and gas extraction	Contamination of groundwater	Design of monitoring and reporting systems Risks of chronic and more acute effects Effects on continued access for customary purposes	Obligations to country Customary economy Livelihoods (constraints on other land uses)	Borrooloola	

Value of interest/concern	Pressure/issue	known or potential impact	Research question(s)	wider connections and context	location
Gross physical disturbance of landscapes	Shale oil and gas extraction, Sea-bed mining, terrestrial mineral extraction	Loss of access to country Breaking connections in cultural landscapes (e.g. interruption of songlines) Landscape instability	Options for reducing risk design of monitoring and reporting systems Risks of chronic and more acute effects Effects on continued access for customary purposes	Human health Obligations to country Customary economy	Borrooloola
Fish populations	Extent and methods of Commercial harvest Tourist numbers	Overharvest Bycatch discards	Quality of allocation and other management prescriptions Options for improved regulatory systems and performance	Customary economy Livelihoods Ecosystem health	Maningrida Borrooloola Darwin
Crab populations	Extent and methods of harvest Change in relative abundance of giant and non-local orange mud crabs	Overharvest Failure to observe size and other restrictions Competition from new species	Quality of management and enforcement Options for improved regulatory systems and performance Understanding source, transport, impact and response	Customary economy Livelihoods	Borrooloola Darwin
Coastal land condition	Feral animals Weeds	Effects on habitat condition, carbon storage and wildlife (e.g. crocodile eggs)	Quantification of impacts of feral animals and weeds on natural and cultural values	Customary economy Livelihoods Incompatibility of some enterprises	Maningrida
Various relating to ecosystem health	Ballast water	Introduction of exotic organisms	Risks under current regulatory and enforcement provisions	Adding to other risks of increased port traffic	Darwin
Harbour management	Marine reserves in ecosystem health	Ongoing loss of ecosystem services - few areas protected from development	Role of marine reserves in maintaining ecological and cultural values	Customary economy livelihoods Aboriginal roles in decision-making	Darwin
<u>Cultural values</u>					
Commercial and recreational fisher access to	Damage and other violation of sacred sites	Gross offence loss of trust and confidence in	Exploration of options for redesign of laws and approaches	Cultural obligations to lands and seas Customary economy	Galiwin'ku Borrooloola Darwin

Value of interest/concern	Pressure/issue	known or potential impact	Research question(s)	wider connections and context	location
Aboriginal lands and seas	<p>Unauthorised (illegal) intrusions into lands and seas</p> <p>Other illegal activity (e.g. taking wildlife)</p> <p>Discarded fishing gear (marine debris)</p> <p>Conflict between commercial and amateur fishers</p> <p>Management of tourist numbers</p> <p>Opportunity for enterprise.</p>	<p>management authorities and in fishers</p> <p>Unwillingness to grant further access</p>	<p>to enforcement of access prescriptions.</p> <p>Education of users</p> <p>Opportunities for enterprise development.</p>	Livelihoods	
Other access to Aboriginal lands and seas	<p>Entry without customary Permission (e.g. for public infrastructure)</p> <p>Choice of inappropriate sites</p>	<p>Gross offence</p> <p>Loss of trust and confidence in management authorities and in fishers</p> <p>Unwillingness to grant further access</p>	<p>Exploration of options for redesign of laws and approaches to enforcement of access prescriptions.</p> <p>Education of users</p>	<p>Cultural obligations to lands and seas</p> <p>Customary economy</p>	Maningrida
Cultural heritage	<p>Lack of recognition and Respect for values important to Aboriginal people, contributing to weak enforcement of rights</p>	<p>Damage to sacred and other heritage sites</p>	<p>Approaches to devolution of enforcement powers to locals</p> <p>Approaches to better protection for archaeological sites</p>	<p>Roles of sea rangers</p> <p>Formal roles of traditional owners</p>	<p>Maningrida</p> <p>Darwin</p> <p>Borroloola</p>
Traditional knowledge	<p>Lack of recognition and Application to management issues</p>	<p>Comprised management outcomes</p> <p>Rejection of management</p>	<p>Optimising systems for joint application of IEK and formal science.</p>	<p>Roles of rangers</p> <p>Design of decision-making forums</p>	Maningrida

Value of interest/concern	Pressure/issue	known or potential impact	Research question(s)	wider connections and context	location
		prescriptions that exclude IEK	Opportunities to enhance IEK and its transmission – including strategic collaborations		
<u>Social issues</u>					
Observance of Aboriginal rights	Weak public and agency Understanding of rights	Conflict Legal challenges to public and private actions	Clarification of existing and emerging rights	Agreements with government and industry	Darwin
Progressive alienation from country	Urbanisation	Erosion of rights and opportunities	Options for assertion of influence over use of country		Darwin
Customary access to country	Urbanisation	Foreshore closures Pollution of creeks	Legal issues in native title and exclusions and chronic losses of customary use	Customary economy Native title rights and obligations	Darwin
Aboriginal influence over fisheries management	Insufficient awareness of respect for Aboriginal views and interests Competition of licence holders with local initiatives Poor, politically-oriented allocation decisions	Gross offence Loss of trust and confidence in management authorities and in fishers Unwillingness to grant further access	New systems for fisheries governance, providing for increased Aboriginal participation in decision-making Redesign of management bodies Law reform	Obligations to country and culture Customary economy Livelihoods	Borroloola Darwin
<u>Enterprise development</u>					
Aboriginal participation in commercial wild-catch fisheries	Limited opportunity Past failures Limited capacity, government and industry targeted support	Exclusion from serious consideration in allocation decisions	Improved models for Aboriginal engagement Business structures for small scale geographically bounded enterprises Options for Aboriginal cooperatives	Conflict with customary economy Compatibility with cultural obligations Access to capital	Galiwin'ku

Value of interest/concern	Pressure/issue	known or potential impact	Research question(s)	wider connections and context	location
Aboriginal participation in aquaculture	Inadequate infrastructure in remote sites Skills base not well-matched to intensive aquaculture	Number of failed ventures	Models for “low intensity”, “low tech” methods dependent on management of natural systems	Customary economy Constraints on customary access	Maningrida
Survey and monitoring	Few options to apply skills and values to pre- and post-development issues	Reduced employment and enterprise Inadequate pathways to other employment	Improving governance structures policy redesign and delivery mechanisms (e.g. government procurement)	Human health and well being Social cohesion	Darwin
Crocodile overabundance and public safety	Intrusion into human population centres	Migration from areas of high crocodile density	Options and management systems for transfer of responsibility to Aboriginal interests	Human health Livelihoods	Darwin
Role of research in socio-economic development	Limited pathways. Little recognition of local Aboriginal research capability and benefits	Unemployment reduced well-being	Optimal approaches for building on benefits of engagement in research to expand range of opportunities	Social cohesion Human health	Maningrida

Discussion

An initial synthesis of the results of consultations is set out below to identify themes and knowledge gaps. These were categorised into four groups: biophysical values, cultural values, social values, and economic development. The consultations also considered appropriate engagement principles when approaching research, and these are discussed at the conclusion of this section.

Biophysical values

A key research interest was to understand and manage impacts and threats to country (and realise opportunities) from damaging natural and human induced causes. Threats identified related, among other things, to the impacts of climate change and proposed, actual or future (externally driven) pressures from mining, fisheries, tourism and urban/coastal development.

Key species and ecological communities

Some key species and marine and coastal environments were identified during consultations including, among others:

- Marine turtle and dugong: Impacts of fishing nets/ghost nets and boat strike, and sustainability of harvest (Borrooloola)
- Seabirds and shorebirds: monitoring nests; sustainability of egg harvest (Maningrida)
- Shellfish toxicology due to water quality issues (Darwin)
- Coral reefs: climate change impacts (Maningrida)
- *Melaleuca*/paperbark and mangrove dieback: extent and cause; changes in carbon stock (Borrooloola)
- Seagrass decline: damage from boats; sedimentation (Borrooloola and Darwin).

Issues affecting a number of other species were identified during consultations (e.g. Atlas Moth, Hermit Crabs, seahorse, Eastern Curlew). These species were identified as being of interest largely due to current or previous externally driven research collaborations, rather than because of any particular cultural, social or economic significance attached to the species. As such, it would not be appropriate to assign priority to these species over others. This reflects the difficulty of prioritising interests given the great variation in exposure of communities to research issues and options, based as it is on idiosyncratic interactions with external agendas rather than comprehensive planning to meet local needs.

But whatever the taxonomic focus, an overarching need for quality baseline ecological/environmental data and establishment of monitoring systems was identified. There are biosecurity concerns associated with bilge/ballast water in Darwin, where for example, it is believed to be responsible for introducing the non-local 'orange crab' (*Scylla serrate*) species giving rise to concerns that they are potentially competing with local crabs (*S. olivacea*). Other issues requiring ongoing monitoring included: exotic plants and animals (e.g. feral buffalo damaging crocodile nests around Maningrida; pigs damaging coastal habitats around Darwin and Borrooloola; Caltrop weed invading coastal habitats around Borrooloola; marine pollution including ghost nets and other discarded fishing gear around Maningrida and Borrooloola and additionally oil spills around Darwin Harbour). Some of these issues can be linked to a number of 'sectors' including but not limited to tourism, urban/port development, mining, and fisheries. [Importantly, other major issues known about but not recorded in this project demand attention, for example *Mimosa pigra* weed infestations effecting the Moil River near Wadeye].

Mining impacts

The consultations highlighted the need for independent information and monitoring of potential and actual impacts of mining (and related activities e.g. ports/roads) on ecosystems and human health. Examples raised include individual projects like McArthur River Mine, Redbank Copper Mine and Western Desert Resources Mine (Borrooloola region), Inpex and Conoco Phillips LNG projects (Darwin); and types of possible resource extraction activities including fracking and seabed mining (Borrooloola).

In Borrooloola, pollution in the McArthur River was an issue of major concern. Strong concerns were expressed about the possibility that fish and shellfish in and near the MacArthur River system may have elevated lead levels. Monitoring of lead levels in riverine fishes is being undertaken, but the process is not understood or trusted by many. In particular, the involvement of Government and the mine operators in the monitoring process is viewed with deep scepticism.

In order to restore confidence, respondents called for a transparent and independent monitoring program, preferably with Aboriginal involvement. Respondents called for monitoring to include all species used by Aboriginal people, including game animals such as kangaroos that may drink water from the McArthur River. Garawa people also like to eat dugong and turtle, but are worried about the downstream effects of pollution from the mine on these estuarine/marine species. They see large amounts of silt from the McArthur River being deposited on seagrass beds each wet season, and wonder what pollutants are carried with it. Some respondents also called for monitoring for potential runoff and leaching impacts from the (currently non-operational) Redbank Copper Mine.

Concern was expressed about high levels of cadmium in oysters in areas near the Bing Bong Port (from where ore from the McArthur River Mine is shipped). Respondents reported that people could no longer eat these oysters. Western Desert Resources is believed to be considering reopening its iron ore mine, with its shipping activities to be moved to Bing Bong Port, or to proposed facilities near the mouth of the Roper River. Opposition was expressed to the development of the new haul road and concern over the prospect of transport from the Roper mouth.

Fracking is a matter of deep concern, in particular the potential impacts on groundwater.

A further comment stressed that outsiders really do not understand the importance of land to Aboriginal people. Damage to land through inappropriate disturbance is felt to have a real physical impact on the health (indeed, life) of traditional owners.

Fishing impacts

Respondents expressed concerns about overharvesting of several fish and crab species and waste of fish (both bycatch species and mismanaged on-target catch) in commercial operations (Maningrida and Borrooloola).

In Darwin respondents indicated that ship (and plane) wrecks provide good fish habitat but most are 'fished out', and it was queried whether any monitoring of these and recently created artificial reefs was happening.

Other concerns about the methods and behaviour of fishers are set out under appropriate headings below.

Urban and coastal development impacts

Clearing of mangroves and marine pollution in Darwin harbour were identified as key concerns during consultations. Biosecurity issues arising from shipping ballast/bilge water discharge including striped mussel, spotted prawn and feral/non-local crab species was also raised, as well as concerns about

plastics and marine debris, including lost or discarded fishing gear and crab pots in and around the harbour.

Concerns were also expressed about current and future use/ development of the harbour particularly if there is an incident such as a processing plant or shipping spill because the tidal movements in the harbour would cause rapid and extensive spread.

It was noted that when research is undertaken it is usually only in response to development which is taking place, rather than establishing a comprehensive pre-development baseline. It was felt that any focused pre- (or post) development research should be done by independent researchers and the results published and made available in their entirety.

Climate change

Concern about actual or potential climate change impacts on coral reefs, *Melaleuca*/paperbark, seagrass and mangrove systems were noted during consultations (Maningrida and Borroloola). Other issues included the lack of recognition of traditional knowledge approaches to recognising and monitoring climate change and the subsequent lack of a focal point to collate and analyse locally collected information. Related to this is the lack of opportunity to use this to enhance and pass on traditional knowledge (for example, seasonal indicators) to next generations.

Cultural values

Fisher access to Aboriginal lands and seas

In Borroloola, there was a perception that commercial crabbers were operating in an uncontrolled manner. Because these operators can enter and disappear into river systems from the sea, Rangers have no ability to monitor their activities. Crabbers have big boats and cut up the seagrass beds, disturbing the feeding of dugongs. There have been incidents of conflict as commercial crabbers cut the floats off the pots of recreational crabbers – presumably leaving a ghost pot behind in the water. Bycatch issues are also a concern. It is well known that dugong are sometimes accidentally killed in commercial gill nets.

In Maningrida, there are ongoing concerns about commercial operators and recreational fishers disregarding fishery closure lines and fishers encroaching on Aboriginal waters, including closed seas, and the ranger group is actively monitoring this. Interest was expressed in research on the impact of moving the fisheries closure lines further out and for Rangers to obtain fisheries inspector qualifications and requisite support – Inspector levels 1 and 2 starting being made available through NT Department of Primary Industries and Resources (Fisheries).

In Galiwin'ku, commercial fishing by Balanda (non-Indigenous people) is concerning for Yolŋu (local Indigenous people) as they are not informed about what is happening on their country and others are accessing sea country without their permission or knowledge. Respondents called for Indigenous rangers to be given enforcement powers.

Other access to Aboriginal lands and seas

In Borroloola, there has been a perceived increase in both the number and size of visitor boats. Increased propeller size on bigger boats was specifically mentioned. Disturbance of seagrass beds and physical injury to dugongs and turtles were described. Visitors in boats were believed to be wasteful, taking too much and throwing away what they don't want. The visitors associated with the 'King Ash Bay fishing club' are seen as creating most of the tourism-related problems in the area. Tourism management is seen as both a burden and an opportunity. There is a desire to restrict tourists to a few designated campsites and possibly build an enterprise from them. Random camping on the islands was seen as a particular problem.

In Maningrida, visitor management issues have arisen relating to the nearby islands. Tourists have been leaving rubbish that attracts problem crocodiles; fast boats are now accessing the islands increasing visitor numbers; and there are concerns by Traditional Owners in particular that turtle and bird eggs are being over-harvested (often by opportunistic and ill-informed locals). Calls were made for rangers to be granted enforcement powers to respond to these issues. Concerns have also been raised about public infrastructure being constructed without proper consultation.

In Darwin, concern was expressed about the influence of recreational fishers, exacerbated by the granting of public open access to the intertidal zone on the Kenbi Land Trust, effectively limiting Larrakia protection and management of their country and limiting potentially highly prospective opportunities for enterprise development in managed tourism.

Cultural heritage

In Maningrida there are many sea country sacred sites yet to be registered, and general concern about the ongoing integrity of sea country sacred sites. It was considered that more work was needed on sacred site registration, recording, and identification.

In Borroloola and Darwin concerns were expressed that protection of sacred sites poses a dilemma, since any overt efforts to protect them such as fencing or signs may just alert visitors to their existence, leading to intentional ingress and possible damage (not to mention danger to the visitors).

Local and traditional knowledge

Maningrida consultations stressed that people would like to see some formal recognition and respect of the vast body of traditional ecological knowledge (and skills) that local Indigenous people hold, and respect for cultural values that can differ from western values. It was also considered important to recognise the central role that the 'two toolbox' approach of utilising both 'Western' science and local Indigenous knowledge plays in land/sea management (and in other areas of community management). Respondents were emphatic that intergenerational transfer of knowledge and bilingual education should be valued. There are many questions about how this may be improved but the commitment amongst partners is generally not there.

Social values

Observance of Aboriginal rights

Consultations in Galiwin'ku and Darwin highlighted that there is weak understanding and observance of existing and emerging Aboriginal legal (and customary) rights by agencies, business and the public. In Galiwin'ku respondents stressed that agencies need to know who has authority over land and sea and Aboriginal people need information about their rights and how to assert their authority.

Maningrida respondents noted that their lore (traditional law) never changes, but seemingly constant changes in western law are incredibly confusing. An example was provided of the Shire Council not actually understanding their own jurisdiction when telling Rangers they couldn't undertake certain activities.

For many respondents, a pressing issue is intertidal zone management – having a say in how it is regulated and understanding ones' rights and how to exercise those rights. It was felt that misunderstandings about these rights created serious tensions between families/clans and that clear, accurate information was needed. Several respondents noted that rights arising from the Blue Mud Bay decision (*Northern Territory v Arnhem Land Aboriginal Land Trust* [2008 HCA 29]) are not well understood. Concerns were also expressed about the limitations of the decision as it deals with the area between the high and low water mark, whereas Aboriginal peoples' dreaming extends well beyond the low-water mark (and as such it was felt that legal rights should respect 'traditional' boundaries).

Progressive alienation from country and limits on customary access to country

In Darwin, increasing urbanisation has led to a corresponding alienation from country and limits on customary access to country. The ability of traditional owners to access and use country for customary purposes is increasingly constrained by urbanisation. Examples cited by respondents included overuse, foreshore closures and pollution of local creeks and Darwin harbour constraining access to and/or edibility of bush tucker. Respondents stressed how difficult it was to manage land and sea in an urban centre.

“We can’t even swim or fish in Rapid Creek now because it’s polluted.” (Darwin, Larrakia respondent).

Increases in traffic in Darwin harbour as a result of port development has led to pollution from spills and bilge toxins leading to calls for a marine sanctuary to be established in the harbour and independent monitoring of the harbour health.

“They are poisoning our water and we don’t have a say.” (Darwin, Larrakia respondent)

Aboriginal influence over fisheries management

Traditional owners’ desire to assert influence over decision making in relation to fisheries management was a strong theme that emerged during consultations (Maningrida and Borrooloola).

The need for a system of monitoring and enforcement was identified. In particular, rangers’ enforcement powers and education of non-Indigenous people about Indigenous values in relation to fisheries were seen as vital.

In Borrooloola, some respondents indicated they would like to see more Aboriginal people sitting on the Fisheries Management Board. In Maningrida, Darwin and Borrooloola several rangers have been trained in fisheries compliance at various levels. One Larrakia ranger has held an Inspector level 1 certification (without the formal position) for some time. Overall, monitoring and surveillance of recreational water-based activities is very difficult when there is no boat registration nor recreational fishing licence system in place in the Northern Territory.

Enterprise development

The desire to realise economic/enterprise development opportunities in the marine environment was a key interest expressed during consultations. However, before committing, Aboriginal people want to understand what effects different activities will have on the attributes they most value.

Indigenous commercial/customary fisheries (including aquaculture)

Consultations affirmed interest in pursuing livelihood opportunities based on fishing and crabbing in Maningrida, Galiwin’ku, and Borrooloola. There was interest in securing licenses for commercial species, but there was a desire to learn more about the sustainability of those fisheries before pursuing such activities. It appeared that existing information about fishery sustainability was not getting back to communities (Maningrida).

In Maningrida, enterprise development interests identified include:

- securing licenses for commercial species (subject to information about the sustainability of those fisheries);
- semi wild harvest and/or ‘ranching’ aquaculture projects of trepang, oysters, pearls, trochus (subject to research to determine population status and potential for harvest). It was also noted that in the past there had been start-ups, but there had not been enough work done to scope

viability. In some case there had been as assumption of transferability from one community situation to another, which proved unsuccessful;

- fee for service monitoring;
- contracting of local researchers (e.g. Aboriginal Research Practitioners Network, Yalu researchers at Galiwin'ku et al)
- biosecurity and other contracted services

In Darwin, interest was expressed in employment and economic opportunities in the 'natural economy' and long-established traditional trade equivalent to the past Macassan trade in trepang.

Aboriginal Coastal Licences (**ACLs**) allow Aboriginal people living in remote communities to catch and sell up to 5 tonnes of fish per annum. The agreement and support of the local community is required and certain fish cannot be taken or sold under an ACL including commercial species (barramundi, king threadfin, Spanish mackerel, trepang, or mud crab). A number of people in Maningrida have been having success with ACLs over the last 10 months, highlighted by a recent shipment to the Darwin market. It is believed people in up to 20 communities (including homelands) are actively using these licences. One local license holder is interested in expanding into crayfish, and thinks some science around viability of these options would be useful. The Bawinanga Aboriginal Corporation has expressed a willingness to support any such research.

In Borroloola, there is only one ACL holder. Some families have held, or currently hold commercial fishing licences and boats, but none are currently working as commercial fishermen. Reasons for the lack of active participation in the enterprise seem to be related to the difficulties of negotiating family and commercial interests. Interest was expressed by one respondent from Ngukurr in getting assistance to obtain a fishing licence and operate a small business which would provide income to support his people to live on their homeland/outstation and for young people to work with him. In Darwin, there is no fishing licence involvement because ACLs are only available in remote communities.

In Galiwin'ku, there has been limited Indigenous involvement in commercial fishing or crabbing in the last generation, despite recent efforts by some individuals. A desire to obtain targeted support to develop specific enterprises including attracting more sea-bound tourists to Galiwin'ku and establishing fishing ventures was highlighted. There is also difficulty identifying services and service providers relevant to specific needs, particularly in relation to economic development opportunities. Another issue was a lack of trust for specific agencies/service providers based on poor track records and concern that local people's priorities and values are continually being overridden by others who pursue the agendas of their agency as opposed to consulting with locals to identify local priorities.

Monitoring and environmental management opportunities

Respondents expressed interest in pursuing fee for service monitoring opportunities e.g. biosecurity (Maningrida and Darwin). Some rangers showed interest in being more involved in crocodile monitoring and removals (Darwin). There was also interest from rangers in undertaking sacred sites protection /heritage management work relating to fish traps and middens and a desire to engage with Elders more regularly to support this kind of work (Darwin).

In Borroloola, Garawa Traditional Owners who are custodians of the stretch of coastline from the mouth of the Robinson River to the Queensland Border noted they have been trying to obtain funding for a Sea Ranger Program for several years so that they can gain the necessary access to manage this stretch of coast. Respondents expressed a desire to monitor tourist activity, conduct biological surveys, (including weed surveys) and to clean up ghost nets. A helicopter survey in recent years revealed an estimated 40 tonnes of ghost nets. Respondents are worried that mangrove die-back may be happening on their coastlines, but they cannot access the area to check. The li-Anthawirriyarra sea rangers, based in

Borrooloola have previous research experience on turtle counts and in recording and preservation of rock art on islands.

Some Darwin respondents are keen to pursue opportunities related to carbon sequestration in marine environment (blue carbon), cultural tourism opportunities, heritage management, and commercial contracts including potentially operating a passenger ferry service and cultural experience to Mandorah - subject to funding and availability of legal advice /business support.

In Galiwin'ku there is some interest in developing 'small scale' fishing and hunting tours, but business advice and support is needed. It was felt that the challenges of establishing and running a business needed to be realised at the outset. The motivations for starting a business also need to be considered as financial gain may not be the main priority. It was felt that small-scale operations were often preferable as large businesses could be expensive to start up and overwhelmingly bureaucratic.

A need for more flexibility to offer training relevant to specific needs identified and requested by local people as opposed to concepts for training being generated by non-local people was also expressed.

Local empowerment, livelihoods and research questions

An obvious feature of this summary of recurring interests and concerns is the substantial proportion not accompanied by specific propositions about related research. Many of the problems articulated are longstanding and some, especially those relating to remote livelihoods, persist despite overarching government policy and programs seeking redress. With regard to livelihoods, principles for effective community development programs are well understood through studies of aid programs in developing nations. But these lessons are rarely applied to remote regions of Australia. Emphasis remains on small numbers of very large developments that research has repeatedly shown deliver benefits in too few places and, even when sited nearby, for too few local people to overcome chronic remote and regional disadvantage.

Work is needed to explore (often small scale) options that draw directly on local assets and capabilities. Some of these, like payments for environmental services, have been highlighted by respondents and are considered further in the sectoral report. Local groups are rarely positioned to consider options systematically and, although plausible livelihood options are identified, small scale developments in cross cultural environments do not usually attract attention or adequate, capable support. Clearly there is much applied research to be done around pathways to sustainable local development – much of which needed from local Indigenous researchers and through equitable partnerships.

As mentioned earlier, engagement in research itself can be an important starting point for building local capability and interest in exploring livelihood opportunities. The now substantial fire and carbon management businesses began as action-based collaborative research program. Research much be approached the right way if such exemplary outcomes with wider mutual benefits are to be realised.

Research engagement

The consultations highlighted that a better approach to research is needed where Indigenous community members are involved in all facets of research development and activity, and where outcomes are accessible, relevant and valuable for Indigenous groups. Particular issues relevant to research engagement that were raised during the consultations are discussed in detail below.

Management of research activity

The need to develop research protocols/strategies was noted during consultations. In particular, concerns were expressed about how to control how researchers and associated people, such as media,

access country. For example, in Maningrida concerns were raised that, without proper planning researchers may accidentally be doing the wrong thing, potentially damaging sites and misrepresenting local opportunities and interests. The need for some kind of local ethics approval process was identified and a formal process whereby researchers apply to work in the area and Traditional Owners/Rangers assess those applications according to local interests. A 'position paper' outlining research and development interests against which to judge applications and align research in relation to the Indigenous Protected Area was suggested as potentially useful at the local level. Overall, it was felt that improved communications with various sectors would be of local and mutual benefit.

In Galiwin'ku and Borroloola, respondents stressed that people wishing to conduct research on Aboriginal land/sea (under ALRA) should contact the Northern Land Council in the first instance – recognising the need for improved processes within the NLC. In Darwin, it was emphasised that engagement by research organisations needs to be based on relationship building and thereby supporting capacity building. It was felt that divisions within local groups and their organisations were sometimes exploited.

Outcomes/benefits for local people

A strong preference was expressed for research directed at livelihoods opportunities and assessing the environmental impact of any proposed development(s). In Maningrida, research aligned to local priorities (as expressed in the Healthy Country Plan, for example) as well as research with commercial outputs for local people were sought (e.g. viability/feasibility studies regarding culture based tourism). Benefits for local people to participate in research was considered of high importance, as was recognition and protection of their intellectual property. There was also strong interest in supporting 'learning on country' (a model for teaching young people through land and sea based activities and tutelage by elders).

One respondent from Ngukurr gave an example of a successful research collaboration where a research institution worked with local women doing biophysical research (e.g. water monitoring work) which resulted, not only in improvements to the health of the billabongs that were fenced as a result but also for the women involved in the research, several of whom went on to study at university as a result of this experience.

Access and communication

It was felt that the outcomes of many kinds of research is not getting back to the relevant community. In Maningrida, consultations highlighted a strong desire for research results to be give back to community (including schools) in local language/s. Another suggestion was to establish a centralised place for such information to be stored and managed by an organisation such as Bawinanga Aboriginal Corporation. Progress reports and a final report into the research must come back to the community in a format and language that ordinary people can understand.

Local researchers and local governance

It was noted that non-Indigenous researchers are often not aware of who and what is happening on the ground, of existing non-Indigenous and traditional governance structures. In Maningrida, it was suggested that it would be good to have a coordinated contact point similar to a past setup for the pastoral industry. Bininj (local West Arnhem Land Indigenous people) want to be respected as equals and want service providers to collaborate with community leaders to develop mechanisms for visiting staff to learn how thee 'Bininj world' works and how to engage appropriately. This includes employing local people more often, as cultural guides from the negotiation stage of projects and activities.

"We need more local researchers doing the work, like the ARPnet/Yalu models; but also driving the research agenda. Bininj (local Indigenous people) should at least be involved in all on-ground Balanda led research activities." (Maningrida respondent)

Recognition and respect for local rights

In Darwin, Larrakia respondents felt that there is much more engagement with Traditional Owners happening elsewhere. Larrakia people are often not recognised as Traditional Owners because their cultural interests in and title to certain land under and around the city of Darwin is not properly recognised. It was also felt that government procurement processes did not support local Indigenous businesses and that perceptions of Larrakia people compared with groups in remote areas impacts funding opportunities.

Overall disappointment was expressed at the lack of real opportunity provided to local Aboriginal people from the mining and resources sector. However, Larrakia rangers are investigating opportunities for marine traineeships (to become skippers) and some interest has been expressed by a resources company to support these marine rangers. This could include research activities/capability building.

Right people, right country, right time

In Borroloola, it was noted that, in some cases, where previously research organisations would come to Indigenous organisations to consult, now they come to them late with an already fixed agenda. Good relationships need to begin with an introduction to the right people who should include:

- A Cultural Advisor
- Traditional Owners for the region where the research is to be conducted, and
- Tjungkayi (ceremonial managers) for the region and/or Traditional Owners involved.

In some instances, it was noted that women prefer small group meetings as they can find it difficult to have their voices heard in large meetings. A strong desire to participate in any research was also expressed.

In Galiwin'ku, respondents noted that agencies need to factor in sufficient time and money to do consultations and show flexibility to accommodate cultural business such as funerals. Concerns were expressed that non-Indigenous individuals and organisations are using their capacity to operate effectively within the mainstream funding environment to represent Indigenous people's interests when securing a range of funding opportunities for themselves with little or no consultation with the people they claim to be representing and providing services to.

Recognition and respect for local customs, knowledge ("two-way learning") and existing capability

One respondent from Yugul Mangi Land and Sea Management group (whose area of operation includes sea country from Wuyagiba to Limmen Bight in the southern Gulf of Carpentaria) in Ngukurr stressed that researchers should have some cultural awareness training before doing any research on their country. He noted that he would like to do the research himself (and be paid for doing it) and that there should be 'two-way learning' – that is, he would like to learn from researchers and have researchers learn from him, including passing on traditional knowledge. He would also like to see the research shared with the community particularly children because "they are the future". Recognition and respect for existing capability is of high importance with Rangers playing an important role in sea country management including carrying out extensive patrols of the coastline.

Key principles of engagement

Some key principles of engagement and criteria for measuring the value of research propositions are reflected in the results of the consultations and can be summarised as:

- know and respect local rights, interests and aspirations
- recognition and integration of traditional/local knowledge
- results given back to community in accessible form

- seeking and obtaining permission to access country and advice on measures to protect sacred sites
- ensure outcomes/benefits for local community
- consider livelihoods research/research assessing environmental impact of development i.e. research beyond traditional science
- Intellectual property recognition and protection
- respect for local authority/governance structures
- use opportunity to employ and pass on skills
- respect local timeframes
- right people, right country
- real involvement in on-ground activity, respecting existing capability and investing in development of future capacity
- recognition of the capability local people already have and of planning to date (e.g. IPA plans, Healthy Country Plans, Sea Country Plans)

Building better processes and structures for industry and government engagement with Indigenous interests is an essential part of a strategy for driving progressive improvements in a deeper understanding of Indigenous research needs.

Research design approaches

One of the purposes of the NTMSC UNA study was to identify common needs for ‘hard’ evidence in biophysical science to inform development decisions, including the “social license” to take up opportunities.

However, it is also necessary to recognise that participants varied in their capacity and interest in contributing to identification and justification of such biophysical research needs. For example, well-established industry organisations and larger companies are well placed to promote options based on long and direct experience and honed analysis of gaps that need to be filled to optimise their performance. These will often require single-discipline (often biophysical) studies. Other groups, especially those representing community interests, may have had limited direct exposure to the utility of basic and applied biophysical research to address their interests about use and care for the marine environment. The experiences of Indigenous landowners and their communities prompts different responses: around compatibility of commercial use and customary obligations and ways of influencing interactions to minimise environmental and cultural costs and capture development benefits locally.

This mix of perspectives creates a somewhat disjunct array of issues and disciplinary emphases. Elements of the problem are summarised in Figure 1 below, which considers the sorts of biophysical and social science needs that arise regarding many economically plausible development options. Our consultations indicate that many of our informants seek better understanding about issues sitting in the upper right quadrant. Whilst they clearly recognise and have identified important biophysical research interests and consider that they have insights to offer in these matters, many (if not most) frequently express concern at the way that management and regulatory systems are deployed to deal with biophysical constraints: in ways that too often fail to recognise their particular socioeconomic needs and to protect cultural values. They are particularly troubled by their present inability to influence design and applications of regulatory instruments.

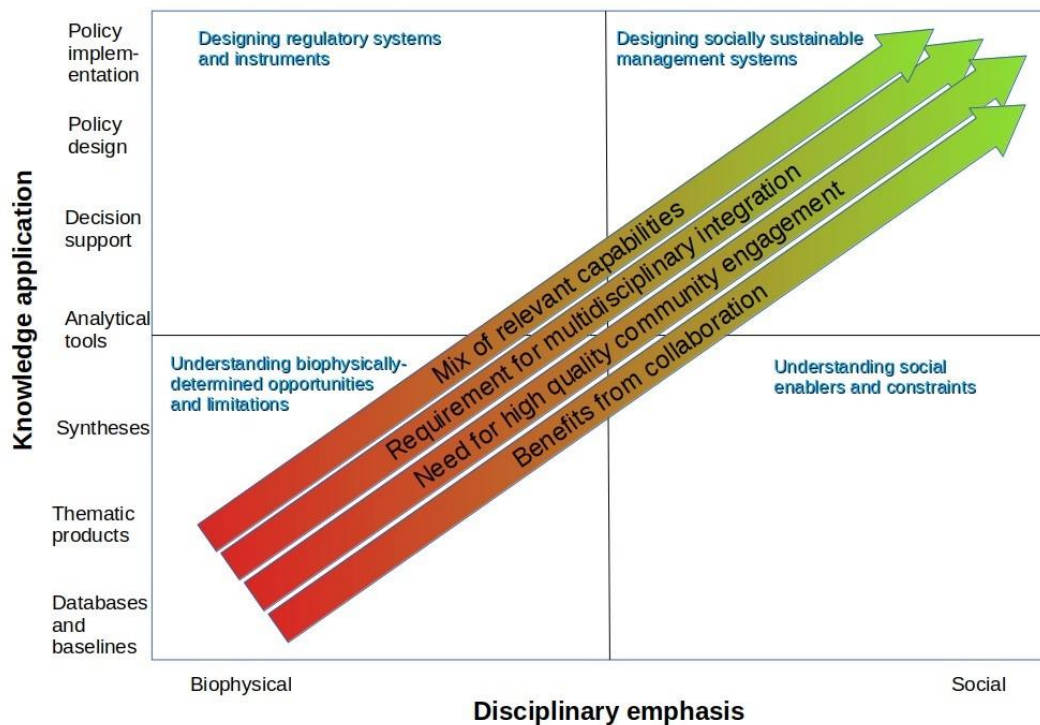


Figure 1: Representation of a 2-dimensional space within which marine research for the Territory may be designed, conducted and applied. Obviously, many other dimensions may be relevant but these are considered most relevant to this discussion.

Within the constraints of the project brief and the available funds and time, there is no simple way to resolve or even to comprehensively explore this perspective. However, there is clearly an obligation to consider how the somewhat disjunct emphases of industry, government and the community of Indigenous owners and managers of sea country (and arguably other sectors of the Territory community) can be brought into better alignment. In particular, how should individual research projects or programs be designed and deployed to help join up the interests and actions of Indigenous people, industry and government?

As foreshadowed in the emphasis on traditional owner and community engagement in presentation of Indigenous views, improving both industry and government processes and structures for engagement is an important part of the answer.

Conclusion

Many of our informants have obligations to look after sea country or depend on it for customary livelihoods. When asked to consider issues for management of marine environments, powerful emphasis on issues affecting contemporary capacity to meet customary obligations, maintain livelihoods and sustain relationships with country is inevitable. Lived experience of recurring disrespect for sacred sites, resource allocation regimes that exclude Indigenous owners, government determination to make agreements that trade off influence over activities on Indigenous lands, and other damaging or offensive behaviour from those gaining access to their lands, strongly influence responses. The relevance of gaps in formal scientific (especially biophysical) knowledge to these immediate dominant concerns is often far from obvious.

This has important implications for this study. In particular:

- some informants were unwilling to forgo the opportunity to put deeply held concerns even if they were unable or unwilling to connect them to research questions
- others connected these fundamental concerns to processes in policy-framing and related decision-making, which are clearly legitimate questions for research but require different disciplinary foci, approaches and participants from the chiefly biophysical interests expected from many industry and government informants
- because we sought to avoid leading the direction of interviews when the project goals had been explained, we were sometimes required to infer research questions rather than cite verbatim questions articulated directly by informants. We did this only where the frequency of responses on such issues and related discussions permitted reasonably robust inference.

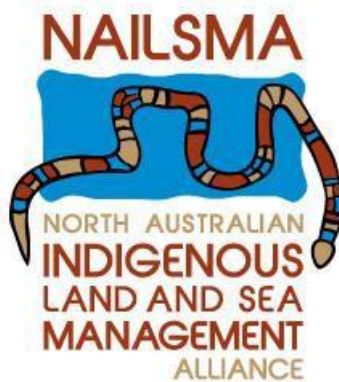
We appreciate that this situation considerably complicates presentation of a coherent suite of research needs; or of clearly articulated “sectoral” overlaps in needs that might be useful in assigning priorities. Treatment of Indigenous interests – one third of the whole of Territory society and most of the coastal population and owners of coastal lands - as equivalent in standing to a discrete industry sector or recreational fishers calls into question the validity of overlap criterion anyway. This problem is exacerbated by the fact that the overwhelming Indigenous response is to question the status quo and seek major policy and regulatory change to accommodate Indigenous interests better, whereas other industry and government statements just as consistently seek to entrench existing non-Indigenous interests and, in the process, weaken Indigenous influence.

This report provides a snap-shot of marine science research needs from Indigenous perspectives – some unique to particular areas and others with apparently common emphases. Perhaps more importantly this work has described the customary, economic and legal context in which much marine research will take place. Hence the particular emphasis on engagement principles.

It is clear that Indigenous people are keen to engage in useful research and perhaps associated development, but wish to do so in accordance with their own interests, rights and wellbeing. Research endeavours based on practical recognition, mutual respect and agreed principles of engagement are more likely to deliver triple bottom line outcomes useful to sea country owners and managers.

This report has also sought to articulate some elements of a conceptual framework for selecting and designing research projects, built predominantly on acceptance of the obligation to engage closely with the traditional owners of coasts and seas to ensure that cultural, social, economic, biophysical and other values inform those processes.

Assigning research priorities across all the issues impacting the lives of the Indigenous people with interests in coasts and seas is presently out of reach, given that various community interests and industry sectors are acting more or less independently and often without agreed mutual aims. This report and the sector focused NTMSEUNA report, confirm the need for such a framework to drive effective application of this large body of information on gaps in understanding of the marine environment and ways in which optimal benefits can be gained from future use and management.



NORTHERN TERRITORY MARINE SCIENCE END USER KNOWLEDGE NEEDS ASSESSMENT - MEETING ABORIGINAL NEEDS

Indigenous Engagement Report Part A – Desktop Report

A report prepared by Rose Rutherford and Peter Whitehead for the joint North Australian Indigenous Land and Sea Management Alliance and Northern Land Council research project

April 2017

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EXECUTIVE SUMMARY

In a nutshell:

- The Australian Institute of Marine Science and Charles Darwin University, with the financial support of the Northern Territory Government, are co-sponsoring an analysis of needs for better information for users of the Territory's marine environments. An important component of the study will be to understand Indigenous peoples needs and ways of securing Indigenous engagement in marine research.
- Aboriginal and Torres Strait Islander people are important end-users of marine science and science more generally.
- Western science is often used to complement customary knowledge and practise with the aim of ensuring healthy people and healthy country.
- Information needs range across many sectors and vary with biophysical and social context.
- There is often strong support to collaborate and engage with non-Indigenous researchers to address Indigenous information needs. Respectful, strong and equitable partnerships underpin successful projects.
- Addressing information needs must go beyond traditional science practise and communication to be effective.

Aboriginal and Torres Strait Islander people accept primary responsibility for the lands and seas with which they are associated. They embrace use of land, waters and resources to meet human needs while meeting long-established and fundamental obligations to care for country.

Changes in the ways sea country is used have created new challenges that also require new knowledge. To inform caring for country and managing, conserving and utilising natural resources in the contemporary Northern Territory, there is a need for western marine science and other disciplines to work together in support of Traditional Owners and managers, especially where others seek to use their land and seas.

Indigenous organisations have identified and documented a number of issues about which they require better information:

- caring for country and related opportunities to deliver environmental services, including:
 - establishing baselines and monitoring systems;
 - managing invasive species and improving biosecurity;
 - marine pollution; and
 - climate change.
- mainstream / orthodox industries and developments, including:
 - mining;
 - tourism

- port and urban development; and
- fisheries.

A key research interest was to understand impacts and threats to country from damaging natural and human made causes across all sectors. Research around opportunities to use natural resources in a way that can enhance the biocultural and biophysical health of lands and seas - while also providing social and economic opportunities - was a recurring theme.

However, accessible formal statements about research needs coming from Indigenous people and their organisations were clearly biased to products built around conservation goals, because support to prepare plans for use of country has been most readily available in these areas. To supplement these statements it is necessary to consider Indigenous submissions on policy and practice on socioeconomic matters that may not directly address marine research or knowledge needs but reveal broader aspirations, interests or concerns that may arise in regard to sea country as well as in other settings.

Key knowledge gaps sometimes related to absence of information at appropriate scales and of direct relevance to Indigenous interests. In other cases it was difficult to know whether apparent gaps resulted from poor accessibility or if additional new research was needed. The various sectors active in the marine environment gather and deploy research information that would be of use to Traditional Owners. However, much of this information may or may not be utilised due to issues of access and communication.

Federal and Territory law and policy in land and resource management do little directly to meet Indigenous knowledge needs. The *Environmental Protection and Biodiversity Conservation Act 1998* (Clth) sets broad goals for participation of Indigenous people in land and resource management but does not translate these into meaningful actions for commercial participation. Federal and/or Territory government and NGO support for conservation planning has no parallel in development planning. National research priorities refer to Indigenous interests only in regard to health. Innovation and Science Australia's developing Strategic Plan focuses on "big" science. There has been no recent statement of NT government research priorities. Clearly there is a large Indigenous gap in Australia's and the Territory's research and innovation framework, including marine systems and issues.

Broader issues of communication, access, consent and intellectual property, scale and context, compensation, appropriate use of Indigenous knowledge and governance were considered in exploring what is best practise collaborative research. These issues highlighted that in the context of cross cultural research the partnerships underlying, and processes adopted in the conduct of projects are of critical importance.

Science research does not occur in a vacuum. In the absence of statements of needs and priorities from Indigenous groups, agendas will be determined by industry or researchers themselves. Adapting projects to encourage greater participation and deliver benefits to Indigenous people can be constrained by available time and funding. And without clear consent and reporting back to communities in a timely and appropriate manner, there may be no uptake of or benefit from research to Aboriginal and Torres Strait Islander people.

The continued growth of, and need for support of Indigenous-driven research currently and into the future is discussed as 'Next Practise', about how science needs and application may evolve. Contributions to greater capacity from communities to design, conduct and commission research as well as foster more Aboriginal and Torres Strait Islander researchers and scientists could do much to accelerate improvements in understanding of the land and seas of the Territory and the place of their people in them.

INTRODUCTION

BACKGROUND

Aboriginal and Torres Strait Islander peoples have lived with and cared for the biocultural and biophysical land and sea scapes of this country for millennia, continuing up to the present day. But since European settlement, governance and management systems across Australia and in the Northern Territory for using lands and seas have changed significantly.

Contemporary pressures, opportunities and information needs for a healthy coastal and marine environment are different from those to which traditional knowledge was previously applied. Rapid change in the complex interplay between human-made and natural processes means that both Indigenous knowledge and western science are needed to make informed decisions about conserving, managing and utilising country. As important end-users of western science, Aboriginal and Torres Strait Islanders recognise the need to apply these different knowledge systems collaboratively.

PURPOSE

This report aims to provide a brief overview of Indigenous research priorities for sea country in the Northern Territory identified by Indigenous organisations, based primarily on a desktop study of readily available written materials. It will be used primarily as background for consultations with a number of Indigenous groups to provide a more comprehensive view of priorities for marine research and options for engaging Indigenous individuals and their organisations in all aspects of research they consider relevant to their interests in marine and associated terrestrial environments.

This work is part of a broader project by the Australian Institute of Marine Science and Charles Darwin University titled “Northern Territory Marine Science End User Knowledge Needs Assessment” which is exploring knowledge gaps and strategies to address gaps for all marine science end users including government, industry and community.

STRUCTURE

Firstly, an overview of the context and key concepts is presented. Identified research issues are then summarised in a number of categories. A broad overview of the current science available relating to the identified categories is offered, set against Aboriginal interests and concerns. Finally, a discussion is presented on the broader issues that support genuinely beneficial, collaborative, just and equitable science research in the cross-cultural context. Aboriginal roles and obligations in all aspects of sea country management and resource use and conservation will be considered.

METHODOLOGY

These issues have been identified primarily from published land and sea country management plans and strategies framed by various Indigenous groups involved in caring for country in the Northern Territory. Because they cover a relatively small part of the Territory coast and mostly focus on sites where protected areas are being considered, other statements with no particular emphasis on research but indicating interests, aspirations and concerns have also been considered.

Taking into account that utilising only published plans and submissions may exclude groups without the capacity and resources to complete them, some additional supporting information is also presented. This includes published resources such as interviews and artwork of Traditional Owners to represent their interests in the marine science space. Further information will be gathered directly from Traditional Owners in the

consultation phase of this project, to ensure that representation of issues and priorities is as comprehensive and accurate as possible.

LIMITATIONS AND QUALIFICATIONS

Three important limitations must be acknowledged. First, such a desktop review creates an inevitable bias to the interests of groups who have the capacity to publish and make publicly available their information needs. Second, that capacity is influenced by the nature of support available to them, which has tended to focus on conservation and other environmental management issues. Third, the research issues and needs identified are unavoidably simplified representations of the great heterogeneity of interests, priorities and opinions among and within Indigenous groups with sea country. Fourth, while this report endeavours to present the available information in its original tone and intent, this report and many of the other reports drawn on have been written by non-Indigenous people. Where possible direct quotes and primary resources are presented to allow Indigenous voices to represent themselves, rather than be filtered through a non-Indigenous perspective.

Finally, it is acknowledged that the relatively small number of research-directed statements have required inferences about the desire or need for more research – as distinct from other more direct action – to advance aspirations or deal with concerns. Issues most relevant here include legal, policy and institutional barriers to active participation in resource management. These observations and suggestions require validation or rejection by Indigenous informants, which will be sought during consultations.

CONTEXT AND CONCEPTS

To understand this report several critical concepts must be established.

INDIGENOUS INTERESTS IN MARINE SCIENCE RESEARCH

Aboriginal people in the Northern Territory are custodians of sea country by Indigenous law and are also owners of, and controllers of access to, 85% of the coastline under Australian law (Brennan, 2008). They continue to assert ownership of sea country well beyond the low tide mark and have clearly and consistently identified themselves as end-users of science in order to inform their resource management decisions and practice. This is done with the over-riding aim of ensuring the best outcomes for people and country. The fragmentation and weakness of research in some areas has been identified by various groups as being a significant challenge in decision-making (Tiwi Land Council 2003; Dhimurru 2006).

Under various laws relating to development and infrastructure on Aboriginal and native title lands and waters, developers, government and researchers must consult with, or have consent from, Traditional Owners. Land rights law requires that landholders and communities understand the nature and purpose of developments, the effects the activities will have on their lands and seas and ways proposed to minimise adverse impacts. Without relevant and accessible information on benefits and risks, especially potential impacts on country, Traditional Owners cannot make fully informed decisions or give free, prior and informed consent to projects.

It is therefore essential that Traditional Owners influence the direction of research and the manner in which it is presented by being recognised as key end-users of science. Like all other land owners, Traditional Owners seek access to the best information available to foster and take up rewarding livelihoods and inform care for country. Better and more accessible information will facilitate sound and timely decision-making.

While Indigenous and non-Indigenous people share interests in, and needs for, high quality marine science information, the premise underlying these interests and needs may be different. This means the basis of all collaboration must be an awareness of different systems of knowledge and avoiding simplistic assumptions about shared understandings that may exist between groups. All collaboration must be grounded in a mutual respect for the different knowledge systems and values that coexist in this context.

Sea Country

"Let me tell you something, the sea, the saltwater, the waves, they are my mother, the sea is my mother, it is her Ancestral being. I know this, I have known this since I was small. Further I will tell you the sea has names, many names, names for the reefs, names for the sea grass beds, names for the sand bars and the sea has boundaries, we know these boundaries, they did not come here recently. From the time of the Spirit Ancestors and our human ancestors they have been there. Our songs and ceremony are also in sea, they are running through the sea both along the bottom of the sea and they also rise and travel on the surface of the sea. White people think the sea is empty that it has no Law, but the Law and the ceremony is there in the salt water, in the fish, in the sea birds, the dugong and the turtle, it is there and we knowledgeable people are holding it." Dinah Norman Marrngawi, Yanyuwa Traditional Owner (Bradley and Yanyuwa Families 2007: 20)

"We do not make a distinction between land and sea the same way as Ngapaki (non-Indigenous people) do when talking about country; it is all country. While our rights to land were recognised by the Australian parliament in the mid 1970s the same rights we hold for sea country was ignored." Banduk Marika, Banul Munyarryun, Buwathay Munyarryun, Napunda Marawili and Wanyubi Marika (Altman and Kerins, 2012: 136)

Sea country refers to the Indigenous conceptualisation of the marine scape. It includes the biophysical aspects of the sea, islands and reefs, flora and fauna, as well as the cultural and spiritual aspects. The sea, as well as the land, contains evidence of events from the Dreamtime in its geographical features (Dhimurru, 2006). It contains song lines and sacred places, as well as kinship connections and totemic relationships for Aboriginal and Torres Strait Islander peoples with sea country (Smyth 2007; Morphy and Morphy 2006; Bradley and Yanyuwa Families, 2007). Furthermore, parts of sea country may have a strong connection to a place, people or processes much further inland in the terrestrial landscape (Morphy and Morphy, 2006; see also the Yan-nhangu Atlas and Illustrated Dictionary of the Crocodile Islands (James and NAILSMA 2016)).

"The shark dreaming runs through the water and connects us to our neighbours and sea country" (Garawa 2014: 19)

Aboriginal and Torres Strait Islander peoples with sea country view it as integral to and inseparable from their estates and living cultural practise, not a separate and independent layer. Caring for sea country is essential to spiritual and physical wellbeing (Dhimurru, 2006). Land and sea must be cared for as a whole (Bradley and Yanyuwa Families, 2007).

In western literature and law, the understanding of Aboriginal concepts of and responsibilities for sea country has been slower than understanding of connection to land and view of customary practices in being narrowed to just cultural practices. In the Yanyuwa Sea Country Plan, Bradley suggests that early anthropologists such as Tindale, Warner, Rose, Bernt and others - in working with saltwater sea country people in the Northern Territory - must have sat on the beach and looked inland (Bradley and Yanyuwa Families, 2007: 21). The first references to sea country in the Northern Territory in western literature begin in the 1970s (see Woodward, 1973; Morphy 1977; Davis 1982, 1984; Palmer, 1983; Palmer and Brady, 1984). Aboriginal and Torres Strait Islanders have since generated numerous publications detailing the importance and characteristics of sea country (see Dhimurru, 2006; Isaacs, 2014; NAILSMA, 2004; James and NAILSMA 2016; Smyth, 2000), which has been followed by improved, but still incomplete, legal recognition.

Ranger Groups and Caring for Country

Across much of the north Ranger groups deliver a considerable amount of on ground activity for land and sea management, under the direction of Traditional Owners. As such Traditional Owners will be key end users of marine science to inform their land and sea country management. The groups looking after country grew organically as an Indigenous initiative as people got their land back under the ALRA (Smyth 2011). These

initiatives have successfully provided a range of environmental services (DPMC, 2015; 2016). They also provide social and employment outcomes and opportunities to individual rangers and Indigenous communities (Altman and Kerins, 2012; Smyth 2011).

Rangers also offer services that benefit Australia as a whole, such as bio-security surveillance and monitoring, as well as control of invasive species (DPMC, 2015; 2016). The area managed by Aboriginal and Torres Strait Islanders, areas under various tenures, sometimes called the Indigenous estate, makes up a significant part of Australia’s reserve systems (Figure 1.). While much is done by ranger groups, other Traditional Owners and managers also contribute and influence the sort of work that is done and shape the methods used: to draw on traditional knowledge and accord with traditional practice.

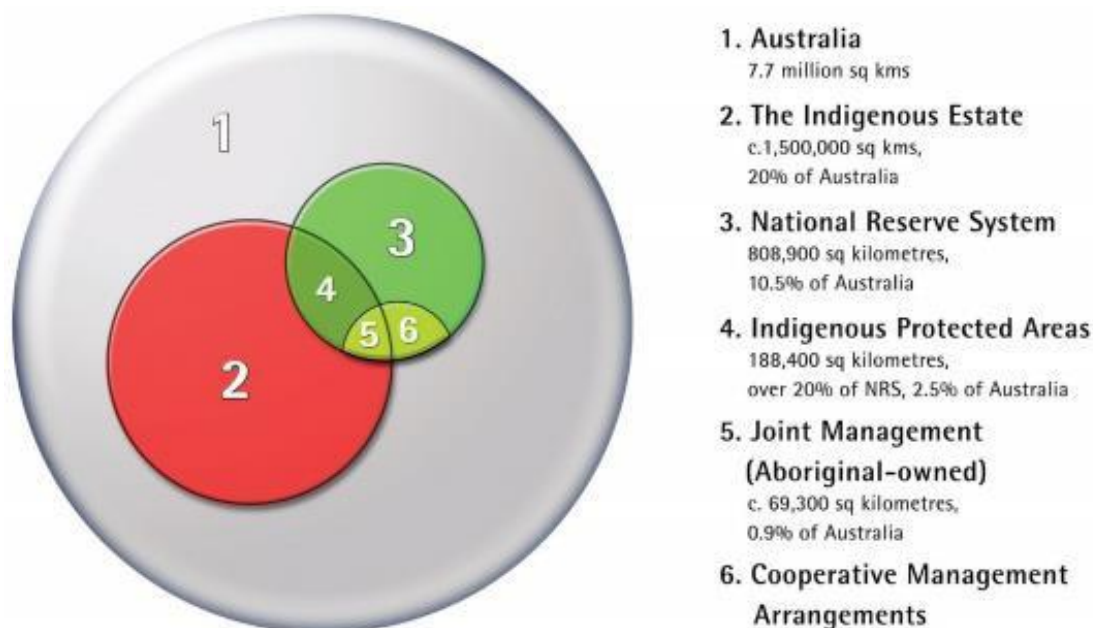


FIGURE 1 - THE OVERLAP OF THE INDIGENOUS ESTATE AND THE CONSERVATION ESTATE (ALTMAN, 2006)

Key policies and programs that currently support ranger groups include the Working on Country Program and the Indigenous Protected Areas program (DPMC, 2016). These provide structural and financial support to ranger groups. However, continued funding after 2018 is uncertain (Haxton, 2016).

LEGAL AND POLICY CONTEXT

Responsibility for management of marine environments is shared by the Federal and Territory governments. In general, the Territory has responsibility for management of waters within the coastal zone: from low water mark to about 5 kms to sea. Outside this zone within Australia’s exclusive economic zone (up to 370 km to sea), the Commonwealth is responsible. In practice, governments have agreed to share management obligations to simplify arrangements. For example, the Commonwealth manages fisheries like the northern prawn fishery that extends across more than one state or territory. Where a fishery is largely confined to waters off a single state or territory, the local authority may have control, even if it extends outside the coastal zone. Specific agreements have also been reached in regard to resource (oil/gas and mineral) exploration and

extraction, so that in most cases the Territory will regulate and supervise these industries when they operate in coastal and near-coastal waters.

Overlying geographic separations of powers are many other Federal laws that apply everywhere and to some extent duplicate Territory laws. Examples of particular interest to Indigenous people include Commonwealth law in particular the *Environment Protection and Biodiversity Conservation Act 1999* covering migratory and marine wildlife like dugong and turtle, seabirds and waders. The Commonwealth also has responsibility for quarantine, human migration, customs and similar laws, but will often work in collaboration with the Territory to meet these obligations. Territory environmental assessment law has been accredited by the Commonwealth, so most activities (including minor or major developments or use of living resources on Aboriginal lands and waters) that require environmental assessment will be done under Territory law in ways that also satisfy federal obligations.

With the recognition of land rights in the *Aboriginal Land Rights (Northern Territory) Act 1976* (ALRA) and the *Native Title Act 1993*, Aboriginal and Torres Strait Islander peoples recovered rights and/or access to traditional lands down to the low tide mark.¹ However, practical recognition through settled claims was overwhelmingly directed to terrestrial areas. Subsequent cases around Croker Island and Blue Mud Bay furthered recognition of sea country under Australian law. These land rights laws and many other aspects of Aboriginal affairs are administered by the Commonwealth.

The contemporary context of land and sea country tenure, ownership and management is complex, with increased recognition of sea country leading to greater opportunities for Aboriginal control over access and opportunities for collaborations among industry, government and Traditional Owners. In many ways, however, this is yet to translate into tangible outcomes for custodians of sea country. Successive governments have urged traditional landowners actively to exploit their ownership of lands (and seas) to generate employment and incomes but offered little practical support, despite recognition of major challenges in creating viable businesses in remote, infrastructure-poor regions (NAILSMA 2014a).

DEVELOPMENT POLICY

From a Commonwealth government policy perspective, northern development - as outlined in the 2015 White Paper - focuses on attracting external investors to large-scale projects. To realise advantage from the north's proximity to Asian markets and its abundant natural resources, the government proposes 'cutting red tape' and investing in large enabling infrastructure (Australian Government, 2015). With a focus on promoting agriculture and aquaculture as well as energy and mineral resources, the paper refers to the involvement of Indigenous Australians in educational and employment opportunities to be created by the government's development agenda. An obvious shortcoming of such an agenda is that it will at best help establish one or a few widely separated nodes of increased activity. But most importantly, it does not recognise Aboriginal and Torres Strait Islander landowners as having their own, distinct development aspirations and so includes no policy support to drive practical implementations of such aspirations (Yu 2016).

Proposals for Indigenous-led approaches to planning for economic development have been articulated in recent publications about development of an Indigenous Prospectus for participation in the sustainable development of northern Australia (NAIEP 2012, NAIEF 2012, NAILSMA 2013). Key elements are to:

- Set out Indigenous community aspirations to participate in and share the benefits of future developments in the north and the conditions under which they, as landowners may consider co-investment in the commercial use of their lands;

¹ In addition to two sea closures under the *Aboriginal Land Act* which extend two kilometres from the low tide. Note also recent extensions of land based IPAs into sea country around east Arnhem Land which extend into Commonwealth waters.

- Identify options for investment, and seek co-investment from industry, NGOs and governments, particularly in the agricultural, pastoral, fisheries, environmental services, tourism, arts and cultural sectors.

Serious pursuit of such an agenda will generate many questions requiring applied research in resource management and related social science, policy and law. Some of these questions are discussed later in this report.

FRAMING RESEARCH NEEDS

In the analysis to follow, we draw predominantly on direct references to marine research needs identified by Indigenous groups. But we consider it essential also to offer some context by reference to broader statements of aspiration and concern regarding management of lands, waters and resources, within the Indigenous estate and more widely.

In considering the following specific areas identified as research needs by Traditional Owners, it will be important that they are interpreted against the background of those overarching themes.

ALREADY IDENTIFIED RESEARCH NEEDS

In materials directly addressing research needs, items were varied and crossed disciplinary boundaries. Many identified research needs do not fall strictly within the disciplinary boundaries of marine science but their inclusion is useful to illustrate the nature of interests raised by Indigenous informants, most often in the context of sea country planning.

It is clear from these statements that communities firmly recognise the importance of western science information supporting and complementing Indigenous practice and law in caring for people and country. The issues identified reflect an intent to build independent and resilient societies with well managed natural resources used in ways that benefit Traditional Owners as well as other users (NAILSMA 2014).

Information needs are deeply embedded in place and context. They do not always refer to an identifiable industry sector or single issue. Nonetheless broad categorisations have been offered here to facilitate an overview of common issues. Issues on which research is sought are also crudely ranked according to the relative frequency with which they were raised. Both the array of matters presented and their relative rankings are indicative only and expected to change based on direct input from Traditional Owners further in the consultation phase of this project.

ASPIRATIONS AND CONCERNS THAT MAY REQUIRE RESEARCH

The important themes identified above relating to Indigenous participation in northern development, barriers to participation and the conditions that Indigenous people seek to apply to development and resource use on their lands and seas cannot be expected to appear in lists mostly made for participation in conservation reserve management. So far as we are aware, Indigenous groups have not been supported in an equivalently systematic way with access to technical and operational advice, or to outline their information and research needs for participating in economic development. As a preliminary step to address this gap we have looked at statements made principally in response to the northern development Green Paper (Australian Government 2014) or related Senate Inquiry.

A full treatment of their content is outside the scope of this work. However, we note several outstanding policy-related discussions - conducted by Indigenous organisations through exhaustive consultation over the last decade or so - that reveal central themes that are directly relevant to marine systems and appear to warrant further research. Among the more significant of these are:

- Effective mechanisms for real Indigenous influence on the way that resources on Indigenous lands and seas are accessed and used, including Indigenous land, sea and resource-use planning (NAILSMA 2012b, 2013a)
- Determining Indigenous-specific resource allocations for both commercial and non-commercial (including customary) purposes (NAILSMA 2009a, b; NAILSMA 2012a)
- Ways of localising decision-making so that traditional owners can be satisfied that they are meeting their obligations to country and to their communities (NAILSMA 2012, 2013, Martin 2011)
- Monitoring and evaluation arrangements for development and conservation that track Indigenous values, benefits and concerns (NAILSMA 2013b, Robinson et al 2016).

Finally, motivation to engage in research relevant to Indigenous lands, waters and the resources they support is not confined solely to greater focus on values important to Indigenous people, although change to address them properly is essential. Indigenous landowners have been active participants in research and management to advance goals - like reduction in greenhouse gas emissions - that sit outside traditional obligations and experience (Russell-Smith et al. 2009). They are eager to deploy assets, skills and practices to problems important to others members of Australian society, especially where delivery of those external goals can contribute to meeting customary obligations to country. Additionally, Indigenous people are aware that the way research is done and choice among methods to meet non-Indigenous goals can affect rights and obligations in regard to issues like customary use of wild plants and animals. There are likely to be no or few areas of research relevant to land, sea and resource management in which Indigenous people are entirely disinterested.

DOCUMENTED RESEARCH INTERESTS

LAND AND SEA MANAGEMENT AND ENVIRONMENTAL SERVICES

In this broad category we include issues related to impacts of land and resource use practice on important values, status of living resources, and approaches to measuring and reporting status of values.

BASELINE INFORMATION AND MONITORING

Traditional Owners are worried about the lack of a coordinated, independent and systematic effort to monitor the impacts, threats and opportunities to sea country (Dhimurru, 2006). There is a desire to develop and implement effective management strategies for issues such as invasive plants and animals as well as quarantine and soil erosion. Comprehensive information is critical to inform these strategies and management plans. The research needs identified in the documents assessed related to baseline information and monitoring are in Table 1. Some of these statements are a decade old or more, but given the limited resources available to address the issues they raise, they remain highly relevant today.

Table 1. Baseline Information and Monitoring Issues

Most shared	<p>Cross-disciplinary research on dugongs and marine turtle species including population status, pressures, threats and habitat (sea grass meadows) degradation (Anindilyakwa, 2016; Dhimurru, 2006; Djelk Rangers 2015; Garawa, 2014; Bradley and Yanyuwa Families, 2007)</p> <p>Record and catalogue baseline data including topography, soils, flora, fauna and water resources. Particular emphasis on culturally and environmentally important species such as shellfish, stingrays and sharks (Anindilyakwa; Dhimurru; Djelk; Garawa; Tiwi Land Council 2003; Yanyuwa)</p>
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	Develop capacity for rangers to carry out surveying, data collection and monitoring (Dhimurru 2015; Djelk; Garawa; Yanyuwa, Layhnapuy Homelands Aboriginal Corporation 2013)
Often shared	Threats and potential impacts of increased erosion and siltation of waterways to sea country. Including contributing factors such as overgrazing, feral animals and inappropriate fire regimes (Djelk; Garawa; Tiwi)
Unique or less frequently shared	Population surveys of migratory species (Djelk) Information on dieback in vegetation communities (Dhimurru) Fresh water quality tests (Djelk; Garawa) Survey population of long neck turtles (Djelk) Survey of crocodile eggs (Djelk) Crocodile monitoring (Garawa) Information on the declining populations of small native mammals (Dhimurru; Djelk)

“We believe our wellbeing and turtle (miyapunu) wellbeing are inseparable. To put it another way, we belong to turtles and turtles to us; we sustain them and they us. As custodians and managers of sea country we have responsibility to work with others to manage turtles. We regularly record green, hawksbill, olive ridley and flatback turtles and we are the custodians of internationally significant rookeries of these four species.”
(Dhimurru 2015 – 06: 25)

Available Research

Overall from a Traditional Owner perspective there is a lack of comprehensive data on the biodiversity and other salient features of coastal and marine areas of the Territory. This includes a lack of ongoing monitoring of key habitats and species.

Communities and Indigenous organisations with the capacity to engage with researchers and commission work have done so, such as the 2013 survey of fauna in the Dhimurru Indigenous Protected Area (IPA) (Vanderduys *et al.*, 2013). Most Indigenous groups with sea country do not have this capacity and are reliant on information and research carried out by government or external academic and research institutions for their own purposes.

Systematic presentation of baseline environmental information overall is lacking, with the Northern Territory as the only state or Territory not producing a State of the Environment report (SoE, 2017). However, useful foundational research includes decades of work by Woinarski and colleagues doing biological surveys to standardised techniques across much of northern Australia, including coastal regions and islands (e.g. Woinarski *et al* 2001, 2007, 2011). Extensive baseline surveying work by Chatto in the 1990s and 2000s (see Chatto, 2000, 2001) focused particularly on the coasts, recording distribution and status of various fauna species including nesting marine turtles, colonial breeding sea birds, shore birds and water birds around the coast and coastal wetlands. Some of the most systematic work involved regular aerial surveys of dugong, magpie geese, and feral animals (see summaries in Whitehead *et al* 2000) but these have now ceased or are run over small areas for particular purposes. Crocodile surveys from boats continue to be run in most major river systems as they are required to support management programs for commercial use of the saltwater crocodile in particular (Fukuda *et al.* 2011, 2015).

All available NT information on flora and fauna, including coastal and some marine species, has been aggregated in a geo-coded database which can be accessed across the web. Whilst this provides a most useful tool for preliminary studies, outside a few heavily surveyed areas data are too sparse to be used for assessing trends in populations or changes in distribution at most locations (Whitehead and Oliver 2014). Arguably,

crocodile surveys are the only regularly-conducted surveys that could be used without local supplement to provide meaningful indices of responses to land or wildlife population management actions.

Land condition monitoring programs using a mix of remote sensing and on-ground assessments at fixed points are run by government on pastoral leases. In its annual reports, the Pastoral Land Board reports regional summaries of the conditions of sites assessed during the year. For example, in 2014/15 the Board reported that the condition of many sites in the Gulf of Carpentaria was poor (PLB 2016), indicating soil instability. However, more useful information (e.g. on specific sites and potential influences on nutrient and sediments entering rivers and streams) is not routinely released to the public. It is therefore difficult to make judgments about effects of poor management on riverine or estuarine values.

It follows that specific monitoring programs will often need to be designed and implemented to answer local questions about effects of existing or changed land use or condition of particular species or phenomena about which Indigenous landholders have concerns.

INVASIVE SPECIES AND BIOSECURITY

Invasive plant and animals can have a large impact on sea country. They also introduce issues of biosecurity. Pigs are degrading and damaging wetland, coastal and marine species and habitat by, for example, consuming turtle eggs and contributing to increased turbidity in the waterways. Their presence on coasts increases risks of entry and spread of exotic animal disease. Weeds can also lead to a decline in native vegetation, change fuel loads and limit access to important places (Dhimurru, 2015). Compromised fire management can result in greater erosion (Russell-Smith et al 2006). A large amount of the time and effort by ranger groups is spent managing and controlling invasive species. This is significant work for the biosecurity and ecosystem health of the entire country as rangers are working to control weeds of national significance and hyper invasive fauna, such as the yellow crazy ant. Relevant research issues are presented below in Table 2.

Table 2. Invasive Species and Biosecurity Research Issues

Most shared	Threats and impacts of feral animals and plants to inform management and control strategies of pigs and buffalo* (Anindilyakwa 2016; Dhimurru 2006,2015; Djelk Rangers 2013; Garawa 2014; Tiwi Land Council 2003 ;Layhnapuy Homelands Aboriginal Corporation 2013)
Often shared	Yellow crazy ants (Anindilyakwa; Dhimurru, Yirralka)
Unique or less frequently shared	Information to inform management strategies of weeds including the rubber plant, hyptis and annual mission grass (Yirralka) Information on biosecurity issues of ports e.g. bilge water from ships (Yanyuwa, Dhimurru)
*Buffalo has historically and currently been a source of conflicting management decisions from Traditional Owners. It can serve as a food source but is also destructive. All documentation surveyed highlighted the excessive numbers of buffalo and the need to control them.	

Although some of these expressions of concern are obviously terrestrial in focus, they illustrate a desire to deal with exotic species issues in general and to recognise and manage “downstream” effects of terrestrial impacts on waters, including marine systems.

Available Research

It is very much in the national interest to have up to date information on invasive species and biosecurity issues. For species recognised as threatening or invasive under the EPBC Act there is extensive research and recommendations provided by the federal Department of the Environment and Energy on invasive species (2017a), feral animals (2017b), marine pests (2013) and weeds (2011).

Further collaborative and localised research, such as the work by Ens et al. (2017) is needed to adequately meet and communicate Traditional Owners knowledge needs at a local level. It is particularly important that local people are engaged in work on impacts of exotic species so that they can assess the relative costs and benefits of active management (Robinson et al. 2005). However, serious systematic study of impacts is rare and assessments are mostly anecdotal, making it harder to justify investments in control.

MARINE POLLUTION

Marine pollution is of significant concern to Traditional Owners as carers for sea country (Table 3). Marine debris and ghost nets are particularly prevalent and dangerous to species such as marine turtles and dugongs, as well as damaging to significant ecological habitats on the coast. A substantial part of sea ranger work is devoted to monitoring or managing marine debris and ghost nets.

Table 3. Marine Pollution Issues

Most shared	Information to inform management strategies for marine debris and ghost nets (Anindilyakwa; Dhimurru 2006, 2015; Djelk; Garawa; Yirralka)
Often shared	Litter from visiting tourists (Dhimurru; Djelk; Garawa)
Unique or less frequently shared	Dumping of oils and pollutants (Dhimurru) Impacts of burning of illegal (confiscated) vessels (Dhimurru)

Concerns about other serious but less direct “upstream” sources of marine pollution appear under other headings (e.g. feral animals and mining).

Available Research

The impact of plastic debris and ghost nets on Australian marine life is increasingly studied (Ceccarelli, 2009; Hardety et al., 2014; Reisser et al., 2014).

There is also a significant amount of research on marine debris and ghost nets in the Northern Territory thanks to the ongoing work of sea country rangers, conservation volunteers and research organisations such as the Commonwealth Science and Industrial Research Organisation (CSIRO). The Indigenous organisation Ghost Nets Australia plays a significant role bringing communities and researchers together to address the issues of marine debris in sea country (Ceccarelli, 2009, Wilcox et al., 2014; Wilcox and Hardesty, 2016). As sea country ranger groups and communities have been ongoing contributors to this research it is much more likely this information is accessible and understood by Traditional Owners in the Northern Territory.

Research has also shown the majority of marine debris and ghost nets washing up and injuring marine life, particularly in the Gulf of Carpentaria, is of foreign origin (Edyvane and Penny 2017; Wilcox and Hardesty, 2016). Thus, as the knowledge gap is being filled, there is a greater focus on managing the issue, domestically and internationally.

Pollution issues such as the impact of authorised burning of boats seized for illegal fishing or people smuggling and impacts of port developments are issues that need further research.

CLIMATE CHANGE

Information on the current and potential impacts of climate change are of critical interest across all sectors. Understanding of how anthropogenic climate change will affect sea country in the Northern Territory is a research priority identified by Traditional Owners (Table 4). Information needs are particularly acute given the potential for sea level rise to change the intertidal zone, already a contentious space, and threaten sacred sites. The direct reliance of some Aboriginal and Torres Strait Islanders on the intertidal environment for sustenance and obligations of ensuring the health of country and people make the information needs in this context all the more critical.

Table 4. Climate Change Issues

Most shared	Information to identify, describe and assess potential climate change impacts (Anindilyakwa 2014; Dhimurru 2015; Djelk Rangers 2013; Garawa 2014; Seed 2017)
Often shared	Issues of sea level rise and protection of marine and coastal sacred sites (Dhimurru; Anindilyakwa)
Unique or less frequently shared	Potential changes to the intertidal zone (Martin, 2011)

Although not raised in the documents examined, recent AIMS reports of coral bleaching in the Darwin area may also be expected to attract interest, whether attributed to climate change or not.

Available Research

Research into potential climate change impacts is often at a broad scale and has varying degrees of certainty. At an international level, the Assessment Reports by the Intergovernmental Panel on Climate Change (IPCC) provide a strong foundational understanding of current climate change science and modelling at a global level (IPCC, 2014).

At a national level reports such as the State of the Climate (e.g. BoM and CSIRO 2016) provide national overview of issues and offer some regionally relevant information and predictions for northern Australia, such as a higher sea level rise than in southern Australia and the predictions of tropical cyclones of decreased frequency but increased severity. These broad scale reports may not offer information at a level localised enough to be of use to Traditional Owners.

Nonetheless, various online hubs of climate change knowledge may be of use to Traditional Owners including: Climate change in Australia (<https://www.climatechangeinaustralia.gov.au/en/>) and Terra Nova (<https://terranova.org.au/>). Both provide regional interactive information and predictions that are aimed at decision makers and natural resources managers. Drawbacks of these resources for some Traditional Owners and communities may be their necessity for high quality, consistent internet connection as well as strong literacy in Information Technology (IT), formal science and English.

At a species or ecological community level in marine science, there is research into commercially important fish species and the seafood industry impact of climate change. While mostly at a national level (Department

of Climate Change, 2008; Flemming et al, 2014) there are also studies focussed on the Northern Territory (Welch et al., 2014).

For information on species or ecological communities of identified interest to Traditional Owners there are various studies related to the potential impacts of climate change on sea grass meadows (Campbell, 2006; Connolly, 2012) and marine turtle species (Butt et al., 2016) in the Australian context. As above, some of these are more applicable to the Northern Territory context than others. Most are published in academic journals, only some of which are open access. Furthermore, the technical nature of some of the reports (for example Campbell 2006) mean this information would most likely not be accessible to the majority of Traditional Owners in the Northern Territory.

Interestingly in a recent paper on *Climate Knowledge Needs for NRM Planning in Australia's Monsoonal North and Rangelands*, natural resource managers were interviewed and conveyed their difficulty in utilising climate change science, data and modelling to inform their management plans and practise (Capon 2015a). The reasons identified for this included that information:

- Lacked regional specificity
- Was highly uncertain
- Was technically complex
- Lacked committal language in reports
- Was very top down
- Had little consideration of how to be fit for purpose
- Lacked formats that were culturally sensitive and catered to an array of literacy levels and languages backgrounds

It is apparent science institutions and researchers are attempting to bridge these knowledge gaps and make climate change science more applicable and better communicated. An example of this is the *Climate Change Impacts for Aboriginal people in Northern Australia* document, which usefully communicates in a clear and straight forward manner what can generally be expected for communities (Capon, 2015b). A more comprehensive report by the Department of Climate Change and Energy Efficiency (2009) may also be of use to Traditional Owners who have the capacity to engage with it.

MINING

Many operational and legacy mines, as well as resources exploration activities, on Aboriginal land and seas have the potential to impact, or currently impact, on sea country. Despite recent improvements in openness (see references below), driven by independent monitoring and reporting, Traditional Owners have identified an information deficit of up to date, independent and relevant information on the potential and current impacts of mining on country, including effects on marine environments (Table 5).

Arguably the previous history of denial of problems, and with-holding of relevant information about problems once acknowledged, has contributed to distrust of government and industry exemplified by the public reaction to “fracking”.

Table 5. Mineral and petroleum/gas extraction Issues

Most shared	Consistent and independent information and monitoring of the potential and actual impacts of mining. This includes but is not limited to information on: broader marine ecosystem impacts of contamination from pollutants leaching through waterways to the sea impacts on threatened species downstream of active and legacy mines information of the impacts of fracking on ground water resources (Anindilyakwa 2016; Dhimurru 2006,2015; Djelk Rangers 2013; Garawa 2014; Smyth 2004; Seed 2016)
Often shared	Information on bioaccumulation of pollutants in fish and other aquatic resources (Dhimurru; Garawa)
Unique or less frequently shared	Information on sea bed mining and potential damage to the sea bed, destruction of sacred sites and severing of song lines (Anindilyakwa)

Although not raised specifically in the documents considered, social and cultural impacts of competition with other land use associated with ramifying infrastructure for unconventional oil and gas extraction may also arise in consultations. Implications for continued access, land (fire) and resource management in exploration and extraction areas are likely to be of particular interest.

Available Research

Some research is available on well established mines and mining practises that have been operating for some time, or are legacy mines in the Northern Territory (Altman and Martin, 2009; Scambary, 2013; Laurecont 2013; NTEPA 2013, 2014; Wollard; 2014). Key issues are Traditional Owners' access to information that is localised and up to date in order to make informed decisions about mining projects on their country and ensuring best practise in operation and rehabilitation. The quote below illustrates the nature of some of the concerns.

“Most recently, at the end of 2013, volatile pyrite iron sulphide was dumped onto a waste rock pile at the mine (McArthur River Mine) and caused spontaneous combustion. The waste rock pile continues to burn, sending toxic smoke into the air and contaminating the water systems. An independent environmental report assessing data from Glencore and the NT Department of Mines has reported on a number of serious issues. These included high levels of lead in nine out of ten fish caught in nearby Barney Creek; an increase in dust levels around the site; and the potential for waste rock pollutants to spill into nearby water systems, including seeping of sulphuric acids. Glencore has been asked to carry out an Environmental Impact Statement to respond to the problem, but this may take up to two years to complete². For people living in Borroloola, fishing is their livelihood and the McArthur River is the lifeblood of the community. We continue to support our people and neighbours in pushing for Glencore to be transparent and accountable for the impacts caused by current pollution.” (Garawa, 2014: 40).

Independent monitoring at McArthur River mine has revealed elevated metal levels (lead and zinc) in samples of fish and molluscs from a number of sites (ERIAS 2016). Cattle exposed to lead have been destroyed.

Another significant knowledge gap is the environmental and social impacts of unconventional oil and gas production. For example, ongoing research in the United States has found a significant increase in methane emissions. However, Australia does not have the baseline data for a standard to measure against (Lafleur et

²The Environmental Impact Statement for overburden management was lodged in March 2017.

al., 2016). Methane is a green house gas that has a global warming potential about 30x higher than carbon dioxide (IPCC, 2014).

In the Northern Territory there is currently an inquiry into hydraulic fracking, with background information outlined in an issues paper (Northern Territory Government, 2017). Information on unconventional oil and gas production will be particularly important to Traditional Owners if (when) the moratorium on fracking in the Territory is lifted (Dias, 2016).

TOURISM AND OTHER LOCAL LIVELIHOODS

Many Traditional Owners in the Northern Territory want to explore opportunities in tourism and other local initiatives that utilise or otherwise depend on healthy natural resources. There is a particular emphasis on creating employment opportunities and supporting people to be on country (Table 6).

Table 6. Tourism and local livelihoods

Most shared	<ul style="list-style-type: none"> Information on impacts and opportunities of tourism including pressures on coastal and marine environment (Anindilyakwa, 2016; Cobourg Peninsula Sanctuary and Marine Park Board of Management 2011; Dhimurru 2006, Djelk, Garawa; Tiwi)
Often shared	<ul style="list-style-type: none"> Identify and quantify potential impacts and opportunities for use of natural resources across a range of sectors, which are consistent with the protection and maintenance of cultural and environmental values (Anindilyakwa; Garawa; Tiwi)
Unique or less frequently shared	<ul style="list-style-type: none"> Support for creating information for tourists on cultural sites and values (Garawa) Information on Indigenous business and employment opportunities in local tourism industries (Garawa) Identify potential impacts associated with heritage, cultural and ecotourism ventures (Anindilyakwa) Information on erosive nature of visitor pressure e.g. vehicle traffic (Dhimurru)

Whilst issues documented in sea country plans are dominated by present experience with tourism, other small scale enterprises (e.g. in sale of bush tucker) that are often associated with tourism can also be expected to arise.

Available Research

As the environmental impacts of mines are better understood and they reach the end of their economic lives, there is recognition of the need and opportunity for Traditional Owners to diversify their economic options (Altman, 2014). Tourism is an important option which is already taken up in many locations and there has been some research on developing opportunities in Indigenous tourism (e.g. Buultjens et al 2010).

There is a particularly large knowledge gap in identifying what other industries and development opportunities are available that place Aboriginal and Torres Strait Islanders as actors in this space. Useful future research would build on scoping studies for livelihoods (NAILSMA 2012a) and the West Arnhem Land Regional Economic Development Scoping Study (CentreFarm 2014). Additional areas of research raised by these and other studies of local livelihood opportunities are discussed in more detail in later sections of this report.

Opportunities need to be evaluated in ways that recognise and value interdependencies between different economic activity undertaken by Indigenous people in remote and regional areas (Altman, 2005; Russell, 2010).

PORTS AND URBAN DEVELOPMENT

Most of the Territory coast and offshore environments are relatively undeveloped, with substantial urban concentrations on the coast only at Darwin and Nhulunbuy. It is unsurprising then that concerns about changes associated with port development and operation and urban development are confined to groups whose lands are occupied by such developments. Concerns appear well-founded, being based on experiences with spills of mining-related pollutants and fuels at both centres and the Bing Bong port facility near Borroloola. During 2016 there were recommendations from the NT Department of Health that fish from sites associated with the McArthur River mine not be consumed due to metal contamination.

Recent environmental concerns identified in relation to Darwin Harbour include: *E. coli* (bacteria) outbreaks, spills of copper concentrate and oil, clearing of mangroves for urban development, industrial and port development, fishery trawling, overfishing, seabed disturbance, by catch issues, sea level rise, and climate change. <http://www.topendcoasts.org.au/resources>

Table 7. Ports and urban development

Often shared	Information on threats from port and urban development (Larrakia, Dhimurru)
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Available Research

Water quality in Darwin Harbour has been summarised annually in the form of a Report Card (since 2009). Aquatic pest, dolphin and beach monitoring is also undertaken. <http://www.denr.nt.gov.au/water/darwin-harbour/reportcards>.

Inpex, operators of the Ichthys LNG Project in Darwin Harbour, undertake environmental monitoring including water quality and subtidal sedimentation, intertidal sedimentation and mangrove community health, coral, seagrass, marine pest, recreational fishing and fish health, coastal dolphin, turtle and dugong. <http://www.inpex.com.au/our-projects/ichthys-lng-project/ichthys-commitments/environment/monitoring-the-environment/>

Some Larrakia Traditional Owners have expressed concerns relating to the safety of eating shellfish from particular waters in the harbour which has led to a research collaboration which will analyse metal trace levels and microbial populations in shellfish and other marine invertebrates collected near sewage outfalls and industrial areas compared to samples collected from reference locations. <https://riel.cdu.edu.au/news/2012/none/keeping-bush-tucker-healthy>

FISHERIES

The coastal and marine areas of the Territory support significant habitat and fisheries populations that enable commercial, recreational and Indigenous fisheries alike. Fishing has been an essential part of life for sustenance, trade and culture and ceremony for as long as Aboriginal and Torres Strait Islanders have lived in coastal and marine areas in Australia.

International trade for trepang (sea cucumber) with the Macassans occurred for centuries before European settlement and there are estimates of its equivalent contemporary economic value being as much as \$100 million annually (C-AID consultants, 2010). There was also significant involvement of Aboriginal and Torres Strait Islanders in commercial fisheries during the 1960s and 1970s. This declined following the introduction of stricter regulation and licencing in the 1980s, which made it prohibitively expensive to enter and operate within the commercial fisheries sector in the Territory (C-AID Consultants, 2010; Department of Primary

Industries and Fisheries, 2003, 2004) Thus, there is a traditional and contemporary interest of Traditional Owners in fisheries and its effects on sea country. Specific research issues are outlined in Table 7.

Table 7. Fisheries Issues

Most shared	Impacts of commercial and recreation fishers including information on: Threats to marine sacred sites Overfishing and by-catch, especially in feeding and breeding areas Impact of on habitat, e.g. vessel damage to sea grass beds (Anindilyakwa 2016; Dhimurru 2006; Garawa, Living on Saltwater country; Tiwi Islands)
Often shared	Impacts and opportunities in aquaculture (Dhimurru 2006, C-AID doc., Anindilyakwa, 2016).
Unique or less frequently shared	Fish population surveys (Djelk) Fisheries compliance monitoring (Garawa) Collect information on Indigenous fisheries to support inclusion of Indigenous fisheries in resource sharing and management (Garawa)

Effects of large scale aquaculture on water availability and quality and risks of exotic disease have been raised by the proposed Project Sea Dragon, and can be expected to attract future interest.

Available Research

While there has been substantial research into fisheries, it has emphasised commercially managed species, such as prawns, for many decades (Burford, 2010; Somers, Crocos and Hill, 1987) The most recent Fisheries' Status Report by the Department of Primary Industries and Fisheries (DPIF) provides an overview of the most recent data and information on several managed commercial species (DPIF, 2014).

There is a lack of research into Indigenous fisheries. Until 2010, there had only been one survey conducted on Indigenous fisheries practise by Henry and Lyle as part of a nation-wide study of recreational and fishing practises (2003). While an extensive and comprehensive study, it has also been criticised by Traditional Owners as misrepresenting fishing practises (Dhimurru, 2006).

The most recent and only other published survey into customary fishing was by Saunders and Carne on Groote Eylandt (2010). Providing insight into the catch of culturally and ecologically significant species on the island, it stands out as an example of successful collaborative research. This study will be further explored later in the report.

AIMS has done relevant research on opportunities in "low tech" aquaculture in which populations of commercially valuable marine organisms (e.g. sponges: Duckworth and Wolff 2007) grown in natural systems may be artificially supplemented or protected from predation. The Darwin Aquaculture Centre is conducting applied research on a number of species, including trepang.

Thus, there are large information gaps when it comes to Indigenous fisheries that must be addressed. This is particularly important within the context of government, commercial and recreational fishers and Aboriginal communities negotiating fisheries access and management following the Blue Mud Bay decision (Case study 1). Obviously there are also issues around the potential for Aboriginal people to take up larger roles in

commercial fisheries (DPIF 2012). Related issues around resource allocations are considered in other parts of this paper.

Case Study 1. The Blue Mud Bay Decision

In July 2008, the High Court of Australia upheld the decision that the Northern Territory government could not grant access to waters covering Aboriginal Land (*Northern Territory of Australia & Anor v Arnhem Land Aboriginal Land Trust & Ors (2008) HCA 29*). This means the Department of Primary Industries and Fisheries does not have the power to issue commercial and recreational fishing licenses over the majority of the intertidal zone, where much fishing activity in the Territory take place (DPIF, 2014). Access to these waters requires the permission of Traditional Owners.

Since 2007 Traditional Owners have been negotiating with the Northern Territory government, and other fisheries stakeholders, through the relevant Land Councils on how best to address this issue of access. A delegation of various stakeholders including representatives of government and commercial, amateur and Indigenous fisheries interests' also travelled to New Zealand to learn from the example of Maori fisheries management (Calogeras and Sarneckis, 2009). Extensive consultations have taken place since the decision (C- AID Consultants, 2010; Martin, 2011) and more recently (NLC LES).

While the initial government position of seeking “enduring and certain access...without individual access permit or access fee” has evolved as a result of Traditional owners voicing their concerns and aspirations around protection of country and sacred sites there is frustration over the slow process of negotiations (La Canna, 2017).

Traditional Owners views in the Blue Mud Bay consultations have been consistent with the view expressed over the course of numerous Indigenous fisheries and sea country consultations over the past decades such as:

- Desire for genuine engagement, inclusion and ability to influence fisheries management
- Greater powers of surveillance and enforcement for sea rangers
- General desire to keep a permit system, despite logistical and administrative challenges, in order to protect sacred sites, generate economic opportunities, and reinforce recognition of Aboriginal ownership.
- Frustrations and cross cultural communication issues over the limited recognition of sea country rights – sea country extends far beyond the intertidal zone and in Yolngu (the lingua franca of Arnhem land) there is no singular word for the intertidal zone
- The need for long term collaboration between Traditional Owners and NTG that is inclusive of transfer and transparency in information, including science around local catch effort and local knowledge of which licences or other fishing access is occurring
- Strong desire for fisheries resources to be enjoyed by the next generation in as good a condition, if not better, than present
- Demand for better ways for government, industry and Traditional Owners to interact to give expression to and achieve policy responses to the large stake that Aboriginal people have as owners and custodians of lands and waters and their resources.

The Northern Territory Government has, since the Blue Mud Bay decision, released various frameworks and strategies with the aim of addressing Aboriginal roles in fisheries management in the Territory. These include the Indigenous Fisheries Development Strategy 2012-14, and the Northern Territory Fisheries Resource Sharing Framework 2013. Neither has resulted in major change in approaches to commercial and recreational fisheries management and little traction to enhance TOs roles in fisheries management and decision making processes.

More recently however, through NLC processes to resolve access arrangements in its jurisdiction, the paradigm is shifting to position Traditional Owners in determining their interests to control access and manage sea

country from the previous negotiation processes based on compensation for permit free access. The NLC is working to secure a participatory planning process to empower local decision making on fishing access and management arrangements.

ADDITIONAL RESEARCH NEEDS

EMERGING AND UNDOCUMENTED ISSUES

We have noted that the specific issues documented by Indigenous organisations came from a small subset of coastal regions and focused on matters associated with establishment of protected areas.

Some Aboriginal organisations have also put statements of interests in particular development options. Often they are offered in response to promptings from external interests like researchers or government agencies: in other cases assembled by local Aboriginal organisations. The summary to follow is dominated by studies done by TopEndFarm / CentreFarm under contract to the Northern Land Council from 2012 to 2014 (Centrefarm 2014). This work appears to be the most comprehensive assemblage of systematically gathered Aboriginal views of favoured forms of development in the NT.

Areas of expressed interest, in approximate order of frequency raised, include:

- tourism;
- land management, often identifying Ranger work;
- horticulture, often small scale;
- pastoralism, often small scale;
- wild harvest, especially of feral animals;
- fisheries, including a few references to aquaculture;
- various minor construction and maintenance services, especially fencing and roadworks;
- forestry, usually around harvesting of natural stands rather than establishing plantations;
- manufacturing only in regard to furniture-making and minor processing of bush products;
- mining *per se* was infrequently raised, and most around construction and maintenance services to mines or small scale quarrying to provide gravel and sand; and
- a couple of references to cropping are about hay production.

Most of these options involve working on country, and using renewable resources present on country. Unsurprising, frequently-raised options appear to be those in which informants have direct experience, because they are or have been in the past available in the remote areas in which they live. And options to which people have direct exposure are mostly of low intensity, like extensive pastoralism or tourism.

For more intensive uses like horticulture, experiences are often small scale. Informants raising horticulture often referred to small domestic gardens used to meet local domestic needs or service local markets. Benefits from these options are most often expressed in terms of local employment, especially for the young, rather than incomes (royalties) for landholders. Frequent references are made to connecting activities to each other, often placing land and sea Rangers at the centre.

There has as yet been no opportunity to “test” these preferences in detail with communities. Nor have people been asked to identify knowledge and research needs connected with them. But the requirement for better information and for systematic interactions between landowners and external informants with detailed knowledge of these activities in other, contemporary settings is illustrated by the observation that options identified by Aboriginal informants often differed from those thought plausible by the consultants recording their views.

Approaches to searching, collaborative examinations of these and other options and the research issues they raise are considered in the next section.

ECONOMIC AND SOCIAL POLICY, GOVERNANCE AND LEGAL ISSUES

Our examination of a set of statements from Indigenous organisations and groups regarding issues in Indigenous economic participation and northern development suggest several areas where targeted research may be useful. In making this assessment we have interpreted research to include investigation and analysis for applying existing knowledge, as well as activities generating entirely new knowledge.

The topics to follow consider recurring emphases in these statements about land (and sea) access, economic development and related policy that may have implications for both the choice of research questions and design of programs and strategies.

ACCESS TO INDIGENOUS LANDS AND SEAS

“... any approach on Indigenous land and waters that does not properly recognise and respect traditional ownership .. (whether or not that ownership is fully recognised at law) will only lead to ill feeling, project uncertainty and delay.”

“... development on Aboriginal land and waters will only be successful and sustainable where Indigenous people are provided with the opportunity to be partners in development ...” (Expert Indigenous Working Group advising the CoAG Senior Officers Working Group (SOWG 2015) on land administration and use)

“Indigenous rights and interests in land and waters must be respected, and rights holders should be able to make choices about how they use their land.” (CoAg Senior Officers Working Group 2015).

Submissions to and from government and industry prior to the high level reviews from which the statements above are taken often sought reduction of rights to make development decisions, including government takeover of development on Aboriginal lands (e.g. NTG 2014). More equitable and productive approaches to gaining access to Aboriginal lands and waters will involve genuine partnerships. Developing models for such partnerships and the governance systems to support them could be an important focus for research, along with the processes and tools for sharing information for timely and sound decision-making.

LAND USE PLANNING / ECONOMIC DEVELOPMENT PLANNING

“ ... in addition to law reform, Indigenous people need to be supported and resourced to fulfil their potential and engage with the mainstream economy”. (Expert Indigenous Working Group advising the CoAG Senior Officers Working Group (SOWG 2015) on land administration and use)

“The ... approach of the Indigenous Experts Forum requires that policies:

- support local, bottom up planning for generating incomes from Indigenous land
- link Indigenous rights in resources, including commercial use, to ownership of land and water”. (NAIEF 2012)

“To drive the implementation of the Indigenous empowerment policy on the ground, each region will need to establish development agendas” (Empowered Communities Steering Committee 2015)

“ The (Northern Australia Indigenous Experts) panel proposes an Indigenous Prospectus for Northern Development ... set(ing) out the benefits that Indigenous investors seek from their lands and waters; the ways that co-investors can also benefit; the conditions under which investments will be sought and accepted; ... and the strategies and plans needed to realise national benefits from full Indigenous participation in northern development”. (NAISMA 2013)

Effective partnerships depend on all parties understanding the opportunities at stake, the risks involved, realistic appraisal of benefits and cost, and the best methods of achieving them. In short, they depend on

planning. At present most Indigenous landowners lack the systems needed to aggregate and interrogate available data for robust land use planning. Designing and testing systems of support, including tools suited to and usable by landowners in remote setting will be an important area for applied research. Exploring the biophysical and socioeconomic implications of new options will be a rewarding and essential component of that research in all settings, including marine.

RESOURCE ACCESS AND ALLOCATION

“The ability for Indigenous people to fully utilise their property rights to create wealth and prosperity is critical (and) ... “law and policy needs to be amended to enable this”. (Expert Indigenous Working Group advising the CoAG Senior Officers Working Group (2015) on land administration and use)

“We urge governments to ... to enable the equitable participation of the Indigenous owners of Australia in the development of policies, setting of allocations, and management of regulatory schemes” (NAILSMA 2012b)

“Any water allocation plan in tropical Australia must, irrespective of historical allocation, include an equitable Indigenous allocation from the consumptive pool for commercial purposes” (NAILSMA 2009a).

These statements reinforce obligations to redesign policy instruments to provide for more equitable Indigenous access to resources, and ways of managing change in management regimes in productive (non-disruptive and mutually beneficial) ways. There are presently no agreed formulae for working out how to add Indigenous allocations to existing resource management regimes, which is especially challenging where they have been fully or even over-allocated without considering Indigenous landowners rights and expectations.

Negotiations over such issues must be underpinned by high quality research and analysis of the biophysical and socio-economic implications. Redesign of management systems and the legal and related instruments for implementing them to provide the predictability sought by both industry and landowners will be challenging and will benefit from independent review and analysis.

The Fisheries Resource and Development Corporation Indigenous Reference Group has identified research, development and extension priorities for fishing and aquaculture with cultural allocations identified as a priority.

COMMUNITY-BASED AND/OR CO-MANAGEMENT OF NATURAL RESOURCES

“... Sustainable Livelihoods ... (require):

- responsive and participatory planning and implementation
- activity focused partnerships
- outcome-based monitoring and evaluation ..” (NLC 2014)

“... various governments have raised options for devolution of powers in some areas of natural resource management ... arrangements need to go well beyond the more or less tokenistic consultative mechanisms that operate in areas like commercial fisheries” (NAILSMA 2012)

“... relevant laws should be amended to establish co-management as the preferred approach to managing sustainable use and conservation of wild plants and animals of significance to Indigenous people” (NAILSMA 2014b)

“ all management programs for wildlife important in the customary economy or valued for other reasons should be developed jointly with Indigenous interests and implemented at regional and local scales with or entirely through local Indigenous experts.” (NAILSMA 2014b)

“Neither traditional knowledge nor orthodox science needs or seeks validation in terms of the other, but skilled practitioners jointly seek the best solutions to management problems” (NAILSMA 2014b)

One of the strongest and most consistent messages from Traditional Owners of sea country is that they lack the influence needed to discharge their obligations under traditional law. Respect for traditional knowledge is urged mostly rhetorically in treatments of research and resource management policy. The best way of showing respect will be to develop systems for Indigenous custodians to apply such knowledge. Co-management or community-based management of marine resources has been an area of active research and experimentation in other nations for decades. Opportunities should be taken to frame and test new models in an adaptive management environment, perhaps using action research techniques.

MEASURING BENEFITS AND COSTS

Each (plan) “should also identify indicators used to measure progress ... and how each party is meeting its responsibilities”. (Empowered Communities Steering Committee 2015)

“Success in joint management will be indicated as much by its social outcomes as its biophysical” (NAILSMA 2014b)

“ ... consultation results show significant continuity of core values, aspirations and views amongst Indigenous people across the savannas, notwithstanding important local and regional differences. There is, as expected, little continuity of actual monitoring of these foundational values or indicators derived from them to date. This research shows that a number of other indicator sets and sources of monitoring exist across the Indigenous land management sector – some more useful than others. Perhaps the most useful are those developed by locality based land manager corporations ...” (NAILSMA 2012)

Research on ways to embed Indigenous views of important values and outcomes from management is in its infancy (Robinson et al. 2016). Much more study is required on design to demonstrate achievement consistent with traditional norms and obligations and to foster active participation in measuring, interpreting, reporting and responding to outcomes of changed policy and practice.

CUMULATIVE AND OFF-SITE ENVIRONMENTAL IMPACTS

“Our fish, creeks and waters are slowly being poisoned by mining companies. Our river’s been diverted ... They made a huge rock pile too. And that’s full of toxic waste that’s gonna slowly leak acid into our waterways. On top of this we got the fracking mob turning up” (Jack Green in Kerins and Green (in review))

“... it is uncertain to what extent wider scale water dependent opportunities are achievable and sustainable. This uncertainty is heightened when water access is evaluated with regard to the critical issue of maintaining water flows required to protect cultural and environmental values on Indigenous- held land” (Indigenous Land Corporation 2014)

Local capacity to deal with complex issues such as cumulative impacts - of multiple exposures to multiple on and off-site effects - is rudimentary. Increased risk of additive or synergistic effects is an inevitable consequence of accelerated development and new forms of land use. As discussed in regard to planning, Indigenous people presently have little or no access to the tools necessary to reveal risks of cumulative impacts, let alone provide quantitative or even ranked qualitative assessment of risk and options for risk treatment. There is an urgent need for development of improved tools for analysis and presentation of such effects.

POLICY REVIEW AND LAW REFORM

“Key shifts in policy for Indigenous development in northern Australia must include:

- serious, integrated planning processes that:
 - instead of setting up competing development and conservation plans, treat both together
 - deploy economic development as a solution to improve and sustain environmental quality and address social problems
- “... match(ing) government programs of all sorts to deeper understanding of local context and aspirations” (NAIEP 2012)

Recurring themes in assessments of government policies and programs in Indigenous affairs are that they are disconnected, discontinuous and sometimes in conflict. Despite centralisation, mismatches across portfolios are common (e.g. NAILSMA 2015). Recent formal audits have revealed severe problems of design and delivery of core programs, with damaging effects on competent local organisations (ANAO 2017) on which local development will depend. There is an ongoing need for independent review of programs to reveal problems and promote greater coherence. Bringing policy goals around northern development and Indigenous socio- economic advancement into alignment is an obvious candidate for serious work, at both an overarching conceptual level and in the elements discussed elsewhere. Opportunities and obligations to make productive advances in the marine environment have been opened up by the Blue Mud Bay decision.

EMERGING COMMERCIAL OPPORTUNITIES

- “... (too) little consideration of emerging economic opportunities, including carbon and other offset industries.” (NLC 2014)
- “... planning to include thorough examination of new options for ... payment for ecosystem / environmental services originating on Indigenous lands” (NAILSMA 2014b)
- “Explicit incorporation of commercial environmental services in procurement policies to favour Indigenous providers can provide an essential bridge to routine engagement with other aspects of the mainstream economy, at low or no additional public cost” (NAILSMA 2015)
- Fishing – ACLs, holding commercial licences

The northern development focus has been on large scale interventions to promote orthodox industry with benefits expected to “trickle down” to north Australia’s resident populations. However, numerous analyses have shown that little benefit reaches remote and Indigenous people through favoured industries, even when large developments occur on their lands. There is an obvious need for smaller scale activities that are better matched to the present interests and skills of Indigenous residents of regional and remote areas. AIMS and other research organisations have looked at opportunities in “low tech” aquaculture and governments have sought participation in small scale local wild catch fisheries. A few options, especially those deploying traditional knowledge in land and sea management, may be commercially viable in isolation, but many more could form part of a viable mix. However, such inter-dependent “hybrid” enterprises can be complex and fragile. There is great scope for research to identify new opportunities and in particular to develop management, financial and governance systems capable of dealing with such complexity. The existing Ranger systems offer working models that often depend on multiple incomes from disparate sources. Research to apply lessons from existing successes that incorporate Indigenous governance principles matched to local context is a potentially rewarding area of study.

IMPLICATIONS

The issues discussed above illustrate only a few of many areas of applied research applicable to Indigenous roles in use and management of the marine environment and its resources. Levels of interest in pursuing these issues and others will be determined in consultations.

Many of the research questions they raise straddle elements of traditional descriptive or hypothesis-driven research in the biophysical sciences; social and community development; planning theory and practice; design

of effective resource management policy instruments; and political science. They are inherently complex and often difficult, but if not addressed, the impacts of ignorance on management effectiveness and the well-being of Indigenous landholders and their communities may be profound.

Engagement of Indigenous people in these and other research activities may be achieved through action research methods. Stringer (2007, p. 1) describes action research as "a systematic approach to investigation that enables people to find effective solutions to problems they confront in their everyday lives". It focuses on localised solutions rather than necessarily seeking generalisations. Such an approach obviously differs strikingly from the way most biophysical research is conducted, where capacity to generalise is treated as an essential feature of good research design. The approach demands much more from researchers than technical skill.

Research protocols developed by Indigenous organisations often embody aspects of the action research orientation. For example, in NAILSMA (2007) guidelines it is indicated that research "should:

- address community landholder goals and aspirations
- promote Indigenous management and control and protect Indigenous rights under Indigenous law
- promote and support natural and cultural resource-based enterprise and economic activity, especially when linked to customary practice
- increase respect, understanding and use of traditional knowledge and skills and
- assist Indigenous people to be active on country."

As indicated earlier, we do not suggest that only research overtly adopting action research methods will be of interest to Indigenous people. However, researchers seeking to engage with Indigenous groups should be aware of the expectation that work will - in one way or another - address practical local problems and thereby help contribute to improvements in well-being. Some of the issues this raises are considered next.

BEST PRACTICE AND NEXT PRACTICE

'BEST PRACTICE' - MEETING END USER NEEDS

Aboriginal and Torres Strait Islanders' research needs as end users are distinctly different to others in that they will not be solved by simply conducting more conventional marine science.

For example, a recent study published on mangrove dieback in the Gulf of Carpentaria (Duke et al., 2017) would very likely be of interest to Traditional Owners in that region. Published in a scientific journal, this article is accessible via a paid subscription. Thus, the primary source is only available to an audience that has the financial means (or the institutional affiliation) to access such publications and the technical capacity to engage with a scientific report presented in this way. On both accounts, Indigenous communities are disadvantaged. Naturally, independent, comprehensive science requires funds and comparative standards. However, this example highlights the importance of additional targeted science communication and that in this cross-cultural context of meeting end user needs, the knowledge needs of Aboriginal and Torres Strait Islanders cannot simply be addressed by publishing more papers.

This provides challenges and opportunities to meet information needs that embrace a more interdisciplinary and transdisciplinary practice of science. Creative and innovative science communication strategies will need to be further explored. To accurately present the end user needs of Aboriginal and Torres Strait Islanders in marine science there must be a consideration of what knowledge is missing or needed, as well as how research is conducted, presented and of its outcomes.

For meeting research needs for Traditional Owners as end users of marine science there must be a consideration of broader issues including:

- **Scope** - Mechanisms are required to ensure that Indigenous interests have real opportunities to participate in framing research questions, and design and implementation of research programs and projects that directly address their values, concerns and interests. The obligation to achieve real engagement also extends to areas that Indigenous people have not identified as high priority, but acknowledge to be important to others and that have the potential to influence policy and/or practice affecting lands, waters and resources in which they have actual or potential customary or commercial interest.
- **Communication** – Cross cultural communication be a challenge between Indigenous and non-Indigenous people researchers and communities, particularly if all consultation, research and study outputs are in English. Consultation, collaboration and research outputs must consider how to be culturally sensitive and cater for varying levels of English and literacy.
- **Access** - As identified, available science relating to the information priorities was in some cases, only available via subscription access academic journals and databases. As such, there is a current large lateral gap in knowledge. Consideration must be given as to how current knowledge can be shared more effectively and how future research can be provided back to communities in an appropriate and timely format.
- **Consent and intellectual property** – Free, prior and informed consent must be negotiated prior to research and intellectual property rights recognised in the publishing of reports and materials (Ens, 2015).
- **Scale and context/recognition of localised interests and issues** – Indigenous knowledge is held in place, and therefore not generally regarded by its custodians as directly applicable to other locations. Non-Indigenous researchers must be aware of working at scales applicable to Indigenous interests and showing how work from other places and situations is relevant.
- **Compensation** – In the case of collaborative research driven primarily for a non-Indigenous research agenda, researchers should negotiate agreed compensation with Aboriginal and Torres Strait Islanders as participants of, or contributing knowledge to, a research project.
- **Use of Indigenous knowledge** – Care must be taken to ensure an equitable collaboration without the appropriation of Indigenous knowledge out of context to simply inform the western research agenda (Barbour and Schesinger, 2012). Also, there is some knowledge that cannot be shared publicly (Figure 2).
- **Governance** – Science research exists within broader political, environment, political and historical contexts. Consultation fatigue can be an issue as Land Councils and Traditional Owners continue to provide information and explanations to changing government and research bodies in an uncertain and erratically shifting policy and funding landscape.



MARGARET ORR

In the middle of the painting is a Council meeting. Grey people (U) are seniors, the old people. Brown U are the community members. White U are the visiting research workers. The meeting gives permission for visiting researchers to go out and talk to the community. One group of community people talk into tape recorders (U with rectangle above). They can decide if their stories are OK to share or if they are private and confidential. Other people talk and the researchers write down what they say (white books). The people are OK for the researchers to take their words away for the research, but they have to give a copy to the community people. Another group talks up strong to the visiting researchers and gives them good ideas but says the stories are confidential (brown books), and the researchers can't write them down.

FIGURE 2 [HTTP://WWW.NINTIONE.COM.AU/RESOURCE/ABORIGINAL-KNOWLEDGE-AND-IP-PROTOCOL-COMMUNITY-GUIDE-BOOKLET-A5.PDF](http://www.nintione.com.au/resource/Aboriginal-Knowledge-AND-IP-PROTOCOL-COMMUNITY-GUIDE-BOOKLET-A5.PDF) - CLC BOOKLET P. 20

An example of a successful recent research collaboration between government, researchers, sea rangers and communities is of the shark and stingray survey on Grootte Eylandt (Figure 3.) A key element of the project's success was recognised as the underlying partnership between community and researchers (Saunders and Carne, 2010).

CASE STUDY 2 – SURVEY OF CUSTOMARY FISHING OF SHARKS AND STINGRAYS: GROOTE EYLANDT

Recognising the cultural and ecological importance of sharks and stingrays and the lack of information on Indigenous fishing practices, this report aimed to address what is a successful method for collecting information on shark and ray harvesting by Indigenous people.

The four phases of the project were:

1. Consulting and forming a partnership
2. Developing the survey
3. Identifying a method to sample a broad section of the community (engagement)
4. Implementing and conducting the survey

Acknowledging that current research practices had not been successful in obtaining information, a key consideration of the study was the survey framework and design. Anindilyakwa sea rangers and researchers worked together for eight months to produce a survey that was culturally appropriate and easy to use.

The final survey design was a poster with images of the species to be surveyed as well as their common, scientific and Anindilyakwa names (Figure 4). Thus, the survey supported the use of Anindilyakwa language and could easily be placed in a prominent place in the home. Images also helped identify species better.

Extensive consultation on how to involve participants led to the survey being conducted at two local schools in the communities of Angurugu and Umbakumba and imbedded into the curriculum.

Participation was high and survey information was collected on blacktip shark, speartooth shark, giant shovelnose ray, cowtail stingray, roughskin stingray, barramundi and mud crab, green turtle and dugong species. Survey sheets were completed weekly at schools for a six month period.



Species other than sharks and rays were included at the request of the Anindilyakwa sea rangers and the Department of Resources in order to support ranger work and other research projects. This project has in turn led to various community benefits, such as engaging school children in learning and creating junior rangers employment opportunities. The Anindilyakwa sea rangers will continue to carry out and expand on the survey in phase II of the project.

This case study highlights the opportunities and challenges of collaborative research in the marine space. From the beginning of the project researchers recognised the need to create a project design that was contextually and culturally appropriate. As a result of the innovative research method, there was successful community engagement as well as social, educational and employment benefits.

Limitations of the project and future improvements are acknowledged and suggested in the report. Recognising these, this report still stands out as a useful example of how marine science research may be conducted in a collaborative and culturally sensitive manner. The study contributed to greater understanding of Indigenous fishing practices (a knowledge priority identified in this study) and had a net benefit to the community more broadly.

‘NEXT PRACTICE’ - INDIGENOUS-DRIVEN RESEARCH

As previously stated, the capacities and contexts of Indigenous communities with sea country in the Northern Territory are diverse. As communities continue to build up their capacity to engage with the western science community on their own terms there is growing research, which is the result of two-way collaboration driven by Indigenous interests and actions (James and NAILSMA 2016; Dhimurru, 2013; Ens, 2012, 2017). This marks a growing change that will continue to expand, away from research projects primarily being founded on only non-Indigenous actors, interests and priorities.

With Aboriginal and Torres Strait Islanders as stronger stakeholders, researchers and scientists in this space, the role and practice of non-Indigenous scientists and researchers may also evolve. For example, researchers in North East Arnhem land recently published a paper exploring how an Indigenous research methodology can support and inform western academia (Wright et al., 2015).

A key issue will be how research is conducted and approached in different contexts. For example, how to encourage Indigenous-driven research in terms of realising Traditional Owners’ research priorities for communities who have information needs but not the capacity to act on them. As well as supporting communities to engage with, commission and/or conduct research for themselves where appropriate, and building their capacity to do so.

This further highlights the heterogeneity of interests and capacities between community groups and of the critical importance of context in prioritising and designing research. It also presents the opportunities available moving forward to conduct new and original marine science research.

CONCLUSION

This report has endeavoured to present the knowledge needs of Indigenous people as end users of marine science in the Northern Territory to the extent that those needs have been identified in the literature. As customary and legal owners of much of the land and sea in the Northern Territory, Aboriginal and Torres Strait Islander people have information needs that are critical to supporting informed decisions on how to care for, develop and utilise sea country.

The review identifies key sectors of interest and a broad overview of available research in each of those sectors is offered. Relevant policy and programs have also been presented. Consideration is given to research needs relevant to Indigenous economic participation in northern development and takes in economic and social policy, governance and legal issues, including resource access and allocation concerns. This report has gone on to highlight the broader considerations that must be taken into account when conducting research in this context such as communication, access, consent and intellectual property, scale and context, compensation, appropriate use of Indigenous knowledge and governance.

Aboriginal and Torres Strait Islander peoples’ research interests go beyond informing external conservation and development agendas. These interests are not limited to informing western biophysical science or providing others with the ‘social licence’ to operate on their estates. The social and environmental obligations of government and industry can only be met through recognition of the underlying rights and interests of Indigenous people to conserve, manage and use natural resources, including marine resources.

It is in the interests of all to ensure Australia’s coastal and marine environments in the Northern Territory are better understood so that they can be better managed and cared for. Seriously addressing the research issues and approaches outlined here will support Traditional Owners’ interests in creating increasingly resilient societies of healthy people on healthy country.

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Appendix 2 – Consultations

Summary of community consultation meetings

Region, community	Individual, Group or Agency	Method
Kimberley	Indigenous land and sea manager /Traditional Owner	Telephone interview
Torres Strait	Indigenous land and sea manager/Traditional Owner	Telephone interview
Nhulunbuy	Yirrkala Ranger Group Coordinator	Telephone interview
Maningrida	Djelk Ranger Group Coordinator	Telephone and face to face interview in Darwin
	Traditional Owner	Telephone interview
	Indigenous research practitioner/Traditional Owner	Face to face interview in Darwin
	Traditional Owners	Small group meeting in Maningrida
Borrooloola	Traditional Owners (Garawa)	Small group meetings in Borrooloola (2)
	Mabunji Board members	Small group meeting in Borrooloola
	Senior ranger (Waanyi Garawa Rangers)	Telephone interview
Ngukurr	Traditional Owner (Yugul Mangi)	Face to face interview in Darwin
Darwin	Larrakia Development Corporation representative	Face to face meeting in Darwin
	Larrakia Nation representative	Face to face meeting in Darwin
	Larrakia Rangers	Small group meeting in Darwin
	Traditional Owners (Larrakia)	Small group meetings in Darwin and Palmerston (2)
Galiwin'ku	Traditional Owners	Individual face to face meetings in Galiwin'ku

Note: Small group meetings ranged in size from 2-8 participants. In addition to the detailed community consultations and interviews noted above, preliminary discussions were held with Traditional Owners/Custodians, rangers and coordinators, Indigenous researchers, and other people with relevant experience to assist identifying issues and interest in further participation.

Sample consultation topics/questions

Looking after your sea country

What are the important things for looking after your sea country? What is going well with the management of your sea country?

Do you have worries about the way your sea country is being managed? What are they?

Do you need more information to help look after your sea country? Do you have questions that you think need to be answered right away?

Using your sea country

Are there new things that you want to do on your sea country to look after it better, or to make money, or to provide opportunities for family and community?

Have you heard about any activity that is happening on your country that may affect your sea country? Do you have any concerns?

Is your community involved in any business on sea country, e.g. commercial fishing? Are there reasons why your community isn't doing business on sea country?

Research

Have you worked with researchers and scientists before to understand more about your country? Is there research about your country that you would like to know more about?

Can you access research and scientific information easily, and how should you and other local people be involved in research about sea country?

Laws and policy for managing sea country

We have looked at statements made by Aboriginal organisations around the Territory about the need for better laws and policies that might affect the way governments try to manage what happens on sea country. To make better laws, they need to know what you think about the use of sea country.

Do you have a say in who comes into your sea country and what they do there? Are you involved in fisheries and other advisory committees? Are you confident your sea country and the important animals and places are being looked after?



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