

Indigenous Coastal Knowledge & Research Priorities: White Paper for the Urban and Coastal Theme, National Marine Science Plan



Photo: By Peter Morris. Wunambal Gaambera Indigenous Protected Area (IPA), North Kimberley WA.

Abstract (100 words)

Aboriginal and Torres Strait Islanders are major stakeholders in the management and protection of Australia's natural and cultural coastal resources. Traditional Owners have cultural and legal rights, and responsibilities, to sustainably use and manage their extensive land and sea country. They have deep ongoing connections to both land and sea and recognize them as inseparable. This world view requires research approaches and policy and management solutions that encompass indigenous perspectives, values, knowledge and aspirations from the outset. The demand for regional assessments and multiple use management tools that are underpinned by both science and cultural knowledge will only increase given national agendas for sustainable development and economic wellbeing. Research priorities will largely be determined by the need to facilitate complex tradeoffs between different values and uses.

Background

[Brief overview - who, how mature it is, how it rates internationally, who currently funds](#)

Indigenous use of coastal and offshore areas varies around Australia (NAILSMA 2012a). Saltwater people make extensive sea journeys in some places such as Torres Strait, whilst in other places use is restricted to coastal and intertidal areas (Smyth 2007, Barnett & Ceccarelli 2007). Dugongs (Nurse-Bray et al. 2010, Crase 2008, Marsh et al. 1999), turtles (Limpus & Chatto 2004) and many species of fish are important to Indigenous people and migrate between inshore areas along the coast and marine areas offshore, often long distances into Commonwealth waters, adjacent State/Territory waters, international waters or neighbouring countries. Indigenous people have sought recognition for their ongoing role in coastal ownership and management through numerous inquiries, forums, planning processes and legal claims, such as: the Coastal Zone Inquiry 1992-3 (Resource Assessment Commission 1993); the Turning the Tide Conference (1993); bioregional marine planning (National Oceans Office 2002, 2004); sea country planning (e.g. North Kimberley saltwater Country Plan 2010); land and native title claims (National Native Title Tribunal 2009, 2010, 2014; Barber 2005); fisheries consultative committees (FRDC 2012); and national workshops (NAILSMA 2012a; National Oceans Office 2002, 2004; National Sea Change Task Force 2014). Indigenous people are therefore critical stakeholders in coastal research with legally recognized ownership, management and cultural rights to the coastal zone. They have locally-specific cultural, linguistic and environmental knowledge about that domain, which is intimately tied to local ownership and traditional management protocols. Indigenous knowledge encompasses the interconnectedness of people with the natural world and, hence, the maintenance, transmission and continued development of such knowledge are important objectives for all Indigenous groups. In this sense Indigenous communities are themselves research and knowledge generators. A priority for Indigenous coastal knowledge today is the emphasis on co-generated research that will improve the social and economic wellbeing of communities by facilitating sustainable natural and cultural resource management (NCRM) of Indigenous traditional land and sea country.

Indigenous-oriented coastal research is generally undertaken in partnership between research institutions and Indigenous people, although independent research is regularly conducted by

regional land councils and indigenous agencies such as the North Australian Indigenous Land and Sea Management Alliance (NAILSMA). However, more frequently these agencies act as research partners and brokers, enabling connections and partnerships between research institutions, local indigenous group or community corporations and/or key indigenous individual spokespeople. Most major public institutions have sought these kinds of partnerships and, as a result, current national research efforts can be characterised as relatively diverse and decentralized. Nevertheless, with respect to NCRM in general and the Indigenous coastal domain in particular, some key concentrations of research capacity reside in:

- CSIRO - particularly the Oceans and Atmosphere and Land and Water flagships.
- Universities – most universities although effort varies considerably ranging from a few individuals to large research centres (e.g. ANU CAEPR/Centre for Aboriginal Economic Policy Research; see Scott 2004 for an outdated inventory).
- Commonwealth research hubs – e.g. Tropical Rivers and Coastal Knowledge (ex-CERF hub TRaCK); National Environmental Research Program (NERP) hubs (e.g. Northern Australia & Tropical Ecosystems hubs).
- Relevant future National Environmental Science Program (NESP) hubs (e.g. Tropical Water Quality & Northern Australian Environmental Resources hubs).
- Consultants and independent researchers (e.g. Dermot Smyth, Paul Josif & Nic Gambold).

The research is funded from diverse sources including: Commonwealth departments and agencies (e.g. AIATSIS, AFMA, DoE, PM&C and CSIRO) and associated programs (WoC, Cfc, NERP/NESP); government corporations such as FRDC (Indigenous fisheries & aquaculture - IFRG); tertiary sector funding (universities, ARC); TERN (NCRIS infrastructure), past and present CRCs (e.g. Tourism, Tropical Savannas, AgNorth). Research has increased considerably in the past few decades and there are now detailed accounts of Indigenous relationships with, and interests in, coastal environments and their management (see NAILSMA 2012a, Barber 2005, Bradley 2010, Peterson and Rigsby 1998, Sharp 2002). Nevertheless, the wider field of indigenous-oriented coastal research could not be described as mature because key research areas remain to be addressed (see Science Needs). Assessment criteria for such research usually prioritise local community participation and adoption (Sithole et al. 2007) and this has influenced the types of outputs generated and formal research impact metrics. For example, our Reference list reflects a strong bias to grey literature although many books have been published. The long lead times and continuity of community relationships needed to develop trust in order to elicit and share knowledge to publish is a major constraint. Additionally, few high impact science journals will accept these types of publications so standard national and international impact metrics are low. Resource economists and socio-ecologists have similar publishing constraints when cutting across social/biophysical disciplines. Nevertheless, research has generally been of high standard and often innovative with relevance to national and international policy contexts (see CAEPR 2012, 2013; NAILSMA 2012a; Kennett et al. 2010). In this sense, formal research impact through conventional journal publications represents an area of future opportunity.

Torres Strait

The Torres Strait marine resources are fundamental to the livelihoods of Torres Strait Islanders for their economic and social well-being. Research for the development and sustainable utilization of these resources has a long history in Torres Strait, and was initially primarily focused on the quantification and monitoring of fishery resources utilized by traditional owners for subsistence, commercial and cultural, purposes. This research has been undertaken by several institutions including CSIRO, James Cook University, Queensland DAFF, AIMS, GA, QLD Museum and several universities with the involvement of >100 scientists and students over the study period. Research on natural resources and the habitats that support them in Torres Strait is well evolved due to high levels of support from funding agencies such as the Australian Fisheries Management Authority, driven primarily by the high reliance on fisheries by Torres Strait Islander communities and obligations under the Torres Strait Protected Zone Treaty.

There have been major field studies focused on fisheries such as rock lobster, beche-de-mer, dugong and traditional subsistence fisheries, and on supporting habitats such as seagrass, coral reef and inter-reef benthic communities, that have provided key habitat and species data of direct relevance to fisheries for commercial and subsistence uses. Ongoing monitoring of fishery species and habitats has advanced our understanding of the dynamics of these natural resources.

Relevance

End-user analysis - who are the end users who benefit/will benefit from this research

Indigenous coastal communities will be the direct end-users and beneficiaries of this research, and indirectly all Australians, particularly in Northern Australia where they comprise about 64% of the total Australian Indigenous population (ABS 2002). The majority of Aboriginal and Torres Strait Islanders in Northern Australia continue to live on their traditional lands in remote settlements and homelands (Wohling 2009, Altman and Whitehead 2003). About 22% of land in Northern Australia is Aboriginal-owned and Indigenous people comprise about 25% of its population (Holmes 1996). Indigenous populations are increasing at twice the rate of non-indigenous people (ABS 2002), and this is a major demographic driver for a rapidly changing socio-political landscape in regional Australia. The existing level of indigenous disadvantage underscores the importance of prioritising national policies of economic development and social wellbeing for indigenous people (IAS 2014, CAEPR 2013, 2012, Altman 2002, Altman et al. 2000). The connectivity between land and sea means that future development will require complex tradeoffs between multiple uses. The sustainable development of Australia's coastal domain will therefore need to address the full range of economic, social, cultural and environmental values through strong partnerships with key stakeholders, particularly with Indigenous people in Northern Australia (Green Paper on Developing Northern Australia 2014, PIVOT 2014). Regional assessment frameworks and multiple-use management tools will hence need to be underpinned by robust science and incorporate indigenous aspirations and cultural knowledge (IEK) via the "Two knowledge systems" or "Two tool boxes" approach (e.g. see AIATSI 2006; Altman & Whitehead 2003; Balangarra Healthy Country Plan 2013; Barber 2013; Bayliss et al. 1996; NAILSMA 2014, 2013a-c, 2012a-c; North Kimberley Saltwater Country Plan 2010; Nursey-Bray 2009a&b; Puntis et al. 2007; Smyth 2009, 2007, 2001, 1990; Smyth & Ward 2008; The National Indigenous Sea Country Statement 2012; Vierros 2013; Wunambal Gaambera Healthy Country Plan 2010; Woodward et al. 2012). Key stakeholders and potential end-users in Indigenous-oriented coastal research include:

- The general Australian public with interests in improved indigenous wellbeing, sustainable development, and reconciliation.
- Indigenous coastal communities, particularly land and sea management groups (e.g. NAILSMA 2004).
- Local and regional Indigenous organisations (e.g. Land Councils, Aboriginal Corporations).
- Regional NRM and catchment management authorities; local governments and local councils
- Relevant Commonwealth, State/Territory and regional government agencies for Indigenous NCRM and development issues (e.g. AFMA/TSRA for fisheries; see DPIF 2012 for developing commercial fisheries by Indigenous people in the NT).
- International, national and state/territory conservation stakeholders/end users associated with: (i) growth markets for biodiversity and ecosystem services (see Green Paper on Sustainable Development in Northern Australia 2014; NAILSMA 2014); (ii) IPAs (NAILSMA 2012a, Kimberley Land Council 2013); and (iii) co-management of high conservation areas (e.g. MPAs, national parks, World Heritage Kakadu (KNP 2007) and Great Barrier Reef Marine Park (GBRMP 1994, Bergin 1993).
- Industry – primary production (fisheries, aquaculture, agriculture, horticulture, forestry, cattle), mining (coastal & seafloor), tourism, ports and shipping, and oil and gas (see PIVOT 2014).
- National and international indigenous, conservation and development agencies (e.g. UNESCO, IUCN) and NGOs (e.g. WWF, WI & TNC).

Although the field is still emerging, existing research demonstrates that a simultaneously high level of engagement by research participants, adoption by end-users, and international research impact can be achieved. For example, as reflected in the long history of research collaboration with Indigenous communities on co-managed World Heritage Kakadu National Park (KNP 2007) and the Great Barrier Reef Marine Park (GBR 1994), and in the Blue Mud Bay Native Title determination (Barber 2005; granting of exclusive rights to the intertidal zone with respect to the ALRA NT (ALARA 1976). These examples demonstrate the importance of fostering key structural conditions for the successful multi-scale adoption of indigenous-oriented coastal research. These conditions can be summarized as: the effective matching of science questions to community needs; the building of long-term partnerships; securing ongoing community involvement and participation; support from key regional stakeholders with political and policy influence; and clear connections made to international theoretical debates in relevant disciplines. Facilitating the creation of these conditions is a key aspect of the science needs for the sector.

Torres Strait

The end users of the marine resource assessments are primarily the peak management agencies such as AFMA and the TSRA, and Torres Strait Islander communities through a developed understanding of the size and extent of available resources, their dynamics and the key threats. These assessments feed directly into regulatory and traditional fisheries management by providing sustainable harvest strategies for exploited species.

As the Torres Strait region includes an important shared stock, the tropical rock lobster, good management of this resource simultaneously protects the share of the resource that is available for harvesting by Papua New Guinea.

There are also flow on effects to other regions via resource utilization and marine supply chains, for example, the major lobster processing facility is located in Cairns.

Research to underpin the sustainable utilisation and management of Threatened Endangered and Protected Species (TEPS — such as dugongs and turtles) impacts overall conservation objectives and targets for these species, many of which move between the Torres Strait and other areas.

Science needs

Key science needs/gaps/challenges

The need to make sound management decisions about Australia's terrestrial and marine estate has never been greater. Whilst increasing regional populations and multiple developments in coastal catchments provide greater economic opportunities, the connectivity between terrestrial, aquatic, and marine environments means that there will be complex tradeoffs between multiple uses. The sustainable management of Australia's coastal domain will therefore need to address the full range of economic, social, cultural and environmental values through enduring partnerships with key stakeholders, particularly with indigenous communities in Northern Australia (Barber 2013).

Traditional Owners have cultural and legal rights, and responsibilities, to sustainably use and manage their extensive land and sea country (Yunupingu & Muller 2009, Savage 2003, Sea Forum 1999). This world view requires research approaches, and policy and management solutions, that encompass Indigenous perspectives, values, aspirations and cultural knowledge (e.g. see AIATSIS 2006; Altman & Whitehead 2003; Green Paper on Developing Northern Australia 2014; Jackson & Tan 2013; Kimberley Land Council 2013; NAILSMA 2014, 2013a-c, 2012a-c; National Oceans Office 2004, 2002; Nursey-Bray 2009a; Puntis et al. 2007; Smyth 2009, 2007, 1990; The National Indigenous Sea Country Statement 2012; Vierros 2013 for blue carbon; Woodward et al 2012).

There are eight issues-orientated high level NMSP Themes based on the Marine Nation 2025 Challenges (Marine Nation 2013): (i) Sovereignty, security and natural hazards; (ii) Energy security; (iii) Food security; (iv) Biodiversity conservation and ecosystem health; (v) Dealing with climate change; (vi) Optimal resource allocation; (vii) Urban coastal environments; and (viii) Infrastructure.

Socio-economic and Indigenous Coastal Knowledge (ICK) research would provide cross-cutting/underpinning science for all themes as with the biophysical sciences.

The following section summarises key high level science needs, gaps and challenges in the marine and coastal domain that have been identified by two Indigenous NCRM organisations.

1. *The Indigenous Fisheries Reference Group (IFRG, FRDC 2012): for fisheries and aquaculture but the framework is overarching and can apply to any NCRM issue*

The FRDC Indigenous Fisheries Reference Group (IFRG) identified key RD&E priorities for indigenous participation in fishing and aquaculture in Australia as part of a strategic and planned approach. They are based on 11 Key Principles identified at the March 2011 Cairns Forum. Participants charged the IRG with taking the principles forward and identifying key RD&E priorities. In November 2012 a second forum was held in Cairns (FRDC 2012) and the following five priorities were endorsed by participants as providing sound guidance on indigenous RD&E needs in the fishing and seafood industry, and can be adapted to other NCRM issues and industry sectors.

Priority 1: Primacy for Indigenous People

Priority 2: Acknowledgement of Indigenous Cultural Practices

Priority 3: Self determination of indigenous rights to use and manage cultural assets and resources.

Priority 4: Economic development opportunities from indigenous cultural assets and rights.

Priority 5: Capacity building opportunities for indigenous people are enhanced.

2. *NAILSMA (Northern Australia)*

The NAILSMA Sea Country workshop report (NAILSMA 2012a) provides a summary of current indigenous participation, gaps, obstacles, successes and opportunities in marine and coastal research and management, and aspirations for the future. Two major high level challenges emerged from the workshop:

- a. Alignment of Indigenous aspirations for a healthy sea country with Australian Government regional and national marine conservation objectives and planning processes, with respect to:
 - Marine Bioregional Planning & the National Representative System of MPAs;
 - Indigenous Protected Areas (IPAs) and Sea Country; and
 - Conservation agreements including co-management.

Indigenous Protected Areas (IPAs) are a rapidly emerging part of our National Reserve System in Australia, particularly Northern Australia. They embody strong partnership agreements between Traditional Owners and the Australian Government to voluntarily manage their natural and cultural assets using both Traditional Indigenous Knowledge and Western scientific research according to international (IUCN) standard through legal and other effective means. However, there is little guidance from mainstream science on how best to achieve this and is, therefore, a high priority research need. A number of coastal and island IPAs are located in sea country. With the exception of the Dhimurru IPA in north-east Arnhem Land NT, which includes registered marine sacred sites, these IPAs do not currently include marine areas largely due to the NRSMPA criteria that require MPAs to be established by an act of parliament (NAILSMA 2012). However, many coastal and island IPAs are now developing management Plans that incorporate marine areas.

- b. The development of an “Indigenous Sea Country Management Framework” as a strategic way forward (NAILSMA 2012a). That is, adopt the National Cooperative Approach to Integrated Coastal Zone Management using a framework and implementation plan.

Current NAILSMA research priorities for Indigenous land and sea management currently reflect key government policy reforms relevant to northern development agendas, in tandem with socio-economic development and sustainable resource management (NAILSMA 2014). These high level priorities reflect:

- natural assets including those contained within World Heritage sites, Indigenous Protected Areas (IPAs), Marine Protected Areas (MPAs), National Parks (NPs) and other nature reserves;
- existing social capital and infrastructure in north Australian remote areas – the demographic of Indigenous people is almost 50% of the total population in the north (tropical savanna region) and up to 100% in remote areas;
- Indigenous land interests through statutory land rights, leases and jointly managed conservation reserves are over 40% of northern Australia's total lands. Inclusion of all Native Title interests (scheduled, determined & to be determined) put Indigenous interests at well over 80% of the north; and
- the rich and unique cultural landscape, the vast and diverse Traditional Knowledge of Indigenous people, and the willingness and readiness of communities to contribute to the Australian economy while sustaining internationally recognised natural and cultural assets for future generations.

Key outcomes and national benefits

1. Strategic research partnerships with Indigenous coastal communities that support their aspirations to manage land and sea country and to create livelihood opportunities (e.g. expanded profile, management roles and responsibilities for Indigenous coastal communities and/or INCRM programs).
2. More effective and collaborative integrated coastal zone research and management in Australia (improved management of key coastal natural and cultural assets).
3. Stronger alignment with national policies for sustainable development, biodiversity conservation and Indigenous aspirations for equity and livelihoods.
4. Provision of scientific knowledge and tools for management of marine-coastal assets in Australia in response to increasing development pressures, particularly in the north.
5. Increased collaboration with other science providers (e.g. government agencies, universities).
6. Adoption of "whole of systems" approaches to NRM that involve critical connectivity issues between land and sea, leading to improved:
 - a. understanding of catchment to coast processes and the impacts of those processes on Indigenous people; and
 - b. identification of tradeoffs and better prioritization and decision making regarding the use and development of coastal resources.
7. Development of motivated multidisciplinary research teams that are well positioned to develop research partnerships, plans and business opportunities to address the opportunities and challenges.
8. Improved socio-cultural and economic indicators for coastal Indigenous people and communities incorporating:
 - a. higher incomes;
 - b. greater reported levels of satisfaction in health and well-being;
 - c. development and diversification of Indigenous businesses; and
 - d. improved educational pathways for Indigenous coastal managers and scientists.

Torres Strait

There remain gaps in our fundamental understanding of many of the species and their interactions in the Torres Strait ecosystem — essential information for developing sustainable, effective and efficient natural resource industries. Information is also required on the influences of physical (nutrients, pollutants) and biological (recruits, marine pests) interactions with adjacent regions such

as the Coral Sea and PNG, and forecasting the future impacts of climate change and other likely drivers.

Key socio-economic information gaps include the development of optimal use co-management harvest strategies for the available natural resources important to the traditional owners for cultural, subsistence and economic benefit, which allow local stewardship and sustainable development of fisheries within broader State and Commonwealth regulatory frameworks. These so called “triple bottom line” strategies allow for effective management in the face of conflicting sectors and ocean uses, such as balancing traditional use of marine resources with increasing shipping. Achieving these complex science challenges will help the Torres Strait community meet the overarching desired end goals of equity and self determination.

Other science needs include the development of new fisheries and value adding to existing fisheries; and exploring the potential for ranching and aquaculture development in this region.

Perspective

Specific science priorities for the next 5 to 20 years

The following two sections highlight some specific science priorities identified by the IFRG (FRDC 2012) and NAILSMA (2014), respectively. These priorities most likely represent the views of most Indigenous NCRM organisations around coastal Australia given the high level of engagement and consultation required by these two organisations.

1. Indigenous Fisheries Reference Group (IFRG) - Indigenous RD&E priorities for fishing and aquaculture (FRDC 2012; note these are a sub-set of a comprehensive list in their Appendix 1).
 - a. Undertake social analysis.
 - b. Develop methods and models to incorporate Traditional Fisheries Management (TFM) and Traditional Fishing Knowledge (TFK) into mainstream fisheries management models.
 - c. More broadly, identify models to incorporate TFK/TFM into aquatic resource management.
 - d. Develop processes to determine Indigenous catch and allocation models.
 - e. Examine what fishing and non-fishing practices impact on indigenous cultural fishing practices, including identifying key iconic species.
 - f. Explore the means to ensure that Australian Indigenous cultural assets and associated fishing rights are being addressed in the broader understanding of fishing rights in Australia
 - g. Identify the real understanding of the non-indigenous groups (other fisheries sectors and conservation NGO's) about indigenous cultural fishing and develop processes/materials to enhance that understanding.
 - h. Quantify cultural fisheries values.
 - i. Quantify fishing and non-fishing impacts on indigenous practices.
 - j. Iconic species role in TFM and TFK acknowledged.
 - k. Fishing restrictions on customary use identified and addressed.
 - l. Develop social indicators of commercial benefits of TFK and TFM.
 - m. Develop governance models that enhance indigenous involvement developed.
 - n. Explore innovative benefit sharing models from fisheries resource use and access (including employment).
 - o. Examine new models to ascertain the total 'value' of indigenous participation in fishing.
 - p. Undertake social sciences and economic modeling to ascertain the real value of indigenous participation in the fishing and seafood industry.

2. NAILSMA - key environmental research priorities for Northern Australia

Environmental research priorities for Northern Australia should link to meaningful opportunities for northern development while supporting both environmental and social systems that preserve key natural assets and promote Indigenous livelihoods (NAILSMA 2014). Three specific priority areas of environmental research are:

- a. Development of tools to measure co-benefits of conservation management and/or the provision of other ecosystem services such as carbon storage. For example, the role of traditional management systems in providing benefits for carbon storage (e.g. blue carbon depending on market value), biodiversity conservation, coastal fisheries production and other livelihoods such as tourism may be substantial (Vierros 2013).
- b. The mobilisation of Indigenous rangers as ecosystem service providers to support the development and implementation of targeted conservation and NCRM plans. Specific research is needed into: effective business development models for provision of ecosystem services such as the management of interconnected key conservation areas for biodiversity and cultural assets across Northern Australia; best practice governance models for management planning processes with linkages to policy and community development; establishment of ecosystem services around key conservation areas of land, freshwater and saltwater (interconnected through whole-of-catchment planning); and identification of co-benefits for environmental, cultural and social indices relevant to/integrative of market economies for water, carbon (see below) and biodiversity.
- c. Concomitant research is required on the impacts of cumulative environmental threats such as climate change and development on communities and livelihoods, the development of culturally appropriate information management systems across regions, and planning and policy prescriptions through the application of tools (i.e. 'Development by Design').

More generally these science priorities can be summarised as:

1. Long term research and education partnerships between research providers and Indigenous communities.
2. Inventory of assets, resources and threats at local and regional scales .
3. Strategic regional assessment frameworks and multiple use management tools to inform decisions and potential tradeoffs.
4. Sustainable coastal development.
 - a. Indigenous business planning and implementation.
 - b. Realising indigenous benefits from the non-indigenous development of coastal resources (aquaculture, mining, fisheries).
 - c. Understanding and mitigating impacts of resource development elsewhere.
5. Fisheries.
 - a. Recognition of traditional knowledge and management.
 - b. Legislative and marine planning consistency across jurisdictions.
 - c. Estimations of quantity and social, cultural, and nutritional value of indigenous harvest.
 - d. Roles and recognition in commercial fisheries – allocations, economic opportunities, management roles and responsibilities.
 - e. Recreational/tourist fishery impacts, management, benefits.
6. NCRM programs.
 - a. Metrics of wider value and benefits – socio-cultural, health, economic.
 - b. Alternative funding sources and funding models.
 - c. Identity ongoing roles of INCRM Indigenous rangers as distinct from National Park rangers and fisheries officers.
 - d. Training and career progression for program participants.
 - e. Geographic and demographic extension.
7. Sea ownership and management.
 - a. ALRA (1976) and Native Title (Native Title Act 1993).
 - b. Roles of Indigenous people in coastal policy and planning.
 - c. Bioregional planning.
 - d. Marine and coastal IPAs.
8. Knowledge and education.
 - a. Indigenous careers in coastal science.

- b. Indigenous knowledge documentation, retention.
 - c. Characterising contemporary NCRM knowledge base (IK and the 'Two tool boxes' approach)
 - d. Culturally appropriate information and data management systems, and visualisation-communication tools.
9. Biosecurity, surveillance and border protection
 - a. Interactions and intersecting responsibilities between northern coastal indigenous communities, rangers, police, fisheries and quarantine, navy.
 10. Climate change (see Langton et al. 2012a&b for NCCARF indigenous research priorities).
 - a. Mitigation – e.g. blue carbon (see Vierros 2013).
 - b. Adaptation.
 - c. Vulnerabilities.
 - d. Disaster readiness (see NCCARF assessments in Langton et al. 2012a&b).
 11. Integration of Indigenous research agendas with broader coastal socio-economic development research agendas.

How we link to international efforts in these areas?

Australian research into IEK and its application to the management of marine and coastal assets has consistently drawn links with relevant international policies and conventions that Australia is a signatory to. For example the (NAILSMA 2012a):

- UN Declaration on the Rights of Indigenous Peoples (UNDRIP);
- Convention on Biological Diversity (CBD);
- IUCN policy and guidelines in relation to sea country and protected area management, in particular Indigenous Protected Areas (IPAs);
- Torres Strait Protected Zone Treaty.

Indigenous understanding of land and sea country and the ecosystem approach to resource management embedded in many international policies and conventions are entirely coherent. For example, Barber (2005) provides the following description of Blue Mud Bay in the Northern Territory:

“In Blue Mud Bay, much of daily life and activities occur in the context of the flow of water, from freshwater rivers which flow into the increasingly salty water of the sea, and the seasonal cycles of rain and storms. These, in turn, affect the life cycles of species both on sea and land that provide food for the Aboriginal communities of Blue Mud Bay. The environments of the land and sea, their seasonality, flows and the animal and human communities that they support are all interrelated, and viewed in a holistic manner by the inhabitants of the area.”

This understanding of intricate relationships in a geographical area is the basis of the ecosystem approach as it is described in international conventions, such as the Convention on Biological Diversity (NAILSMA 2012a). The ecosystem approach is inherent in most traditional systems of management that acknowledge ecological relationships (Ruddle & Hickey 2008).

Torres Strait

The key science priorities to further develop marine resource assessment in Torres Strait should build on our current advanced state of knowledge on the spatial distribution of resources and influencing factors assembled from over three decades of field and desk-based research. A key priority should be the incorporation of traditional owner needs into targeted assessments and capacity building to allow achievement of local aspirations. Management strategy evaluation at both fisheries, local and regional scales will be important to identify optimal utilization of available resources under the triple bottom line approach, and to evaluate multiple often conflicting ocean uses.

There is a need also for research to inform on the regional challenges of changing climate, and development and application of tools and applications of an ecosystem approach to fisheries,

including ecosystem modeling, integrated approaches to multiple use management, and triple bottom line approaches that account for biological, economic and social/cultural considerations.

Australia is at the forefront of research in many areas and could contribute to capacity building and knowledge sharing in other regions, such as developing countries and neighbouring nations.

Realisation

Key infrastructure and capability requirements/impediments

1. Resources are initially required to undertake comprehensive community engagement and consultation processes in order to elicit and articulate Indigenous values and aspirations at the outset, and subsequently for capability development such as the establishment and training of land and sea management ranger groups and the development and implementation of strong cross-cultural research partnerships.
2. However, for coastal communities that already have well developed Healthy Country Plans and/or IPA management plans (e.g. the North Kimberley Saltwater Country Plan for Balangarra, Unguu, Dambimangari and Mayala Saltwater Country 2010), the acquisition of infrastructure and associated capability training needed to undertake collaborative research, monitoring and evaluation activities in partnership with scientists will become the priority. For example, well-equipped ranger boats and coxswain certification of Indigenous drivers with local and traditional knowledge are required. The NAILSMA Cyber Tracker/I-Tracker project (Kennett et al. 2010) is an excellent example of a successful infrastructure investment for the consistent and reliable collection of survey, monitoring and research data for a range of Indigenous NCRM programs across Northern Australia.
3. Nevertheless, further and continuing consultation is required about:
 - NMSP content and priorities with:
 - National and regional indigenous representative bodies
 - Local indigenous group corporations and agencies
 - Government program staff focused on indigenous, conservation, and development issues
 - Ongoing indigenous involvement in governance and oversight of marine science research of major relevance and interest to indigenous people
 - Ongoing indigenous involvement in wider government and community feedback processes guiding marine research
 - Indigenous capabilities and ability to assist with national marine science research agendas (i.e. the development of co-research agendas)
4. Consultation should be oriented to the better coordination of marine and coastal research activity of direct relevance to indigenous people, such as:
 - Indigenous coastal natural and cultural resource management
 - Indigenous livelihoods and co-investment pathways
 - fisheries and aquaculture development
 - coastal biodiversity and biosecurity
 - coastal and seabed resource mining
 - catchment and coastal planning
 - marine and coastal tenure, indigenous fresh and saltwater rights and interests
 - marine and coastal governance and institutions
 - social, cultural, and economic development

5. Required capacity/capability to achieve ongoing consultation, coordination and co-research with indigenous communities includes specific resources and activities targeting:
- The enhancement of marine and coastal knowledge and research engagement capability of local customary managers and traditional owners.
 - The recording, transmission, and ongoing development of indigenous traditional knowledge
 - The development of programs to specifically encourage indigenous people into marine and coastal science and management careers
 - The establishment and ongoing facilitation of a network linking coastal and marine researchers with research-engaged indigenous communities
 - The development of ongoing co-research capability with indigenous communities which overcomes conceptual and institutional divisions between marine, coastal and terrestrial operating environments, divisions that are not emphasized in indigenous perspectives (see below)
 - The development of ongoing multi, inter, and trans-disciplinary marine research capability, encompassing not just diverse natural sciences, but strong initial social science involvement in research framing and design. This reflects indigenous perspectives that embed human action and human management at the centre of combined natural and cultural systems. It also reflects the fact that the great majority of 21st century marine and coastal management challenges arise from human action/inaction and will therefore require robust research agendas addressing the human dimension.

For fisheries and aquaculture research in particular, the IFRG (FRDC 2012) states that all barriers to full and effective Indigenous involvement in mainstream fisheries decision making processes and forums needs to be addressed. The following are specific examples:

1. Identify the costs and benefits of effective indigenous consultation, engagement and extension;
2. Develop methods to Improve the involvement of indigenous people in all levels of aquatic biological resource management;
3. Develop and implement co-management and/or self-management models that acknowledge Indigenous TFK/TFM;
4. Develop consultation models that meet indigenous peoples' needs;
5. Develop NCRM governance models that enhance indigenous involvement;
6. Develop and implement processes to enhance indigenous participation in RD&E process;
7. Ensure measurable economic outcomes derived from the fishing and seafood industry are in place;
8. Ensure research outputs/information is available in appropriate formats and language (i.e. extension and adoption);
9. Improve the capacity of (& opportunities for) indigenous people to engage in research, fisheries management, compliance and other commercial activity;
10. Blockages (constraints) to indigenous involvement in business around the fishing and seafood industry need to be identified and removed;
11. Commercial fishing governance structures that meet indigenous needs need to be adopted;
12. Culturally appropriate extension practices need to be in place to provide indigenous people with a better understanding of the fishing and seafood industry; and

13. Fishery management and research agencies need to have sufficient adequately qualified staff to engage appropriately with indigenous people.

Institutional impediments

Overcoming the institutional divide that exists between marine, coastal and terrestrial environments in resource management agencies and research organisations is crucial to maximising economic and social value from transformational development in northern Australia. For example, the estuaries of Australia's tropical rivers support commercial fisheries worth over \$220M p.a., and much of this marine productivity is dependent on freshwater flows from relatively undeveloped catchments. The recent Flinders and Gilbert Agricultural Resource Assessments studies (FGARA; Petheram et al. 2013, Bayliss et al. 2014) demonstrate that regional assessments that address ecological, cultural and other socio-economic values need to be undertaken in parallel to agricultural assessments so that defensible tradeoffs between competing demands for water can be explored transparently. Such balanced assessments will provide foundations for prioritisation, decision-making and implementation of sustainable natural resource management plans for the future development of Northern Australia.

Torres Strait

To optimize research on marine resource assessment in Torres Strait there needs to be collaboration and coordination between the science agencies, management agencies and Torres Strait islander communities with participation by traditional owners. Although vessels are available in Torres Strait, a dedicated research vessel with broad capability would greatly enhance the capability for targeted resource assessments. Current low capacity of traditional owners in several science and technical areas (diving, vessel operation, database maintenance) is an impediment to successful collaborations between science agencies and local participants. Centralization of Torres Strait marine resource assessment funding would improve the efficiency of research initiatives, in comparison with the current status where funds are distributed through disparate sources available through various CRCs and government bodies.

List of contributing authors and affiliations

CSIRO Peter Bayliss and Marcus Barber; Tim Skewes, Darren Denis and Eva Plaganyi for Torres Strait.

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Acronyms

AIMS	Australian Institute of Marine Science
AFMA	Australian Fisheries Management Authority
AgNorth CRC	Northern Australia Agricultural Cooperative Research Centre
AIATSIS	Australian Institute Aboriginal Torres Strait Islander Studies
ARC	Australian Research Council
CBD	Convention on Biological Diversity
CDU	Charles Darwin University
CFC	Caring for Our Country
CRC	Cooperative Research Centre
CSIRO	Commonwealth Scientific and Industrial Research Organisation
	O&A CSIRO Oceans & Atmosphere Flagship
	LWF CSIRO Land and Water Flagship
DoE	Commonwealth Department of Environment
FRDC	Fisheries Research and Development Corporation
IAS	Indigenous Advancement Strategy
IFRG	Indigenous Fisheries Reference Group
IPA	Indigenous Protected Area
IUCN	International Union for the Conservation of Nature
JCU	James Cook University
MAFF	Queensland Department of Agriculture, Fisheries and Forestry
NCCARF	National Climate Change Adaptation Research Facility
NAILSMA	North Australia Indigenous land and Sea management Alliance Pty Ltd
NCRIS	National Collaborative Research Infrastructure Strategy
NERP	National Environmental Research Program
NESP	National Environmental Science Program
NLC	Northern Land Council
NNTT	National Native Title Tribunal
MPA	Marine Protected Area
PM&C	Prime Minister and Cabinet
TERN	Terrestrial Ecosystem Research Network
TFM	Traditional Fisheries Management
TFK	Traditional Fishing Knowledge
TNC	The Nature Conservancy
TRaCK	Tropical Rivers and Coastal Knowledge
TSRA	Torres Strait Regional Authority
UNDRIP	UN Declaration on the Rights of Indigenous Peoples
UNESCO	United Nations Environmental Scientific Cultural Organisation
UWA	University of Western Australia
WAMSI	Western Australian Marine Science Institute
WI	Wetlands International Pty Ltd
WoC	Working on Country
WWF	World Wide Fund for Nature