



Full length article

Connecting conservation & culture: The importance of Indigenous Knowledge in conservation decision-making and resource management of migratory marine species[☆]

Mercedes McLean^{a,*}, Brian Warner^b, Robert Markham^a, Mibu Fischer^{c,d}, Jim Walker^a, Carissa Klein^a, Maia Hoeberechts^e, Daniel C. Dunn^a

^a School of Earth and Environmental Science, University of Queensland, St Lucia 4072, Australia

^b Kabi Kabi First Nation, Queensland, Australia

^c CSIRO, Oceans and Atmosphere, Queensland Biosciences Precinct, St Lucia 4072, Australia

^d Centre for Marine Socioecology, University of Tasmania, Taroona 7053, Australia

^e Ocean Networks Canada, University of Victoria, Victoria, British Columbia V8W 2Y2, Canada

ARTICLE INFO

Keywords:

Marine conservation
Transboundary species management
Integrated Sea Country governance
Cross-cultural knowledge
Ocean connectivity
Traditional Ecological Knowledge

ABSTRACT

Migratory marine species (e.g., seabirds, marine mammals, fish, and sea turtles) cross and connect distant communities and ecosystems throughout their transboundary journeys. Due to their multi-jurisdictional and cross-cultural movements, studying, managing, and protecting migratory marine species as well as their habitats and migration routes are deeply political and geographically complex tasks. Despite a place-based cultural connection to migratory marine species; inherent rights, responsibilities, and authority to manage Sea Country (marine territory), Indigenous communities are far too often excluded from marine conservation decision-making. In this paper we conduct a narrative review and synthesis of relevant literature and analyze four community-driven case studies (both terrestrial and marine) that recognize the incorporation of Indigenous knowledge to support the governance and management of a culturally significant migratory species. The case studies are presented from an Australian Sea Country context as well as from a Canadian marine territory setting. Together these case studies highlight how Indigenous knowledge can increase the understanding of connectivity as well as provide a spatio-temporal baseline for species with limited science-based knowledge. It is essential that Indigenous communities as rights holders to Sea Country (marine territory) and owners of vast amounts of relevant marine knowledge be at the forefront of migratory marine species conservation decision-making for both coastal and distant offshore areas such as Areas Beyond National Jurisdiction. Bringing Indigenous knowledge and scientific monitoring data together has the potential to respond to Indigenous priorities for Sea Country and further contribute to the understanding of migratory marine species distribution, abundance, life cycles, threats, and oceanic connectivity.

1. Introduction

Migratory marine species move cyclically and predictably between ecosystems to fulfill their needs across a variety of life-history stages [53, 68]. Species of seabirds, marine mammals, fish, and sea turtles cross a multitude of jurisdictions, connecting distant locations (e.g. coastal

areas to the high seas) through their transboundary journeys [53,43]. As a result, studying, managing, and protecting migratory marine species, their habitats and migratory routes are political and geographically complex tasks [43]. Many of these migratory marine species are listed as Near Threatened or Threatened by the International Union for Conservation of Nature (IUCN), including: 87% of assessed migratory sharks;

[☆] Positionality: This work was a collaboration between Indigenous academics, Indigenous knowledge holders and conservation scientists from Australia and Canada. Five of eight co-authors identify as Indigenous, First Nations or Traditional Custodians from distinctive cultural, gender, age, and biodiverse backgrounds. Although from geographically distant areas and diverse cultural backgrounds the connections to Country and the ancestral ties link the authors through similarities in worldviews.

* Correspondence to: School of Earth and Environmental Sciences, The University of Queensland, Brisbane, Qld 4072, Australia.

E-mail address: mercedes.mclean@uq.edu.au (M. McLean).

<https://doi.org/10.1016/j.marpol.2023.105582>

Received 3 August 2022; Received in revised form 10 February 2023; Accepted 23 March 2023

Available online 25 June 2023

0308-597X/© 2023 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

85% of sea turtles; 31% of seabirds; and 17% of marine mammals [33, 53,21,49]. With many populations of migratory marine species in decline globally, there is an urgent need to synthesize animal movement data and connectivity information into actionable knowledge which can be utilized to inform conservation decision-making [26]. While recent approaches to aggregating such knowledge (e.g., Important Bird and Biodiversity Areas, Important Marine Mammal Areas, or the Migratory Connectivity in the Ocean (MiCO) system) have gained traction and informed area-based management approaches and ocean governance, they have predominantly focused on scientific data and lack integration of other knowledge systems or perspectives including Indigenous knowledge, practices, innovations, and teachings. For example, while nearly half of all descriptions of Ecologically or Biologically Important Areas by the Convention on Biological Diversity refer to migratory connectivity, virtually none derive that information from Indigenous Knowledge [25]. The term Indigenous knowledge encompasses a rich body of place-based knowledge that has evolved through the intimate interactions, interpretations, and site-specific connections between the Indigenous people and their Country (or territory), that have been passed through the generations [71,66].

Indigenous kinship systems differ from western ideas of kinship in that they encompass relationships with Country or the territory (land, sea, waterways, and sky) and all that is within it (plants, animals etc.); all parts of the environment are an ancestral connection with obligations, roles, responsibilities, and relations defined for all [59]. Country is the term that is commonly used in the Australian context, however, in other places such as Canada, the word territory, lands, or ancestral lands and waters are commonly used. Throughout this paper Country will be the term used to describe the land, sea, waterways, and sky to which Indigenous Peoples are connected to through the complexities of laws, customs, language, cultural practices, spiritual beliefs, ancestral connections, family, identity, and custodianship of the surrounding environment. For some Indigenous communities with Sea Country these connections extend to marine species, including species that cross cultural, national, and international boundaries. Coastal Indigenous Peoples are deeply connected to and heavily dependent on the marine environment (culturally, spiritually, economically and socially) and therefore are the first communities to be impacted by cascading ecosystem changes such as the mismanagement of stocks [7,29,78,6,62]. Migratory marine species are culturally significant for a variety of reasons unique to each community, however coastal communities are deeply connected to, and dependent on the predictability of seasonal cycles and synchronised movements of these species through their Sea Country [66,72,60; Ross and Pickering 2002).

Coastal Indigenous communities are particularly vulnerable to experiencing adverse ecological and cultural implications if migratory marine species are not managed appropriately, both within their Sea Country as well as in critical habitats, which in some cases exist beyond their jurisdiction or territory [27,10,72]. These connections occur across jurisdictional boundaries such as neighbouring Indigenous communities, municipalities, offshore waters into areas beyond national jurisdiction, or into distant coastal or inland communities. There is a profound relationship between Indigenous communities and caring for Country – ‘healthy Country, healthy people’ underscores the link between Indigenous human health and environmental conditions [15,45]. Despite their inherent rights and responsibilities to manage their ancestral territories, Indigenous communities and their knowledge systems have consistently been marginalised from decision-making processes through colonial processes continuing today [72,13,11,66].

Bringing Indigenous knowledge and existing biophysical monitoring data together has the potential to further contribute to the understanding of species distribution, abundance, life cycles, threats, and migratory connectivity [60]. Understanding and accounting for Indigenous knowledge, across jurisdictional boundaries, is imperative for a robust approach to the conservation of migratory marine species [27]. In order for migratory marine species to be sustainably managed and

recover, a coordinated and cross-cultural approach across all relevant jurisdictions, involving all rights holders and applicable worldviews is required [70,53,58,57].

In this paper, we conduct a narrative review of the existing academic literature that upholds Indigenous knowledge as an integral part of conservation planning. A narrative review was used to collate general discussions; assess previous studies; identify the current lack of knowledge; and highlight motivations for future research within this area of study. Demiris et al. [20] define narrative reviews by the characteristics of having “no predetermined research question or specified search strategy, only a topic of interest”. The general framework of narrative reviews outlined in Ferrari [31] writing narrative style literature reviews was used as a guide. We synthesize this literature along with insights from four case studies with a focus on the applicability of these approaches to the management, governance, and conservation of migratory marine species and their ranges. The analysis and discussion is organized in the following sections: 2) the history and enduring exclusion of Indigenous perspectives from conservation decision-making and resource management of marine species; 3) weaving Indigenous knowledge and science-based knowledge together; 4) coastal Indigenous communities connections to distant offshore areas through migratory species movement; 5) the rationale for including Indigenous knowledge in the governance, conservation and management of migratory marine species; and 6) case studies: Indigenous knowledge in migratory species management.

2. The history and enduring exclusion of Indigenous perspectives from conservation decision-making and resource management of marine species

Countless aspects of Indigenous culture and knowledge have been lost or severely impacted by centuries of oppressive policies and racist colonial processes in many nations around the world [6,56,46]. Across many lands and waters, Indigenous Peoples were forcibly removed from their territories, prohibited from accessing their Country (both land and sea), banned from conducting stewardship practices, limited by state-imposed harvest quotas; and blamed for the decrease in species abundance among other tactics aimed at reducing Indigenous sovereignty and autonomy of their territories and natural resources [8]. These unjust strategies were aimed at removing Indigenous people’s rights and authority over their ancestral territories and eradicating Indigenous connection to Country, spiritual traditions, governance systems, economic structures, languages, and cultures [78,18]. An example is the decline in Indigenous languages (endangered, or at best, heavily under pressure) across Australia since European colonization, which parallels the decline in Australia’s biodiversity loss (Ens et al., 2016).

Settler-colonial systems were not just an event in the past that interrupted the lives of Indigenous Peoples; they are systems that continue to impose inequity, racism, injustice and disconnection with culture and traditional governance systems [76,74,32]. In many colonized regions of the world, Indigenous Peoples maintain a strong connection to Country and never relinquished their rights to their lands, waters, and resources, nor did they cede title of their territories [67]. Therefore, Indigenous Peoples continue to assert their Indigenous rights to Sea Country (including marine resources), which are protected under the United Nations Declaration on the Rights of Indigenous Peoples and Article 8(j) of the Convention on Biological Diversity (UN General Assembly 2008; Secretariat of the Convention on Biological Diversity 2010).

Despite this international recognition, Indigenous communities and their ancestral laws, lores, and knowledge systems have consistently been excluded from the governance, management, and protection of natural resources, in both the terrestrial and marine realm [4]. Indigenous Peoples continue to be omitted and underrepresented from local to national marine management dialogues and decision-making processes [72,17]. Due to the complexities of overlapping Colonial-Indigenous

governance structures, science-based approaches to marine resource management frequently lack meaningful engagement with Indigenous communities and therefore fail to include Indigenous perspectives or priorities [44,10]. The study, conservation and management of highly transboundary species needs to take into consideration not only the myriad of layered colonial-Indigenous governance structures and interactions, but also a matrix of Indigenous-Indigenous, Indigenous-Colonial and Colonial-Colonial interactions [13]. The focus of this paper is on the dynamics of Colonial-Indigenous interactions in regard to the conservation, management, and governance of migratory marine species. Including Indigenous resource management practices, teachings, and lore in the synthesis of migratory marine species knowledge through community-led research is a critical component of Indigenous governance and decolonizing marine resource management [72,13].

3. Weaving Indigenous knowledge and science-based knowledge together

Western science has often insisted that Indigenous knowledge be validated by scientific methods when used across natural resource management fields [75]. However, these two, unique ways of knowing are independent of each other and offer distinctive environmental epistemologies. In comparison to the science-based epistemologies commonly applied across natural resource management, Indigenous knowledge systems offer an alternative way of interpreting and understanding the natural world which has only recently been acknowledged in academic literature, such as the landmark studies by [47] *Using Traditional Ecological Knowledge in Science: Methods and Applications*; Bekers et al., 2000 *Rediscovery of Traditional Ecological Knowledge as Adaptive Management*; Agrawal 1995 *Dismantling the Divide Between Indigenous and Scientific Knowledge* and; Turner et al., 2008 *From Invisibility to Transparency: Identifying the Implications*. Academics within the environmental science and natural resource management community have incrementally begun to recognize the importance of Indigenous perspectives and are responding to Indigenous needs and priorities [66]. Researchers are now progressively acknowledging the need to collaborate with and learn from Indigenous peoples to decolonize existing resource management practices [24,23]. An example of this outlined in the Great Barrier Reef Marine Park Authority's Strong Peoples – Strong Country Indigenous Heritage Monitoring Framework (2019). This framework aims to measure progress in achieving Traditional Owner objectives and actions within the Reef 2050 Long-Term Sustainability Plan, and the Aboriginal and Torres Strait Islander Heritage Strategy for the Great Barrier Reef Marine Park [50]. This framework demonstrates how Indigenous heritage and knowledge of Sea Country can be centred around knowing through oral history; managing by knowledge of Country and heritage; protecting and managing knowledge and heritage; and having access to Country, including access to heritage sites; being able to continue oral histories through the transfer of knowledge; and interaction with western science [50]. The incorporation of Western science and Indigenous knowledge recognises that both knowledge systems offer benefits in conjunction with each other to tell a more integrated story of the Great Barrier Reef [50]. Similarly, albeit further North, the Arctic Council's Strategic Plan 2021–2030 emphasises strategic actions to co-produce knowledge based on different knowledge systems, where science-based recommendations as well as Indigenous knowledge are valued and utilized, as appropriate, to inform policy shaping and decision making relevant to Arctic people and their communities [3]. While this acknowledgement is encouraging, there is still much progress to be made to reach a point in which Indigenous and scientific-based knowledge could truly be seen as 'weaving together.' Firstly, research efforts need to be grounded in Indigenous worldviews from the onset, as a legitimate way of knowing (Arsenault et al., 2019; [66]. As Reid et al. [66] states, Indigenous knowledge systems are "valid in their own right, and through the application of a decolonial research framework, they can be used to determine the values, processes, and

methodologies that guide and direct research".

Secondly, Traditional Owner-led marine research that prioritizes Indigenous knowledge and perspectives of Sea Country is far too often lacking or completely absent from marine research [78]. An example of this was noted in The Kimberley Indigenous Saltwater Science Project, a research project developed as part of the Kimberley Marine Research Program, through the Western Australian Marine Science Institution where at the outset of the research community-driven mechanisms/processes for researcher engagement with Traditional Owners was lacking, and opportunities for Traditional Owners to direct research on their Country was absent [78]. However, Traditional Owner groups came together to gain control of the research being undertaken on Indigenous owned and managed Sea Country and became a leading example of both collaboration between Indigenous Peoples and researchers, and the process of weaving Indigenous and western knowledge systems into marine research [78].

Thirdly, the collective knowledge of the local marine environment that is held within Indigenous communities affords detailed information on population cycles, trends, and dynamics between species, whilst also uniquely enabling prompt detection of abnormal occurrences across Sea Country. The intergenerational knowledge held within coastal Indigenous communities surrounding stock dynamics [1]; sustainable harvesting practices [8,5]; weather and climatic norms [78,60]; and tide and current patterns [19]; among others, can amplify stewardship capacity and augment monitoring programs [10]. Indigenous peoples are the custodians of their territory, and are often the earliest to observe changes in their Sea Country such as declines in species abundance or changes in population dynamics, and therefore must be rightful and full partners in research [16]; [55]; Ksenofontov, Backhaus, and Schaeppman-Strub 2019; [28].

4. Coastal Indigenous community connections to distant offshore areas through migratory species movement

Coastal Indigenous communities are deeply connected to and depend on their marine environment including faraway offshore areas. Therefore, they are often the first communities to be impacted by anthropogenic, climatic, or environmental shifts (e.g. negative effects of ocean acidification on shellfish harvesting practices) that can cascade on to affect local biodiversity and highly migratory species [51]. Indigenous communities are also the first to suffer when species or habitats of cultural importance are overexploited or degraded because of inadequate colonial management practices and/or insufficient policies as is the case for many highly migratory species that are of significant cultural importance for Indigenous communities [27]. Exploitation of these migratory species often takes place in national and international waters beyond coastal Indigenous territories or Sea Country, yet what happens in these distant areas still has profound impacts on coastal Indigenous communities [42]. These communities are heavily dependent on the seasonal cycles of migrating seabirds, sea turtles, fish, and marine mammals for maintaining food security, economies and cultural identities. Many migratory marine species are of cultural significance to Indigenous communities and their cyclical movements from distant areas back to coastal habitats are used as key calendrical indicators across seasons [72,60]. Coastal communities' cultures, economies, knowledges, languages, laws, well-being, and worldviews are profoundly linked to the annual return or movements of migratory marine, species such as salmon across the Pacific Northwest or the arrival of mullet in Quandamooka Country [66]; Ross and Pickering 2002).

However, the inclusion of Indigenous knowledge specific to migratory marine species that travel to distant offshore areas as part of their migration cycle is still relatively uncommon in academic research. Despite the vast number of highly migratory marine species that are also of cultural and economic importance to Indigenous communities, there remains a very limited literature that includes Indigenous knowledge of marine connectivity and Indigenous practices of cross-jurisdictional

species management and governance. Many coastal Indigenous communities hold stewardship lores, laws, and management practices for respective places and species which are based on the collective, long-term observational knowledge that have allowed sustainable use of marine resources across millennia [35]. These laws and management practices can be applied to contemporary conservation and contribute to informed decision-making for migratory marine species.

Vierros et al. [72] states that place-based Indigenous knowledge, innovations, and practices enrich the diversity of conservation approaches, worldviews, and solutions within the context of governance of international waters. Applying Indigenous knowledge beyond nearshore areas is a relatively new approach (within academia) which holds value and shows potential in refining the understanding of ocean connectivity and the sustainable management of marine species and habitats globally [72]. Although there is significant research supporting this approach, there remains a delay in the uptake and application of Indigenous knowledge for the conservation of culturally significant marine species, in particular the management of transboundary migratory species that travel between coastal and distant off-shore areas [14]. Recently however, negotiations over an international legally binding instrument under the United Nations Convention on the Law of the Sea on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction (colloquially known as the BBNJ Treaty) have extensively included mention of “traditional knowledge of indigenous peoples and local communities”. Within the text, Indigenous knowledge is included as an important and equal consideration alongside “the best available science and scientific information.” Indigenous rights are acknowledged and access to Indigenous knowledge is contingent on free, prior and informed consent. Further, Indigenous peoples are included as stakeholders throughout the text, and included in the groups who may submit proposals for area-based management tools and inform scoping of environmental impact assessments. Although the text is not adopted yet, it is an indication of the growing international acceptance of the importance of Indigenous knowledge for the management of species that cross jurisdictional boundaries.

5. The rationale for including Indigenous knowledge in the governance, conservation, and management of migratory marine species

In addition to the inherent rights Indigenous Peoples hold by virtue of their historic and present-day relationship to their lands and waters; there are various reasons emerging across academic literature that promote the application of Indigenous knowledge alongside science-based knowledge. In a review of the literature, various notable reasons emerged (Table 1) for including Indigenous knowledge in conservation decision-making. These reasons, among many others, consistently arose across a variety of disciplines such as environmental justice, conservation science, marine policy, and environmental management, and can be clearly applied to the marine connectivity and migratory marine species discourse. Although not exhaustive, this is a starting point for highlighting the critical importance of including Indigenous knowledge, perspectives, and practices in marine conservation and natural resource management within the context of migratory marine species.

Indigenous knowledge offers an unparalleled ability to expand existing science-based knowledge of “data poor species” or species that have been understudied by scientists due to their cryptic behaviour, remote locations, or transboundary migrations [12,69,60]. As outlined in Table 1. Indigenous knowledge extends scientific baselines of habitats, biodiversity, and sustainable management practices. In many cases, science-based approaches and the study of elusive species only date back several decades, however Indigenous knowledge has been curated over thousands of years, enabling current baseline information to be extended and augmented [9,28]. An example of Indigenous knowledge expanding temporal baseline information was demonstrated in the Eckert et al. [29] paper ‘Diving back in time: Extending historical

Table 1

The rationale for applying Indigenous knowledge alongside science-based knowledge to augment management and conservation practices for culturally significant species.

Rationale	Examples
Support Indigenous self-determination and authority over their territory and resources.	(von der [64]; [13])
In accordance with International policy.	[60,78]
Driven by and aligned with community priorities.	[22]
Detailed place-based knowledge (spatial).	[77,52]
Understanding and predicting movements of migratory species.	[60]
Local knowledge of species ecology, behaviour, habitat conditions and customary management systems.	[38]
Extends scientific baselines for habitats, biodiversity, and sustainable management practices (temporal).	[28,54,69,38]
Recognizes the validity of diverse knowledge systems.	[69]; [39]
Innovative and diverse solutions.	[2]
Expands evidence-base and increases legitimacy.	[2]
Supports inter-generational observations/experience/knowledge.	[30]
Adaptable/dynamic type of information that is also relevant and applicable in contemporary terms.	[65,63]
Continuity of culture.	[28]
Improves equity between researchers and Indigenous communities.	[69]

baselines for yelloweye rockfish with Indigenous knowledge’ in the Central Coast of BC, Canada where Indigenous knowledge was used to illustrate repeatable methods for extending baselines of data on species such as the yelloweye rockfish, and highlighted the importance of integrating Indigenous knowledge into marine research and management.

Movements of many migratory marine species are still poorly understood across taxonomic groups and large geographic regions by scientists. As Mulalap et al. [60] demonstrates, Indigenous knowledge can accurately predict the movement of highly migratory fish species as well as link fish movements and connectivity between coastal areas and the high seas. Co-production of marine connectivity research with coastal Indigenous communities (as full research partners) would allow Indigenous knowledge systems and worldviews to become a starting point for better understanding and improving knowledge gaps across Sea Country [27,61]. This approach could be a step forward in ensuring that research is grounded in Indigenous priorities and supports Indigenous self-determination of Sea Country whilst also informing migratory connectivity and improving conservation outcomes for culturally significant transboundary species.

6. Case Studies: Indigenous Knowledge in migratory species management

Indigenous knowledge of culturally significant migratory species has previously been incorporated into science-based research across terrestrial species management such as the 2013 Indigenous-led Klinse-Za mountain caribou herd recovery partnership agreement between the West Moberly and Sahtéu First Nations, the province of British Columbia, and the Government of Canada. This research has been applauded for the incorporation of Indigenous knowledge and governance systems to produce measurable outcomes for the migratory herd and has been referred to as a blueprint for Indigenizing wildlife conservation [46]. “In the eight years since this partnership agreement, the Klinse-Za caribou population has more than doubled, habitat protection has been afforded, and cross-cultural relationships have been fostered” [46]. Examples of migratory species management from the terrestrial realm can be drawn upon and applied within the marine context such as applying similar methodologies [73].

Indigenous knowledge of transboundary marine species has been incorporated into science-based research and species management, however to a lesser extent than the terrestrial realm. For example,

beluga whales (*Delphinapterus leucas*) and white-winged and surf scoters (*Melanitta fusca* and *M. perspicillata*) were used in Huntington et al. [48] to illustrate how the incorporation of Indigenous knowledge alongside science-based knowledge improves the understanding of marine connectivity and provides a more complete picture of migratory marine species' movements and conservation needs.

Below, we present four case studies that were selected based on a review of the published literature. This approach applied several methods including searches across a number of databases and search engines using a wide variety of search terms; a comprehensive literature search using the 'snowball method' which included literature based on suggestions by co-authors and people currently working in relevant disciplines; and by scanning bibliographies of highly relevant references [38]. These case studies were selected based on how they have woven Indigenous knowledge and science-based knowledge together for the successful management and conservation of a migratory species. The migratory species presented in the case studies: Caribou (*Rangifer tarandus*); Eulachon (*Thaleichthys pacificus*); Magpie Goose (*Anseranas semipalmata*); and Hammerhead sharks (*Sphyrna* sp.) are each of tremendous value and significance to their respective ecosystems and communities [40]. Although there is no internationally unified definition for culturally significant species, there are defining features and characteristics of culturally significant species that are pertinent to Indigenous communities across both Australia and Canada [41]. Culturally significant species are critical to Indigenous Peoples' identities and fundamental to their connection to and protection of Country [41]. Culturally significant species are specifically defined by their exceptional significance to Indigenous Peoples because of their functional role or prevalence in their diet, material items, medicines, cultural identity, language, spiritual values, traditions and practices [37,34,41].

Two case studies are presented from the terrestrial realm and two case studies from the marine environment. Two case studies (one terrestrial and one marine) are presented from an Australian context, and another two from a Canadian setting. The geographic focus of this narrative review was selected based on the author's knowledge and experience working across related fields in Australia and Canada. Moreover, these two nations were also selected based on their similar colonial histories. The case studies provide examples of community-driven projects that recognize Indigenous rights and interests, and are strengthened by the incorporation of Indigenous knowledge to support the management of a culturally significant species. Further commonalities and connections between the case studies include community-led resource management that represents Indigenous ownership and governance over species decisions that in turn ensures returned benefits to the community, and which also affords the opportunity for Indigenous knowledge and science-based methods, technologies, and approaches to be brought together [75].

While examining the case studies, three key concepts emerged: (1) the importance of community-led research; (2) Indigenous rights and responsibilities to migratory species; and (3) how Indigenous knowledge augments scientific data by enhancing and expanding knowledge. The first notable concept to arise was the importance of the research being community-led, community driven, or grounded in genuine collaboration with Traditional Owners throughout the entirety of the project. This ground-up approach enabled research to be centred around community knowledges and priorities, which was of particular significance in the caribou case study. Gagnon et al. [36] emphasized that community-based monitoring programmes that are built on long-term relationships (built over years, and in some cases such as that in Gagnon et al. [36] span a decade or more) between scientists and Traditional Owners that are grounded in respect and trust can act as venues and catalysts for knowledge co-production leading to successful conservation outcomes for highly migratory species such as caribou. This community-based approach also increased authority over the management of the species and Country. Secondly, in addition to increased authority, it was evident that these projects asserted inherent Indigenous

rights and responsibilities over their respective migratory species and in some cases such as the Nuxalk project, contested the exclusive colonial state jurisdiction over the management of the species including in offshore areas (beyond Nuxalk territory or jurisdiction). This case study is an example of contested authority and resurgent Indigenous management whereby Nuxalk is challenging state imposed management and jurisdictional authority by owning their places as the legitimate authority and stewards of their ancestral waters by "upholding and formalising traditional forms of management, implementing locally-derived management priorities and practices, and exercising inherent and constitutional rights to fish and manage marine resources" [36]. This was of significance because although migratory species exist beyond coastal Indigenous community territory or Sea Country, the governance and management of the species still have direct implications on people's relationship with the culturally significant species. Similarly, in the case study of hammerhead sharks in Northern Australia, Gerhardt [38] emphasized how the application of Indigenous knowledge in the management and conservation of migratory marine species is deeply linked to the expression of marine resource use rights and interests, and the continuity of Indigenous culture tied to Sea Country. Thirdly, each of the four case studies highlighted how knowledge of culturally significant migratory species can be enhanced with the incorporation of Indigenous knowledge and perspectives from the onset. As seen in the magpie geese case study in Kakadu National Park, the use of drones, machine learning and AI coupled with Indigenous knowledge of the landscape enable unparalleled approaches for caring for Country and monitoring a contemporary threat, the invasive para grass weed. More specifically, the case studies provide examples of Indigenous knowledge as a detailed form of knowledge relating to migratory species: informing spatial and temporal scales; contributing detailed information to the knowledge base of species ecology, distribution, movements, and population demographics; providing detailed observations on species behaviour.

As the case studies in Table 2 highlight, participatory involvement in the management of marine systems has been proven to have greater success when local people and Indigenous communities are involved early and often (Armitage et al., 2017). Literature in addition to the four case studies presented, such as Atlas et al. [5] demonstrate that many purely science-based monitoring programs and management initiatives have resulted in varied success when they did not appropriately involve local communities in the development and planning phases. As seen in the case studies presented as well as in Atlas et al. [5], successful monitoring programs need to be co-developed (inferring mutually agreed terms) with community members, be based in traditional management systems, incorporate robust outreach and education programs, and strive towards advancing capacity building for ongoing monitoring initiatives.

7. Conclusion

Based on the key concepts that arose from the four case studies reviewed, we encourage further co-developed marine research to support Indigenous community driven conservation priorities. Methods from terrestrial migratory species management, such as the two case studies outlined in Table 2, provide valuable insights into collaborative research best practices for the establishment of nation-to-nation relationships in species co-management that can then be adapted and applied to the marine realm.

We make the following recommendations to advance conservation decision-making and enhance the management of migratory marine species based on the insights that arose in the literature review and the fundamental concepts that emerged from the case studies presented. For the benefit of maintaining cultural connections and identities as well as supporting developments in marine policy, we encourage more community-led research that: is grounded in Indigenous priorities; supports inherent Indigenous rights and responsibilities of migratory

Table 2

Case Studies of terrestrial and marine migratory species that have woven Indigenous knowledge and science-based knowledge together to improve conservation and management outcomes for culturally significant species.

Case Study	Authors	Species	Environment	Location	Significance
<i>Merging Indigenous and scientific knowledge links climate with the growth of a large migratory caribou population</i>	[36]	Caribou (<i>Rangifer tarandus</i>)	Terrestrial	Kaktovik and Arctic Village Alaska, USA Old Crow Yukon, Canada Aklavik, Fort McPherson, Inuvik, Canada Tsiigehtchic and Tuktoyaktuk Northwest Territories, Canada	- Highlights how scientific data can be enhanced with the inclusion of long-term Indigenous observations into a community-based monitoring program to improve the understanding of the ecology of a migratory caribou herd. - Most important results of the study were that Indigenous knowledge is a reliable indicator of spatial and temporal scales for the migrating caribou population which was not easily monitored by researchers. - Indigenous knowledge contributed detailed information surrounding caribou distribution, movement, and population demographics. - Draws attention to the power dynamics within the natural resource management sector where the inclusion of Indigenous knowledge frequently transpires as lip service in a disingenuous way. - Encourages resource managers and Indigenous communities to work together to develop genuine and inclusive community-based monitoring programs.
<i>The Nuxalk Sputc (Eulachon) Project: Strengthening Indigenous management authority through community-driven research</i>	[13]	Eulachon (<i>Thaleichthys pacificus</i>)	Marine	Nuxalk Nation Central Coast of British Columbia, Canada	- Emphasizes how Indigenous knowledge and scientific data have been used together to support Indigenous community management and governance of a migratory marine species – the eulachon, a small anadromous fish. - Increased Indigenous authority over an endangered migratory fish. - Successful because of its ground-up nature, broad community engagement, articulation of Nuxalk knowledges and management priorities for eulachon. - Project contests the exclusive Canadian state jurisdiction over the management of the eulachon fishery by asserting their inherent Indigenous rights and responsibilities related to eulachon within Nuxalk territory. - Importance of Indigenous communities being included in a Nation to Nation management approach for eulachon in offshore areas beyond Nuxalk territory. - Management implications of migratory marine species such as eulachon in distant offshore areas have profound repercussions on Nuxalk People's relationship with eulachon. - This study shows that the application of Indigenous stewardship (Nuxalk knowledge, stories, ancestral laws, fishing practices, family rules, and local science) not only have the ability to support the conservation of a migratory marine species in coastal areas but also strengthens Indigenous governance systems and protocols for the management of resources within and beyond their jurisdiction (including offshore).
<i>Magpie geese return to Kakadu with help from ethical AI and Indigenous Knowledge</i>	CSIRO (Cranney 2019)	Magpie Goose (<i>Anseranas semipalmata</i>)	Terrestrial	Bininj Country Kakadu National Park Northern Territory, Australia	- Rangers are bringing together ethical Microsoft Artificial Intelligence (AI) such as machine learning and Indigenous Knowledge to care for Country. - Through a machine learning model that combines Indigenous knowledge and Microsoft AI, drones help stewards identify which areas of the park need care in the ground. - The results are promising; thousands of culturally significant magpie geese are returning to roost in the wetlands. - Bininj Traditional Owners and Kakadu National Park Rangers are working with scientists to adaptively track and manage Country and bring magpie geese back to the once para grass weed-choked wetlands that kept magpie geese off Bininj country. - In Biniji Country, magpie geese are a key marker of 'healthy country' and are culturally significant for Bininj. - The project ensured that the technology and the method were Indigenous-led from the beginning as well as how the science carried out. - Traditional Owners are front and centre of decision-making for Country.

(continued on next page)

Table 2 (continued)

Case Study	Authors	Species	Environment	Location	Significance
Indigenous knowledge and cultural values of hammerhead sharks in Northern Australia	[38]	Hammerhead sharks (<i>Sphyrna</i> sp.)	Marine	The Torres Strait Northern Australia	• Meaningful, genuine collaboration and engagement with Traditional Owners throughout the entirety of the project. • Recognised that community priorities may not be aligned with the project objectives, timeline or research outcomes. As a result, the research team provided multiple opportunities for community involvement including skill exchange and knowledge transfer. • Involvement of Indigenous rangers while working on Sea Country: Indigenous knowledge and detailed observations resulted in successful tagging field trips. • Indigenous knowledge provided insight into hammerhead shark movements, behaviour, ecology, and distribution. • Indigenous knowledge contributes to the knowledge base of species and was used to inform science and management projects for hammerhead sharks. • Recognises the species itself and acknowledges its rights and interests to exist on Country: “The application of IK in the management of marine species (whether they be cultural keystone species or not) is therefore closely tied to the expression and continuation of Indigenous culture and traditional marine resource use rights.” [38]

species; maintains expression and continuation of Indigenous culture and traditional marine resource use rights; incorporates traditional methods and contemporary technologies to care for Country; expands scientific knowledge and baselines for scientifically data-poor species; increases understanding of marine connectivity between coastal areas and offshore waters; strengthens Indigenous governance systems and protocols for the management of resources within and beyond Indigenous jurisdiction (including international waters); and decolonizes resource management practices, all to improve conservation efforts of transboundary culturally significant species. The reality of advancing these types of recommendations into tangible practices are driven by research funding mechanisms at the highest level. Financial commitment for this type of research made by major national funding bodies could further incentivise and support collaborative research across this realm. Indigenous knowledge systems are essential to the conservation of all migratory species and their associated marine ecosystems. Indigenous communities and their respective knowledge holders must be front and centre of conservation research, management decisions, and governance processes related to migratory marine species.

Role of the funding source

This workshop and associated paper were supported by University of Queensland's Centre for Biodiversity and Conservation Science, Australia; and this paper draws on research supported by the Social Sciences and Humanities Research Council of Canada, Canada.

CRediT authorship contribution statement

Mercedes McLean: Conceptualization, Collaborative brainstorming and writing workshop, Writing – original draft preparation, Writing – review & editing. **Daniel Dunn:** Supervision, Collaborative brainstorming and writing workshop, Writing – original draft preparation, Writing – review & editing. **Brian Warner:** Collaborative brainstorming and writing workshop, Writing – original draft preparation. **Rob Markham:** Collaborative brainstorming and writing workshop, Writing – original draft preparation. **Jim Walker:** Collaborative brainstorming and writing workshop, Writing – original draft preparation. **Mibu Fischer:** Writing – original draft preparation, Writing – review & editing. **Carissa Klein:** Collaborative brainstorming and writing workshop, Writing – review & editing. **Maia Hoeberechts:** Background

discussions, Writing – review & editing.

Declarations of interest

None.

Data availability

No data was used for the research described in the article.

Acknowledgements

The lead author initially drafted this paper. The ‘Connecting Conservation & Culture’ workshop was hosted to cultivate discussions and inspire further writing on the importance of including Indigenous knowledge in conservation decision-making and resource management of migratory marine species, which informed later drafts of the paper. The ‘Connecting Conservation & Culture’ workshop was undertaken on lands of the Turrbul and the Jagara Peoples. The contributing authors acknowledge the Traditional Owners of this Country and their custodianship of the lands on which we gathered. We collectively pay our respects to their Ancestors and their descendants, who continue cultural and spiritual connections to Country. We recognize their valuable contributions to Australian and global society. This work was a collaboration between Indigenous academics, Indigenous knowledge holders and conservation scientists from the University of Queensland's Centre for Biodiversity and Conservation Science, and CSIRO. We would also like to recognize that five of eight co-authors are First Nation peoples from the following Indigenous communities: Algonquin from the Great Golden Lake First Nation, Ontario, Canada; Kabi Kabi First Nation, Queensland, Australia; Jawoyn from Kakadu, Northern Territory, Australia; Yiman and Goreng Goreng First Nations Peoples, Queensland, Australia; and Noonucal, Ngugi and Goenpul from Quandamooka, Queensland, Australia. We acknowledge our cultural connection to Country and ancestral ties to our respective communities.

Submission declaration and verification

The work is all original research carried out by the authors. All authors agree with the contents of the manuscript and its submission to the journal. No part of the research has been published in any form

elsewhere, unless it is fully acknowledged in the manuscript. The research featured in the manuscript does not relate to any other manuscript of a similar nature that the authors have published, in press, submitted or will soon submit to Marine Policy or elsewhere. The manuscript is not being considered for publication elsewhere while it is being considered for publication in this journal. Any research in the paper not carried out by the authors is fully acknowledged in the manuscript. All sources of funding are acknowledged in the manuscript, and authors have declared any direct financial benefits that could result from publication. All appropriate ethics and other approvals were obtained for the research. Research protocols have been approved by the University of Queensland's multi-disciplinary Human Research Ethics Committees.

References

- [1] Megan S. Adams, Jennifer Carpenter, A.Housty Jess, Douglass Neasloss, C. Paquet Paul, Christina Service, Jennifer Walkus, T.Darimont Chris, "Toward increased engagement between academic and indigenous community partners in ecological research.", *Ecol. Soc.* 19 (3) (2014) <https://doi.org/10.5751/ES-06569-190305>.
- [2] Steven M. Alexander, F.Provencher Jennifer, Dominique A. Henri, Jessica J. Taylor, Jed Immanuel Lloren, Lushani Nanayakkara, Jay T. Johnson, Steven J. Cooke, "Bridging Indigenous and Science-Based Knowledge in Coastal and Marine Research, Monitoring, and Management in Canada.", *Environ. Evid.* 8 (1) (2019) 1–24, <https://doi.org/10.1186/s13750-019-0181-3>.
- [3] Arctic Council, 2021, "Arctic Council Strategic Plan 2021 to 2030." Arctic Council's 25th anniversary at the Council's 12th Ministerial Meeting. Reykjavik. 1 - 7. (https://oarchive.arctic-council.org/bitstream/handle/11374/2601/MMIS12_2021_REYKJAVIK_Strategic-Plan_2021-2030.pdf?sequence=1&isAllowed=y).
- [4] Rachel Arsenault, Sibyl Wentz Diver, Deborah McGregor, Aaron Witham, Carrie Bourassa, "Shifting the Framework of Canadian Water Governance through Indigenous Research Methods: Acknowledging the Past with an Eye on the Future.", *Water (Switz.)* 10 (1) (2018) <https://doi.org/10.3390/w10010049>.
- [5] William I. Atlas, G.Housty William, Audrey Béliveau, Bryant DeRoy, Grant Callegari, Mike Reid, Jonathan W. Moore, "Ancient Fish Weir Technology for Modern Stewardship: Lessons from Community-Based Salmon Monitoring.", *Ecosyst. Health Sustain.* 3 (6) (2017) <https://doi.org/10.1080/20964129.2017.1341284>.
- [6] William I. Atlas, C.Ban Natalie, Jonathan W. Moore, Adrian M. Tuohy, Spencer Greening, Andrea J. Reid, Nicole Morven, et al., "Indigenous Systems of Management for Culturally and Ecologically Resilient Pacific Salmon (*Oncorhynchus* Spp.) Fisheries.", *BioScience XX (X)* (2020) 1–19, <https://doi.org/10.1093/biosci/biaa144>.
- [7] Natalie C. Ban, Chris Picard, C.J.Vincent Amanda, "Moving toward Spatial Solutions in Marine Conservation with Indigenous Communities.", *Ecol. Soc.* 13 (1) (2008) <https://doi.org/10.5751/ES-02473-130132>.
- [8] Natalie C. Ban, Emma Wilson, Doug Neasloss, "Strong Historical and Ongoing Indigenous Marine Governance in the Northeast Pacific Ocean: A Case Study of the Kitasoo/Xai'xais First Nation.", *Ecol. Soc.* 24 (4) (2019) <https://doi.org/10.5751/ES-11091-240410>.
- [9] Natalie C. Ban, Alejandro Frid, Mike Reid, Barry Edgar, Danielle Shaw, Peter Siwallace, Incorporate Indigenous Perspectives for Impactful Research and Effective Management. *Nat. Ecol. Evol.* 2 (11) (2018) 1680–1683. (<https://doi.org/10.1038/s41559-018-0706-0>).
- [10] Nathan J. Bennett, Maery Kaplan-Hallam, Gerry Augustine, Natalie C. Ban, Dyhia Belhabib, Irene Brueckner-Irwin, Anthony Charles, et al., "Coastal and Indigenous Community Access to Marine Resources and the Ocean: A Policy Imperative for Canada.", *Mar. Policy* (2018) 87, <https://doi.org/10.1016/j.marpol.2017.10.023>.
- [11] Nathan J. Bennett, Laure Katz, Whitney Yadao-Evans, Gabby N. Ahmadi, Scott Atkinson, Natalie C. Ban, Neil M. Dawson, et al., "Advancing Social Equity in and Through Marine Conservation.", *Front. Mar. Sci.* 8 (July) (2021) 1–13, <https://doi.org/10.3389/fmars.2021.711538>.
- [12] Charlotte Berkström, Myron Papadopoulos, Narriman Saleh Jiddawi, Lina Mtwana Nordlund, Fishers' Local Ecological Knowledge (LEK) on Connectivity and Seascape Management, *Front. Mar. Sci.* 6 (MAR) (2019) 1–11, <https://doi.org/10.3389/fmars.2019.00130>.
- [13] Rachelle Beveridge, Megan Moody, Grant Murray, Chris Darimont, Bernie Pauly, "The Nuxalk S'p'ut (Eulachon) Project: Strengthening Indigenous Management Authority through Community-Driven Research.", *Mar. Policy* 119 (2020), 103971 <https://doi.org/10.1016/j.marpol.2020.103971>.
- [14] Kaitlin Breton-Honeyman, P.Huntington Henry, Mark Basterfield, Kiyo Campbell, Jason Dicker, Tom Gray, Alfred E.R. Jakobsen, et al., "Beluga Whale Stewardship and Collaborative Research Practices among Indigenous Peoples in the Arctic.", *Polar Res.* 40 (2021) 1–18, <https://doi.org/10.33265/polar.v40.5522>.
- [15] Christopher P. Burgess, H.Johnston Fay, Helen L. Berry, Joseph McDonnell, Dean Yibarbuk, Gunabarra Charlie, Mileran Albert, Ross S. Bailie, "Healthy Country, Healthy People: The Relationship between Indigenous Health Status and 'Caring for Country.' *Med. J. Aust.* 190 (10) (2009) 567–572, <https://doi.org/10.5694/j.1326-5377.2009.tb02566.x>.
- [16] Cameron, Liz, 2022, "Indigenous Ecological Knowledge Systems – Exploring Sensory Narratives" 23 (January). <https://doi.org/10.1111/emr.12534>.
- [17] Cisneros-Montemayor, Andrés, and Yoshitaka Ota, 2019, Coastal Indigenous Peoples in Global Ocean Governance. Predicting Future Oceans: Sustainability of Ocean and Human Systems Amidst Global Environmental Change. <https://doi.org/10.1016/B978-0-12-817945-1.00028-9>.
- [18] Charlotte Coté, 'Indigenizing' Food Sovereignty. Revitalizing Indigenous Food Practices and Ecological Knowledges in Canada and the United States.", *Humanities* 5 (3) (2016) 57, <https://doi.org/10.3390/h5030057>.
- [19] Council of the Haida Nation, 2011, "Haida Marine Traditional Knowledge Study Volume 1: Methods and Results Summary." Vol. 1. papers3://publication/uuid/577CE3E4-BD6E-4E0F-9D34-B4389CDC1E2C.
- [20] Demiris, George, Debra Parker Oliver, Karla T. 2019. Washington, "Chapter 3 - Defining and Analyzing the Problem." Behavioral Intervention Research in Hospice and Palliative Care. Academic Press Pages 27–39, (<https://doi.org/10.1016/B978-0-12-814449-7.00003-X>).
- [21] M.P. Dias, R. Martin, E.J. Pearmain, I.J. Burfield, C. Small, R.A. Phillips, O. Yates, B. Lascelles, P.G. Borboroglu, J.P. Croxall, "Threats to seabirds: A global assessment.", *Biol. Conserv.* 237 (June) (2019) 525–537, <https://doi.org/10.1016/j.biocon.2019.06.033>.
- [22] Steve Diggon, Butler Caroline, Heidt Aaron, Bones John, Jones Russ, Craig Outhet, "The marine plan partnership: indigenous community-based marine spatial planning.", *Mar. Policy* (July 2018) (2019), 103510 <https://doi.org/10.1016/j.marpol.2019.04.014>.
- [23] Sibyl Wentz Diver, "Negotiating indigenous knowledge at the science policy-interface: insights from the Xáxl'p Community Forest.", *Environ. Sci. Policy* 73 (2017) 1–11, <https://doi.org/10.1016/j.envsci.2017.03.001>.
- [24] Rebecca J. Dobbs, L.Davies Christy, Michelle L. Walker, Neil E. Pettit, Bradley J. Pusey, Paul G. Close, Yoshi Akune, et al., "Collaborative Research Partnerships Inform Monitoring and Management of Aquatic Ecosystems by Indigenous Rangers.", *Rev. Fish. Biol. Fish.* 26 (4) (2016) 711–725, <https://doi.org/10.1007/s11160-015-9401-2>.
- [25] D.C. Dunn, J. Cleary, S. DeLand, C. Barrio Frojan, G. Ortuño Crespo, C. Curtice, V. Gunn, C.Y. Kot, D.E. Johnson, P.N. Halpin, "A Review of Ecologically or Biologically Significant Marine Areas (EBSA).", *CBD/EBSA/WS/2020/1/INF/2, Convention on Biological Diversity.*, Montreal, 2019, p. 33.
- [26] Daniel C. Dunn, Autumn Lynn Harrison, Corrie Curcio, Sarah DeLand, Ben Donnelly, Ei Fujioka, Eleanor Heywood, et al., "The importance of migratory connectivity for global ocean policy.", *Proc. R. Soc. B: Biol. Sci.* (2019) 286, <https://doi.org/10.1098/rspb.2019.1472>.
- [27] Dunn, Daniel C., Guillermo Ortuño Crespo, David Freestone, Erika Rosenthal, and Steven Roady; Amalia Alberini; Autumn-Lynn Harrison; Andres Cisneros; John W. Moore; Matt R. Sloat; Yoshi Ota; Richard Caddell, Patrick N. Halpin, 2017, "Adjacency: How Legal Precedent, Ecological Connectivity, and Traditional Knowledge Inform Our Understanding of Proximity," no. 17: 1–12. <https://doi.org/10.13140/RG.2.2.21359.12968>.
- [28] Lauren E. Eckert, Natalie C. Ban, Alejandro Frid, Madeleine McGreer, "Diving back in time: extending historical baselines for yelloweye rockfish with indigenous knowledge.", *Aquat. Conserv.: Mar. Freshw. Ecosyst.* 28 (1) (2018) <https://doi.org/10.1002/aqc.2834>.
- [29] Lauren E. Eckert, Natalie C. Ban, Snxakila Clyde Tallio, Nancy Turner, "Linking marine conservation and indigenous cultural revitalization: first nations free themselves from externally imposed social-ecological traps.", *Ecol. Soc.* 23 (4) (2018) <https://doi.org/10.5751/ES-10417-230423>.
- [30] Álvaro Fernández-Llamazares, Mar Cabeza, "Rediscovering the Potential of Indigenous Storytelling for Conservation Practice.", *Conserv. Lett.* (2018) <https://doi.org/10.1111/conl.12398>.
- [31] R. Ferrari, "Writing narrative style literature reviews.", *Med. Writ. (Leeds)* 24 (4) (2015) 230–235, <https://doi.org/10.1179/2047480615Z.000000000329>.
- [32] M. Fischer, Kimberley Maxwell, Nuunoqu, Halfdan Pedersen, Dean Greeno, Nang Jingwas, Jamie Graham Blair, Sutej Hugu, Tero Mustonen, Eero Murtoma, Kaisu Mustonen, "Empowering her guardians to nurture our Ocean's future, *Rev. Fish. Biol. Fish.* 32 (2022) (2022) 271–296, <https://doi.org/10.1007/s11160-021-09679-3>.
- [33] S. Fowler, "The Conservation Status of Migratory Sharks.", *UNEP/CMS Secr., Memo. Underst. Conserv. Migr. Sharks* (2014) 1–30.
- [34] C.T. Freitas, P.F.M. Lopes, J.V. Campos-Silva, M.M. Noble, R. Dyball, C.A. Peres, "Co-management of culturally important species: A tool to promote biodiversity conservation and human well-being.", *People Nat.* 2 (2020) 61–81, <https://doi.org/10.1002/pan3.10064>.
- [35] Alejandro Frid, Madeleine McGreer, Angela Stevenson, "Rapid Recovery of Dungeness Crab within Spatial Fishery Closures Declared under Indigenous Law in British Columbia.", *Glob. Ecol. Conserv.* 6 (2016) 48–57, <https://doi.org/10.1016/j.gecco.2016.01.002>.
- [36] Catherine A. Gagnon, Sandra Hamel, Don E. Russell, Todd Powell, James Andre, Michael Y. Svoboda, Dominique Berteaux, "Merging Indigenous and Scientific Knowledge Links Climate with the Growth of a Large Migratory Caribou Population.", *J. Appl. Ecol.* 57 (9) (2020) 1644–1655, <https://doi.org/10.1111/1365-2664.13558>.
- [37] Ann Garibaldi, Nancy Turner, Cultural Keystone Species: Implications for Ecological Conservation and Restoration, *Ecol. Soc.* vol. 9 (3) (2004) (JSTOR), (<http://www.jstor.org/stable/26267680>).
- [38] Karin Gerhardt, Indigenous Knowledge and Cultural Values of Hammerhead Sharks in Northern Australia. Report to the National Environmental Science Program, Marine Biodiversity Hub, James Cook University., 2018.

- [39] Amber Giles, Shelley Denny Lucia Fanning, Tyson Paul, "Improving the American Eel Fishery Through the Incorporation of Indigenous Knowledge into Policy Level Decision Making in Canada.", *Hum. Ecol.* 44 (2) (2016) 167–183, <https://doi.org/10.1007/s10745-016-9814-0>.
- [40] Goolmeier, T., Skroblin, A., Grant, C., van Leeuwen, S., Archer, R., Gore-Birch, C., & Wintle, B.A. 2022. "Recognizing culturally significant species and Indigenous-led management is key to meeting international biodiversity obligations." *Conservation Letters*, 15, e12899. <https://doi.org/10.1111/conl.12899>.
- [41] Gore-Birch, Costello, O., Garnett, S., Goolmeier, T., Legge, S., Moggridge, B., Robinson, C., & van Leeuwen, S. (2020). "Submission to the 2020 independent review of the Environment Protection and Biodiversity Conservation Act 1999 A case for Culturally Significant Species." 1–8. Retrieved from (<https://epbcactreview.environment.gov.au/sites/default/files/2020-06/ANON-QJCP-UGT1-F%20-%20Indigenous%20Working%20Group%20-%20Threatened%20Species%20Recovery%20Hub.pdf>).
- [42] Harriet Harden-Davies, Fran Humphries, Michelle Maloney, Glen Wright, Kristina Gjerde, Marjo K. Vierros, "Rights of Nature: Perspectives for Global Ocean Stewardship.", *Mar. Policy* (xxxx) (2020), 104059 <https://doi.org/10.1016/j.marpol.2020.104059>.
- [43] Autumn Lynn Harrison, Daniel P. Costa, Arliss J. Winship, Scott R. Benson, Steven J. Bograd, Michelle Antolos, Aaron B. Carlisle, et al., The political biogeography of migratory marine predators, *Nat. Ecol. Evol.* 2 (10) (2018) 1571–1578. (<https://doi.org/10.1038/s41559-018-0646-8>).
- [44] P. Hedge, E.I. van Putten, C. Hunter, M. Fischer, "Perceptions, motivations and practices for indigenous engagement in marine science in Australia.", *Front. Mar. Sci.* 7 (2020) 522, <https://doi.org/10.3389/fmars.2020.00522>.
- [45] Michael Heiner, David Hinchley, James Fitzsimons, Frank Weisenberger, Wayne Bergmann, Tina McMahon, Joseph Milgin, et al., "Moving from reactive to proactive development planning to conserve indigenous community and biodiversity values.", *Environ. Impact Assess. Rev.* 74 (September 2018) (2019) 1–13, <https://doi.org/10.1016/j.eiar.2018.09.002>.
- [46] Mateen A. Hessami, Ella Bowles, Jesse N. Popp, Adam T. Ford, "Indigenizing the North American Model of Wildlife Conservation.", *Facets* 6 (2021) 1285–1306, <https://doi.org/10.1139/facets-2020-0088>.
- [47] Henry P. Huntington, "Using Traditional Ecological Knowledge in Science: Methods and Applications.", *Ecol. Appl.* 10 (5) (2000) 1270–1274.
- [48] Henry P. Huntington, S.Suydam Robert, H.Rosenberg Daniel, "Traditional Knowledge and Satellite Tracking as Complementary Approaches to Ecological Understanding.", *Environ. Conserv.* 31 (3) (2004) 177–180, <https://doi.org/10.1017/S0376892904001559>.
- [49] IUCN, 2022, The IUCN Red List of Threatened Species. Version 2022–2. (<https://www.iucnredlist.org>).
- [50] D. Jarvis, R. Hill, R. Buissere, C. Moran, L. Taibot, R. Bullio, C. Grant, A.P. Dale, S. Deshong, D. Fraser, M. Gooch, L. Hale, M. Mann, G. Singleton, L. Wren, Strong Peoples - Strong Country Indigenous Heritage Monitoring Framework: Summary Report, Great Barrier Reef Marine Park Authority., Townsville, 2019.
- [51] Stanislav Ksenofontov, Norman Backhaus, Gabriela Schaeppman-Strub, "There are new species': indigenous knowledge of biodiversity change in Arctic Yakutia.", *Polar Geogr.* 42 (1) (2019) 34–57, <https://doi.org/10.1080/1088937X.2018.1547326>.
- [52] D.P.M. Lam, E. Hinz, D.J. Lang, M. Tengö, H. vonWehrden, B. Martín-López, "Indigenous and local knowledge in sustainability transformations research: a literature review.", *Ecol. Soc.* 25 (1) (2020) <https://doi.org/10.5751/ES-11305-250103>.
- [53] Ben Lascelles, Giuseppe Notarbartolo Di Sciara, Tundi Agardy, Annabelle Cuttelod, Sara Eckert, Lyle Glowka, Erich Hoyt, et al., "Migratory marine species: their status, threats and conservation management needs.", *Aquat. Conserv.: Mar. Freshw. Ecosyst.* 24 (S2) (2014) 111–127, <https://doi.org/10.1002/aqc.2512>.
- [54] Mauro Sergio Pinheiro Lima, Jorge Eduardo Lins Oliveira, Marcelo Francisco de Nóbrega, Priscila Fabiana Macedo Lopes, "The use of local ecological knowledge as a complementary approach to understand the temporal and spatial patterns of fishery resources distribution.", *J. Ethnobiol. Ethnomed.* 13 (1) (2017) 1–12, <https://doi.org/10.1186/s13002-017-0156-9>.
- [55] Theresa Klara Loch, Maraja Riechers, "Integrating Indigenous and Local Knowledge in Management and Research on Coastal Ecosystems in the Global South: A Literature Review.", *Ocean Coast. Manag.* 212 (October) (2021), 105821 <https://doi.org/10.1016/j.ocecoaman.2021.105821>.
- [56] Lorisia MacLeod, "More than personal communication: templates for citing indigenous elders and knowledge keepers.", *KULA: Knowl. Creat., Dissem., Preserv. Stud.* 5 (1) (2021) <https://doi.org/10.18357/kula.135>.
- [57] Kimberley H. Maxwell, Kelly Ratana, Kathryn K. Davies, Caine Taiaipa, Shaun Awatere, "Navigating towards Marine Co-Management with Indigenous Communities on-Board the Waka-Taurua.", *Mar. Policy* 111 (October 2019) (2020), 103722 <https://doi.org/10.1016/j.marpol.2019.103722>.
- [58] Rachel L. Miller, Helene Marsh, Claudia Benham, Mark Hamann, "A framework for improving the cross-jurisdictional governance of a marine migratory species.", *Conserv. Sci. Pract.* 1 (8) (2019) 1–15, <https://doi.org/10.1111/csp2.58>.
- [59] Aileen Moreton-Robinson, Relationality: a key presupposition of an indigenous social research paradigm, *Sources Methods Indig. Stud.* (2017) 69–77, <https://doi.org/10.4324/9781315528854>.
- [60] Clement Yow Mulalap, Elise Huffer Tekau Frere, Kenneth Paul Edvard Hviding, Anita Smith, Marjo K. Vierros, "Traditional Knowledge and the BBNJ Instrument.", *Mar. Policy* (2020), 104103 <https://doi.org/10.1016/j.marpol.2020.104103>.
- [61] Mae M. Noble, David Harasti, Christopher J. Fulton, Bruce Doran, "Identifying spatial conservation priorities using traditional and local ecological knowledge of iconic marine species and ecosystem threats.", *Biol. Conserv.* 249 (November 2019) (2020), 108709 <https://doi.org/10.1016/j.biocon.2020.108709>.
- [62] Meg Parsons, Lara Taylor, Roa Crease, "Indigenous Environmental Justice within Marine Ecosystems: A Systematic Review of the Literature on Indigenous Peoples' Involvement in Marine Governance and Management.", *Sustainability* 13 (8) (2021) <https://doi.org/10.3390/su13084217>.
- [63] Tristan Pearce, Incorporating indigenous knowledge in research, Routledge Handb. Environ. Displac. Migr. (2019) 125–134, <https://doi.org/10.4324/9781315638843-10>.
- [64] Suzanne von der Porten, Yoshi Ota, Andrés Cisneros-Montemayor, Sherry Pictou, "The role of indigenous resurgence in marine conservation.", *Coast. Manag.* 47 (6) (2019) <https://doi.org/10.1080/08920753.2019.1669099>.
- [65] Julie Raymond-Yakoubian, Brenden Raymond-Yakoubian, Catherine Moncrieff, "The incorporation of traditional knowledge into alaska federal fisheries management.", *Mar. Policy* 78 (December 2016) (2017) 132–142, <https://doi.org/10.1016/j.marpol.2016.12.024>.
- [66] Reid, Andrea J., Nathan Young, Scott G. Hinch, and Steven J. Cooke, 2022, "Learning from Indigenous Knowledge Holders on the State and Future of Wild Pacific Salmon," 718–740. <https://doi.org/10.1139/facets-2021-0089>.
- [67] Anne K. Salomon, Ken Lertzman, Kelly Brown, Kii'iljuus Barbara Wilson, Dave Secord, Iain McKechnie, "Democratizing conservation science and practice.", *Ecol. Soc.* 23 (1) (2018) <https://doi.org/10.5751/ES-09980-230144>.
- [68] Jennifer L. Shuter, Annette C. Broderick, David J. Agnew, Niclas Jonzén, Brendan J. Godley, E.J. Milner-Gulland, Simon Thirgood, "Conservation and management of highly migratory species. *Animal Migration*, Oxford University Press., 2011, pp. 172–206, [https://doi.org/10.1016/0964-5691\(94\)90028-0](https://doi.org/10.1016/0964-5691(94)90028-0).
- [69] Eleanor R. Stern, Murray M. Humphries, "Interweaving Local, Expert, and Indigenous Knowledge into Quantitative Wildlife Analyses: A Systematic Review.", *Biol. Conserv.* 266 (2022), 109444 <https://doi.org/10.1016/j.biocon.2021.109444>.
- [70] The National Oceans Office, 2002, Sea Country – an Indigenous Perspective The South-East Regional Marine Plan Assessment Reports.
- [71] K.-L. Thompson, T. Lantz, N.C. Ban, "A review of Indigenous knowledge and participation in environmental monitoring.", *Ecol. Soc.* 25 (2) (2020) 10, <https://doi.org/10.5751/ES-11503-250210>.
- [72] Marjo K. Vierros, Autumn Lynn Harrison, Matthew R. Sloat, Guillermo Ortuño Crespo, Jonathan W. Moore, Daniel C. Dunn, Yoshitaka Ota, et al., "Considering indigenous peoples and local communities in governance of the global ocean commons.", *Mar. Policy* 119 (September) (2020), 104039 <https://doi.org/10.1016/j.marpol.2020.104039>.
- [73] E.A. Virtanen, A. Moilanen, M. Viitala, "Marine connectivity in spatial conservation planning: analogues from the terrestrial realm.", *Landsc. Ecol.* 35 (2020) 1021–1034, <https://doi.org/10.1007/s10980-020-00997-8>.
- [74] Jessica K. Weir, Woelfle-Erskine Cleo, Fuller Sharon, Wentz Sibyl, Diver, Margot Higgins, Investigating best practice: doctoral fieldwork experiences with and without indigenous communities in settler-colonial societies, *ACME* 18 (6) (2019) 1300–1320.
- [75] Kristen Weiss, Mark Hamann, Helene Marsh, "Bridging knowledges: understanding and applying indigenous and western scientific knowledge for marine wildlife management.", *Soc. Nat. Resour.: Int. J.* (2012) <https://doi.org/10.1080/08941920.2012.690065>.
- [76] Kyle Whyte, Settler colonialism, ecology, and environmental injustice, *Environ. Soc. vol. 9* (2018) (2018) 125–144 (JSTOR), (<https://www.jstor.org/stable/26879582>).
- [77] Benjamin T. Wilder, Carolyn O'Meara, Laurie Monti, Gary Paul Nabhan, "The importance of indigenous knowledge in curbing the loss of language and biodiversity.", *BioScience* 66 (6) (2016) 499–509, <https://doi.org/10.1093/biosci/biw026>.
- [78] E. Woodward, R. Hill, P. Harkness, R. Archer (Eds.), *Our Knowledge Our Way in Caring for Country: Indigenous-Led Approaches to Strengthening and Sharing Our Knowledge for Land and Sea Management. Best Practice Guidelines from Australian Experiences*, NAILSMA and CSIRO, 2020.