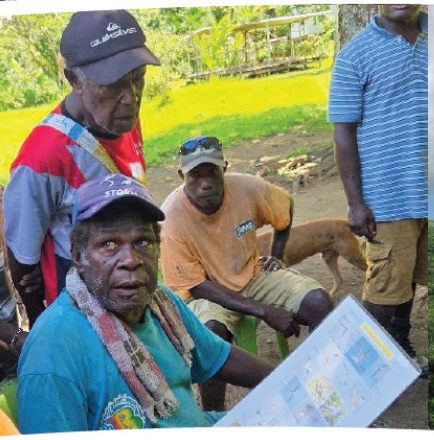
REVIEW OF TRADITIONAL KNOWLEDGE OF SEABIRDS IN THE PACIFIC OCEAN



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Written by John Lamaris, Peter Allen, and Rohan Clarke. Research Ecology Conservation Group School of Biological Sciences, Monash University.

Cover photos: Main image: Great frigatebirds and red-footed boobies at Tern Island (U.S. Fish & Wildlife Service). Right bottom: A student from Kapsipau Primary School in southern New Ireland checking out a poster with the endemic Beck's Petrel (© John Lamaris). Centre bottom: The outlook from a Vanuatu Petrel breeding area on Vanua Lava, Vanuatu (© Peter Allen). Left bottom: Clan chief Robert Thomas sharing his knowledge of seabirds with young men in Konoagil, Southern New Ireland referring to the ID card used in this review (© John Lamaris).

SPREP
Secretariat of the Pacific Regional Environment Programme

PO Box 240, Apia, Samoa **T:** +685 21929 **E:** sprep@sprep.org **W:** www.sprep.org

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Executive summary

Traditional knowledge is a system of collective understandings transferred through communities across generations. It includes indigenous peoples' knowledge of the natural environment and the ecosystems they occupy, which is founded upon long-term and deeply meaningful connections between people and place. This means traditional knowledge often contains vital perspectives and information relevant to the conservation of wildlife, especially in remote areas where academic research has been historically limited. Pacific Ocean seabirds are the subjects of a rich body of traditional knowledge, which may hold vital perspectives for protection and study of this highly threatened group.

To date, no work has attempted to document the scope and details of seabird traditional knowledge in the Pacific Ocean. In this report, key questions that arise from this knowledge gap are answered, aiming to:

1. Review the current representation of seabird traditional knowledge in the Pacific in the scientific and grey literature.
2. Generate novel information capturing details of seabird traditional knowledge in the Pacific, focussing on Melanesia as an understudied region.
3. Provide a set of recommendations both for future research into seabird traditional knowledge in the Pacific, and how this traditional knowledge should inform applied conservation management and science.

While seabird traditional knowledge exists across the Pacific, relatively little of this is captured in the scientific literature. A questionnaire survey of five communities spread across Papua New Guinea, the Solomon Islands, and Vanuatu showed that while seabirds are considered highly important to traditional knowledge systems, this knowledge is less extensive among younger community members. It is critical for future research to expand upon the approach provided here to better understand seabird traditional knowledge in local, problem-specific ways across the Pacific. Community members should also be engaged in research and conservation work to affect long-term, sustainable management that provides outcomes for Pacific Ocean seabirds while maintaining local livelihoods and cultural practices.

Contents

1. Introduction

The traditional and cultural knowledge of seabirds in the Pacific is a rich, complex, and dynamic body of insight developed through sustained human interaction with the natural environment (Berkes et al., 1994; Tidemann & Gosler, 2012). The extensive island chains distributed across the Pacific Ocean are home to diverse and abundant seabird communities (Aylesworth, 2009; Pippard et al., 2017; Steibl et al., 2024). These seabirds have profoundly shaped the lives, cultures, and ecological understandings of Pacific peoples (Cody et al., 2022; Pillay, 2024; Richter-Gravier, 2019).

Seabirds perform a wide range of ecological functions, and provide a multitude of intermediate (supporting and regulating) and final (cultural) ecosystem services (Reynolds et al., 2019; Signa et al., 2021). By feeding at sea and breeding on land, seabirds transfer marine-derived nutrients to terrestrial ecosystems via guano, discarded food, and decomposing carcasses around colonies, enriching otherwise nutrient-poor island soils and supporting plant growth and biodiversity (Appoo et al., 2024). The high nitrogen content of guano specifically sustains island vegetation (Colombo et al., 2022; Estupiñán-Montaño et al., 2023; Gaiotto et al., 2022) and contributes to processes such as reef building on small, remote islands (Dunn et al., 2024; Honig & Mahoney, 2016; Lorrain et al., 2017; Signa et al., 2021). These ecological contributions ultimately support agriculture and human livelihoods on remote islands worldwide (Erlandson & Fitzpatrick, 2006; Rodrigues & Micael, 2021).

The functional importance of seabirds is closely tied to their deep cultural significance across the Pacific (Winter et al., 2023). Shared across widely dispersed island communities, seabirds are often considered sacred, symbolic, or spiritually significant within Indigenous knowledge systems. Traditional practices include sustainable harvesting of seabirds or their eggs (Richter-Gravier, 2019), and seabirds figure prominently in mythology, art, oral traditions, and totemic systems (Cody et al., 2022; Winter et al., 2023).

Beyond cultural roles, seabirds provide vital mechanistic services. Historically, Pacific Islanders used seabirds' flight patterns as natural navigational aids to locate land across the vast Pacific (Bedford & Spriggs, 2019; Steadman et al., 1990). Observing seabird foraging behaviour also helps fishers locate productive fishing grounds (Croxall et al., 2012). Seabird colonies—such as those in the Galápagos, Hawaii, and New Zealand—support eco-tourism, generating economic benefits for local communities (Rodríguez et al., 2017). In some regions, seabird guano has been harvested as a natural fertiliser, sustaining agriculture and providing critical economic benefits (Rodrigues & Micael, 2021; Steadman & Intoh, 1994). Recognising the value of seabird-derived fertilisation, many Pacific communities have developed traditional practices to protect seabird colonies.

The cultural and economic relationships between Pacific communities and seabirds highlight a deep interdependence that reinforces the importance of protecting traditional conservation practices (Smith & Huffer, 2023). These connections are vital not only for ecological health but also for maintaining cultural identity and livelihood security. However, this need is increasingly urgent, as seabirds are the most threatened group of birds globally, with deteriorating conservation statuses across all major taxa. In the Pacific, seabirds face both terrestrial threats—such as habitat degradation and invasive predators on breeding islands—and pelagic threats that arise during migration and foraging at sea. Key drivers of decline include anthropogenic climate change, introduced predators, and the depletion of prey stocks due to oceanic shifts and human exploitation. Although numerous conservation initiatives have shown local success, these efforts are often context-specific and difficult to scale across the region's ecologically diverse islands and seabird populations. Addressing the scale and complexity of these challenges requires integrated, multinational approaches, including global agreements such as the Agreement on the Conservation

of Albatrosses and Petrels (ACAP) and regional programs like the Secretariat of the Pacific Regional Environmental Programme (SPREP), which play critical roles in coordinating seabird conservation across jurisdictions.

Even with international coordination, Indigenous Pacific communities remain central to seabird conservation. The diversity and depth of connections between Pacific peoples and seabirds highlight the necessity of collaborative, culturally informed conservation approaches that balance ecological protection with livelihood needs. Pacific Islanders are increasingly leading community-based conservation initiatives, with the success of these efforts depending largely on how well conservation strategies integrate traditional and cultural knowledge. Therefore, understanding the cultural dimensions of seabird–community relationships is a critical foundation for developing effective conservation frameworks. As conservation efforts expand, drawing upon the traditional ecological knowledge of Pacific peoples offers unparalleled insights into seabird ecology and sustainable management practices.

2. Scope and aims

This study reviews the documented traditional and cultural knowledge of seabirds in the Pacific Ocean, using a systematic approach suited to a field where valuable information spans both academic and grey literature. To complement this review, we present a novel empirical study that gathers primary data on seabird traditional knowledge from selected Pacific communities. This includes a review of scientific literature, the compilation of oral stories, and in situ surveys with community members—methods that together reflect the rich diversity of relationships Pacific Indigenous peoples have with seabirds and their environments.

To frame this inquiry, we begin by distinguishing between traditional knowledge and cultural knowledge as distinct but overlapping modes of Indigenous engagement with seabirds. We then synthesise seabird-related knowledge recorded across the Pacific, integrating findings from the literature and our contemporary fieldwork to illustrate how traditional knowledge is applied in various cultural and ecological contexts. Finally, we explore current challenges facing the practice and transmission of this knowledge, identifying key pathways for incorporating traditional perspectives into seabird conservation, and for ensuring that seabird recovery efforts contribute to broader cultural resilience in the Pacific.

3. Methods

3.1 Definitions

Although often used interchangeably, ‘traditional’ and ‘cultural’ refer to distinct aspects of Indigenous knowledge systems, each contributing uniquely to the relationship between people and their natural environments. A substantial body of research explores the significance of Indigenous knowledge for addressing conservation challenges, employing a range of terms including Traditional Ecological Knowledge (TEK), Indigenous Traditional Ecological Knowledge (ITEK), Traditional Knowledge (TK), and Indigenous Ecological Knowledge (IEK). This diversity reflects differing scholarly perspectives, the discussion of which lies beyond the scope of this review. Here, we use the terms *traditional knowledge* and *cultural knowledge* to illustrate key elements and applications of these knowledge systems, while encompassing the broader definitions found across the literature.

Traditional knowledge refers to long-standing practices, skills, beliefs, and understandings developed and transmitted across generations within specific communities (Berkes et al., 1994). Rooted in place and environment, it is often conveyed orally or through direct practice, and adapts over time in response to environmental and societal changes (Berkes et al., 2000). Traditional knowledge tends to be practical and closely tied to survival, subsistence, or sustainable resource management. For example, Pacific communities' knowledge of seabird behaviour to aid fishing practices exemplifies this tradition (Richter-Gravier, 2019). While deeply historical, traditional knowledge remains dynamic, evolving to incorporate new observations, such as navigational cues drawn from seabird flight patterns that necessarily accumulate with time (Cody et al., 2022; Richter-Gravier, 2019; Smith & Huffer, 2023).

Cultural knowledge, by contrast, encompasses the beliefs, customs, values, arts, and symbolic expressions that shape a community's identity and worldview (Bihari, 2023; Berkes et al., 2000). It is expressed through mythology, rituals, language, and traditions, embedding meaning in both everyday life and ceremonial practice (Tidemann & Gosler, 2012). Cultural knowledge is holistic, integrating spiritual, emotional, and social dimensions, and is more readily subject to reinterpretation over time than traditional knowledge (Girard et al., 2022; McCarter & Gavin, 2014).

Both traditional and cultural knowledges are transmitted formally and informally through kinship networks, social interactions, oral narratives, and ritual practices (Berkes et al., 2000). They encompass oral histories, cosmological observations, symbolic communication, ecological expertise, and tool-making skills (Cody et al., 2022; Tidemann & Gosler, 2012). In the Pacific, Indigenous knowledge systems are fundamentally interconnected with daily life and the surrounding landscapes and seascapes, whether expressed through spiritual beliefs or practical activities (Cody et al., 2022; Ramstad et al., 2007; Richter-Gravier, 2019). In this study, we adopt this holistic understanding to examine how traditional knowledge systems encapsulate the relationships between Pacific peoples and seabirds.

3.2 Literature search

A systematic review structure was used for extracting relevant literature on seabird TK in the Pacific, with methods designed to obtain as near as possible to obtain a census of the academic and grey literature. A pure systematic approach, rather than a structured approach, was adopted to ensure adequate capture of grey literature and other informal sources. References were drawn from Google Scholar using reiterative search strings and collated into a database by primary location.

Initial literature searching was undertaken by developing an a priori Boolean search string containing key terms relevant to TK of seabirds in the Pacific Ocean. Papers returned by this search string were filtered for relevance by manual screening. In all assessments of relevance, inclusion criteria required that literature must contain an explicit reference to an acknowledged definition of traditional knowledge, explicit reference to at least one seabird species, genus or family, and be spatially explicit with at least one reportable result for the Pacific Ocean and its contained islands. Sources meeting these criteria were determined through title and abstract screening, prior to only papers deemed relevant at this stage being read in full.

Search strings for subregions of the Pacific were iterated by keyword mining, developing a final set of utilised search strings based on location-specific terminology and context-appropriate language. Keyword mining entailed compiling the keywords of papers identified to be relevant, and adding relevant terms identified through this process to subsequent search strings to ensure a

comprehensive set of search terms. Citation trawling of included papers was also used to identify additional relevant papers as a quality-assurance check on the extractive power of subsequent search strings. Citation trawling entailed examining all refences contained in each relevant paper, and then using title and abstract screening to add those that met the inclusion criteria into the ultimate literature set. These also acted as a quality check by providing a snapshot of papers that should be captured by future search strings.

Although some sources may not have been identified through this process, the large volume of literature returned by the iterative search process indicates that a representative sample is likely. All sources that could not be accessed as full texts, or were not available with an official English translation, were excluded to ensure accurate interpretation of all sources included in the review. In total, after search string refinement and screening according to these criteria, the final relevant literature set was reduced from an initial 3,300 papers and other texts to 250 relevant resources.

3.3 Questionnaire survey

A two-part survey was developed to document the traditional knowledge (TK) of seabirds held by Pacific communities. eight communities were surveyed, these were spread across Papua New Guinea (n = 3), Solomon Islands (n = 3), and Vanuatu (n = 2) (Figure 1). **Part 1** focused on assessing participants' seabird knowledge, including self-perceived and demonstrated identification skills, as well as knowledge of seabird conservation. **Part 2** explored the nature of human–seabird relationships within participants' communities, incorporating traditional, cultural, and self-defined dimensions of seabird knowledge.

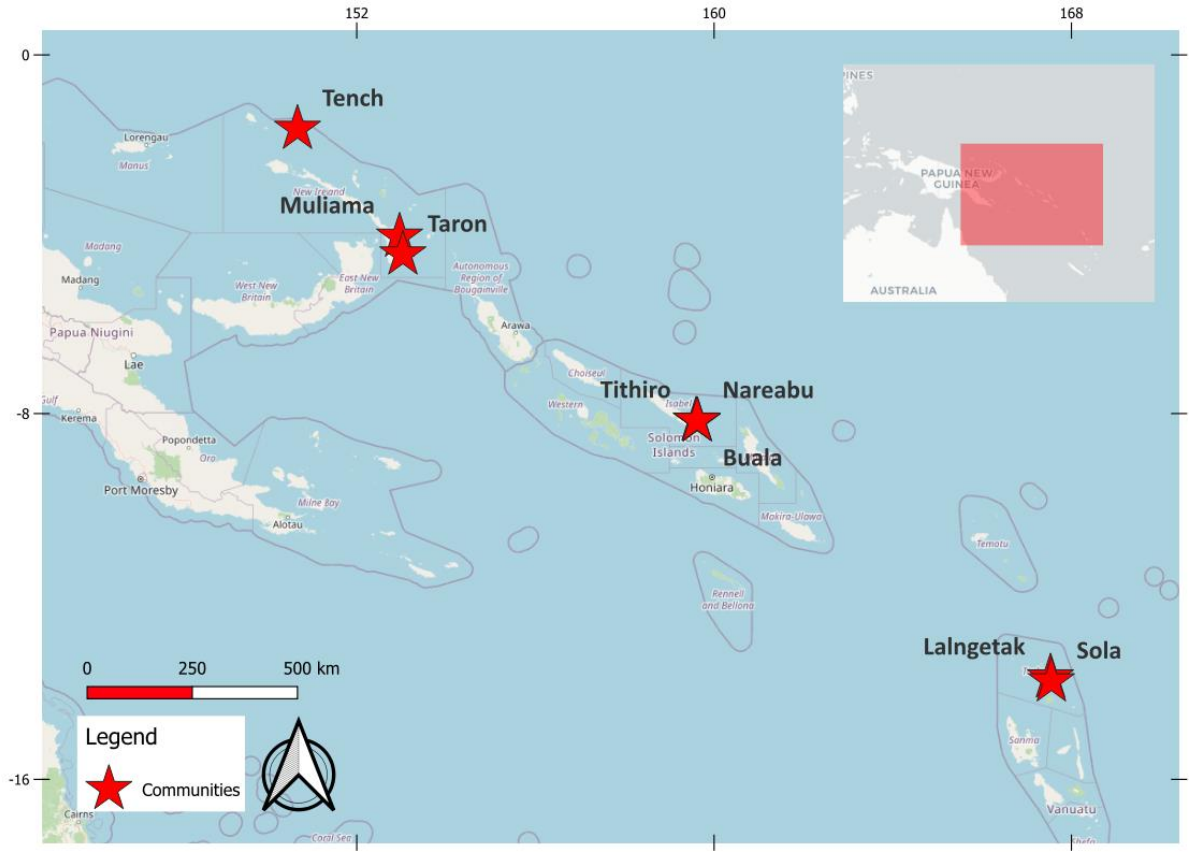

Figure 1. Names and locations of communities that participated in a survey of seabird traditional knowledge in the Pacific Ocean in 2024 and 2025.

Participants were recruited via an opt-in approach, with the survey advertised directly to community members. This method was selected as the most appropriate for collecting potentially sensitive cultural information while respecting community autonomy and informed consent.

To evaluate seabird knowledge, participants were shown an identification card featuring images of seven seabird species. The species depicted were tailored to each community based on local seabird abundance, ensuring ecological relevance. Species selection was informed by citizen-science datasets, informal expert elicitation, and field experience. Each card included: two common, two uncommon, one rare but locally present species, and two control species not found in the region. This design allowed for both realistic assessment and internal validation. The seabird species used are summarised in Table 1. To assess participants' familiarity with each seabird species presented, the following questions were asked:

1. How frequently have you seen this species?
2. Where have you observed this species?
3. Do you know where this species breeds or comes ashore?
4. Is this species considered taboo by your clan or tribe?
5. Are there any other seabird-related taboo areas in your community?
6. Does your community, tribe, or clan have any specific cultural association with this species?

To better understand community-level relationships with seabirds, participants were also asked:

1. Are seabirds important or helpful for livelihoods or other purposes in your community?
2. Do you, or others in your community, use seabirds to locate fish?
3. Have seabirds been harvested for domestic use in your community?
4. Are there cultural associations with other seabird species not included in the identification card?

Surveys were conducted in three Pacific countries: Papua New Guinea (PNG), Vanuatu, and the Solomon Islands. Site selection was determined by logistical opportunity—either due to concurrent research activity by the authors (New Ireland, PNG; and Vanua Lava, Vanuatu) or through collaboration with other researchers working in relevant locations (Isabel, Solomon Islands).

Table 1. Seabird species included in region-specific identification cards for surveying Traditional Knowledge of seabirds of indigenous communities in the Pacific in 2024 and 2025.

Tier	Papua New Guinea	Solomon Islands	Vanuatu
Common	Red-footed Booby	Red-footed Booby	Wedge-tailed Shearwater
	Greater Crested Tern	Greater Crested Tern	Greater Crested Tern
Uncommon	White-tailed Tropicbird	White-tailed Tropicbird	Red-tailed Tropicbird
	Frigatebird sp.	Frigatebird sp.	Frigatebird sp.
Locally unique	Beck's Petrel	Heinroth's Shearwater	Vanuatu Petrel
Absent	Atlantic Puffin	Atlantic Puffin	Atlantic Puffin
	Kelp Gull	Kelp Gull	Kelp Gull

4. Results

4.1 Literature review

4.1.1 Cultural and traditional knowledge of Seabirds

Seabirds are deeply embedded in the traditional knowledge systems of Pacific communities, providing vital ecological insights and practical guidance for Indigenous peoples (Cody et al., 2022; Richter-Gravier, 2019). Their flight paths, nesting habits, and behaviours have long been used by navigators to predict weather, locate land, and identify fishing grounds, making them essential allies in navigating the vast oceanic environment of the Pacific (Bedford & Spriggs, 2019). This knowledge, passed down orally across generations, is central to oral traditions that support the sustainability of both human livelihoods and natural ecosystems (Berkes et al., 1994). Beyond navigation, seabirds also act as indicators of seasonal change and shifting oceanic conditions (Brooke & Pearson, 2018). Their integration into ceremonial life, mythology, and art further illustrates their cultural significance and the deep ecological relationships coastal peoples maintain with the natural world (Winter et al., 2023).

Pacific communities have developed a nuanced understanding of the ecological interdependence between seabirds and marine systems. Observing seabird behaviour—particularly their flight and feeding patterns—enables fishers to locate schools of fish, highlighting the role of seabirds in subsistence economies. While the worldviews that underpin this knowledge vary regionally, they consistently emphasise relationality, where all elements of the environment are spiritually infused and humans are not considered separate or superior (Richter-Gravier, 2019; Tidemann & Gosler, 2010). This ethos is reflected in the multifunctional role of seabirds: they are ecological indicators (Einoder, 2009), spiritual entities (Tidemann & Gosler, 2010), and essential food sources in environments where terrestrial protein is limited (Steadman, 2006; Winter et al., 2023). Specific examples, include settings where feathers from the White Tern *Gygis alba* are used in ceremonial garments, and seabird bones are crafted into tools and ornaments (Richter-Gravier, 2019).

Importantly, the use and harvest of seabirds are often governed by traditional knowledge systems that promote sustainable practices (Berkes et al., 2000; Lyver & Moller, 2012). Many communities regulate harvesting based on breeding seasons, species type, or ecological conditions, employing culturally embedded systems of control (Johannes, 1978; Moller et al., 2009). These systems are known by various names across the Pacific, including ra'ui in the Cook Islands, rahui in Aotearoa/New Zealand (Wheen & Ruru, 2011), tabu in Fiji and other Melanesian islands (Caillaud et al., 2004; Hickey, 2006), mo in the Marshall Islands (Ahlgren, 2016), vala in the Bismarck Archipelago (Aini et al., 2023), and tambu or gwala in the Trobriand Islands (Mitchell, 2023; Whitmore et al., 2016). These practices typically restrict resource use spatially, seasonally, or by species until resources are replenished (Table 2).

Taboos generally fall into three management categories: (1) species-specific restrictions that distribute harvest pressure, (2) temporal restrictions aligned with life-cycle events, and (3) spatial exclusions such as no-take zones (Colding & Folke, 1997; Pernetta & Hill, 1984). These restrictions may be initiated idiosyncratically, and can apply to entire communities, or be limited to certain clans or individual families or people within a community (Colding & Folke, 1997; Colding & Folke, 2001). Across the Pacific, spatially defined and temporally bounded restrictions are generally applied to marine systems, while species-specific and seasonal restrictions are generally used to regulate use of terrestrial species and resources (Berkes et al., 2000; Berkes et al., 1994; Colding & Folke, 1997).

Such systems provide empirically grounded wildlife management strategies predating modern conservation science.

In addition to direct harvesting, seabirds are integral to cultural practices that do not involve take. Observations of their behaviour aid in both fishing and navigation, with birds serving as indicators of fish presence and safe travel routes. These practices reflect a long-evolved synergy between human survival and seabird ecology. In many communities, seabirds are not hunted due to spiritual beliefs. Certain species are viewed as kin, ancestors, or deities, rendering them tapu (Cody et al., 2022; Pillay, 2024). Across Polynesia, a wide array of prohibitions governs the edibility and treatment of birds (Richter-Gravier, 2019). Similar beliefs are found across Melanesian (Pernetta & Hill, 1984) and Micronesian societies, where kinship, reverence, and cosmological beliefs continue to shape human-seabird relationships.

4.1.2 Cultural Significance of Seabirds

Seabirds hold deep cultural significance in the Pacific, they are woven into the fabric of spiritual beliefs, navigation, and daily life of the island peoples. For many Pacific communities, including Polynesians, Micronesians, and Melanesians, seabirds are revered as sacred beings, and often viewed as messengers of the gods or ancestors (Richter-Gravier, 2019; Tidemann & Gosler, 2012; Winter et al., 2023). Their behaviours and flight patterns are intricately studied for navigation, guiding seafarers across vast ocean expanses (Bedford & Spriggs, 2019; Steadman, 2006). Seabirds are also deeply embedded in local myths, representing strength, protection, or omens of change. In traditional practices, seabirds serve as both symbols of abundance, due to their connection to fishing grounds, and as central figures in rituals, storytelling, and art (Winter et al., 2023). This respect for seabirds reflects a broader worldview in these cultures that emphasises harmony with nature, and their integral role in the survival and spiritual well-being of islands and coastal communities (Tidemann & Gosler, 2012).

On Polynesian outlying islands of Kapingamarangi, seabird species kept as pets include terns, noddies and frigatebirds. Boobies, frigatebirds, terns, noddies are also kept in Luangiua, while only frigatebirds are kept in Taku, and only noddies occur as domestic birds in Tikopia (Richter-Gravier, 2019; Steadman, 2006; Steadman et al., 1990).

On other Polynesian islands, it is a belief that souls temporarily assumed the form of birds (Pillay, 2024). In Mangareva, for instance, it was recorded that people believe that the souls of the dead come to visit their relatives in the shape of ngoio (Brown Noddy, *Anous stolidus*) (Richter-Gravier, 2019). As such, birds, whose power of flight suggests a 'communion with higher powers', are seen as intermediaries between the living, dwelling on the earth, and the spirits, dwelling in the heavens (Richter-Gravier, 2019).

In Micronesia, frigatebirds served as message carriers in Nauru. As these birds do not land on the ocean, the material that they were entrusted to carry would not get damaged according to local lore (Petit-Skinner, 1983). This practice may have existed in parts of Polynesia too, such as in Samoa and Tuvalu, where the people of Niutao were fond of taming frigatebirds. Similarly, in Tokelau, young frigatebirds were tamed and kept on perches near houses (Richter-Gravier, 2019). This shows that seabirds played an essential role in the material culture of traditional Polynesian societies.

Table 2. Traditional marine and terrestrial conservation measures actively employed by Pacific Island communities, as documented in a review of the scientific literature. Types of restrictions are spatial, temporal, and species-specific.

Action	Local name	Locality / Country	Type	Source
Restrictions on taking seabirds and /or their eggs	*Tabu*	Anuta / Solomon Islands	Species / Active	Johannes, 1978
Restrictions on taking seabirds and /or their eggs	*Ra'ui*	Pukapuka / Cook Islands	Species / Active	Johannes, 1978
Restrictions on taking seabirds and /or their eggs	*Mo*	Enewetak / Marshall Islands	Species / Active Spatial/Temporal	Johannes, 1978 Ahlgren, 2016
Restrictions on taking seabirds and /or their eggs	*Bul*	Tobi / Palau	Species / Active	Johannes, 1978
Rakiura mātauranga (Rakiura Māori TEK) Sooty Shearwaters (*Ardenna griseus*)	*Rakiura mātauranga*	Rakiura / New Zealand	Spatial/Temporal Species / Active	Johannes, 1978
Marine Restrictions	*Fono* (temporary) *Tapu* (longer term control)	Niue	Spatial/Temporal	Johannes, 1978
Terrestrial/Marine Restrictions	*Tui'i*	Manus Island/ Papua New Guinea	Spatial/Temporal	Lamaris & Whitmore, 2018; Whitmore et al., 2016; Cinner et al., 2005
Marine Restrictions	*Vala*	Lavongai island / Papua New Guinea	Spatial/Temporal	Aini et al., 2023
Marine Restrictions	*Gwala*	Milne Bay/Papua New Guinea	Spatial/Temporal	Mitchell, 2023

Table 3. Seabirds that are culturally significant to communities in the Pacific Ocean.

Country/region	English name	Scientific name	Local name	Practice		Information source
				Cultural	Traditional	
Marquesas	Frigatebird sp.	*Fregata sp.*	*mokole*	Yes	Yes	Richter-Gravier (2019)
Tatakoto /Tuamotu Archipelago	Frigatebird sp.	*Fregata sp.*	*torea*	Yes	Yes	Stimson & Marshall (2013) Richter-Gravier (2019)
Tītī Islands/ Rakiura (Stewart island)	Sooty Shearwater	*Ardenna griseus*	*titi*	Yes	Yes	Newman & Moller (2005) Charleton et al. (2009)
Tahiti	Frigatebird sp.	*Fregata sp.*	*torea*	Yes	Yes	Richter-Gravier (2019)
Nauru	Frigatebird sp.	*Fregata sp.*	*iti*	Yes	Yes	Pollock (2009) Intoh, M.& M. Eda (2009)
Palau	Tropical Shearwater White-tailed Tropicbird	*Puffinus dichrous* *Phaethon lepturus*		Yes	Yes	Ketebengang & Gupta (2010)
Kiribati	Lesser Frigatebird	*Fregata ariel*		Yes	Yes	Pollock (2009) Intoh & Eda (2009)
Solomon Islands/ Ontong Java	White-tailed Tropicbird Brown Noddy White Tern Frigatebird sp.	*Phaethon lepturus* *Anous stolidus* *Gygis alba* *Fregata sp.*		Yes	Yes	Bayliss-Smith & Christensen (2008)
Solomon Islands/ Anuta island	White Tern Frigatebird sp.	*Gygis alba* *Fregata sp.*		Yes	Yes	Kirch (2002) Steadman et al. (1990) Kirch (2002)

Frigatebird species (*Fregata* sp.) are also well recognised in Pacific cultures for their unique figures and behaviour, with their unmistakable, long, pointed wings, and long, deeply-forked tails. Traditional navigators in the Pacific frequently relied upon frigatebirds when searching for land, and their tails are symbolised as the stylised bow and stern of Carolinian sailing canoes (Michiko & Masaki, 2009; Steadman & Intoh, 1994). The kleptoparasitic behaviour of Frigatebirds, and their aerial agility catching flying fish while on the wing, made these birds highly respected by Pacific peoples, particularly in Micronesia (Michiko & Masaki, 2009; Steadman & Intoh, 1994). The long, black feathers of Frigatebirds are also admired for their ornamental value in some Pacific cultures. For instance, in the Marshall Islands, men wore head ornaments of frigatebird feathers in war and in dances. In general, chiefs wore frigatebird feathers as a sign of status, while lower-status community members wore other feathers, most commonly domestic chicken *Gallus gallus* (Michiko & Masaki, 2009; Waite, 2021).

Two varieties of frigatebird head ornaments were historically worn in Chuuk (Michiko & Masaki, 2009). Men wore one type of wooden comb, decorated with red *Spondylus* sp. shell beads and frigatebird feathers for dancing. Another type of comb (named an epico, ebidjau) had an elaborate frigatebird feather attachment resembling a small fan (Figure 3b), and a row of wing feathers was fastened to a thin stick of mangrove wood which in turn was lashed to the handle of the comb (Figure 3a). A sketch by Atsushi in 1934 also showed an elderly man from Fais wearing a comb (roai) decorated with a frigatebird feather (Figure 3c) (Michiko & Masaki, 2009).

Frigatebird feathers were also attached to fishing lures made of pearl shell (Fig.2d), and their bones were made into tattoo chisels in some areas in Micronesia, such as Marshall Islands and Yap (Steadman & Intoh, 1994). Body tattooing was also practiced extensively on Tobi in Palau, as on other Central Caroline Islands (Steadman & Intoh, 1994). Since frigatebird wing bones are thin-walled and hard, they were also used as surgical scalpels in Chuuk (Michiko & Masaki, 2009).

Figure 2. (a) A wooden comb decorated with frigate-bird feathers -collected from Chuuk in 1934 (b) an elaborately decorated head ornament made of frigatebird feathers (c) an old man wearing a decorated comb with a frigatebird feather (d) a trolling fishhook from Lamo-rek, a cut feather of a frigatebird attached at the bottom as lure (sketch by A. Someki) Source: Michiko & Masaki, 2009).

In the Solomon Islands, frigatebirds are a symbol of bonito fishing. They hover around schools of bonito (Katsuwonus) and are thought to embody the spirits of deceased fisherman. Bonito fishing canoes have frigatebirds carved on their bodies and their floats. Prominent men displayed their prestige by serving feast foods like taro or yam puddings in wooden bowls carved to resemble frigatebirds. Similar bowls were used in the Central Caroline Islands and Mortlock islands of Micronesia (Michiko & Masaki, 2009).

In the Torres group of islands in Vanuatu, the frigatebird when flying high up in the sky signals that a tropical cyclone will be expected in a few days. This knowledge of the frigatebird has been incorporated into Vanuatu traditional knowledge and awareness of tropical cyclones (Vanuatu Meteorology & Geo-Hazard Department, 2024).

Similar stories were also shared by people of Bougainville in "Birds and Bird Lore of Bougainville and the North Solomons" (Hadden, 2004) and Ontong Java atolls, Solomon Islands (Bayliss-Smith & Christensen, 2008).

Apart from myth and legends, an example the of the relationship humans have with birds, especially in Melanesian societies, can be observed in the use of birds as totems for clans. An example of this is the 12 clans of Lovongai island (New Hanover) in the New Ireland Province, Papua New Guinea. On Lovongai Island, people are socially grouped into twelve matrilineal clans, symbolised by bird totems, known as Pat-mani (connotes the "head-bird" that a group associate with). Seabirds are represented in this structure, with one clan holding the name Kanai (Terns – Seagull) (Kaiku & Kaiku, 2008). Based on the foraging, breeding and nesting habits of their totems, each clan has spiritual powers (manteng) emulating this to perform a specific task to ensure maintenance of social order within communities on the island (anecdotal coms - Paul Pira). Every totem bird is taboo to members of each clan, and marriage within a clan remains forbidden. If this happens, it is a breach of social law which formerly resulted in death for either one or both parties involved, however these capital punishment practices are frowned upon in modern times (Patrick Karabuspalau Kaiku & Tukul Walla Kaiku, 2008).

In another display of the relationship humans have with seabirds in New Ireland, the Kulepteina dance performed by women of Kara and Tigak villages. Each performer perches on a "nest" built on a single long stilt (Figure 3a). This dance is performed in five parts; the first part relates to the calling of the shark; the second part mimics the seabird searching for fish in the sea; while the third and fourth relates to the deceased member; and the final part depicts the bird discovering new life and symbolically shares that life continues (Figure 3).

Figure 3. Mimicking of a seabird - Kulepteina dance of New Ireland Province, Papua New Guinea. (a) Birds nest (b) Women dancers on nest (c) Women performing the dance. Source: Naomi- Faik Simet, Institute of PNG studies (a&b), and John Lamaris image (c).

4.2 Questionnaire survey

80 responses were collected across all communities surveyed. By region, Papua New Guinea had 26 responses (10 from Tench and 16 from Southern New Ireland), Solomon Islands had 40 responses all from Isabel, and Vanuatu had 14 responses (10 from Lalngetak and 4 from Sola).

4.2.1 Seabird knowledge and identification skills

From the first component of the survey, assessing local people's perception of seabird identification and encounter rates, substantial differences between countries and communities were evident (Figure 4). Relatively few individuals from PNG and the Solomon Islands identified as having very good knowledge of seabirds, though many from the Solomon Islands identified as having good knowledge (Figure 4). In Vanuatu nearly one quater of people surveyed identified as having very good seabird knowledge, but overall fewer people identified as having good knowledge compared to the Solomon Islands (Figure 4). Many more people in PNG identified as having little or average knowledge. Knowledge was differentiated by age class, with older community members generally considering themselves to have more extensive knowledge of seabirds than younger generations. From conversations *in situ*, this was largely considered to be experience-based, with younger people having accumulated less time in marine settings where they might routinely encounter seabirds. There was a substantial gender bias in survey respondents, with only 10% of participants (n = 8) being female across all countries and communities. This made it difficult to identify differences in levels of self-identified seabird knowledge between genders.

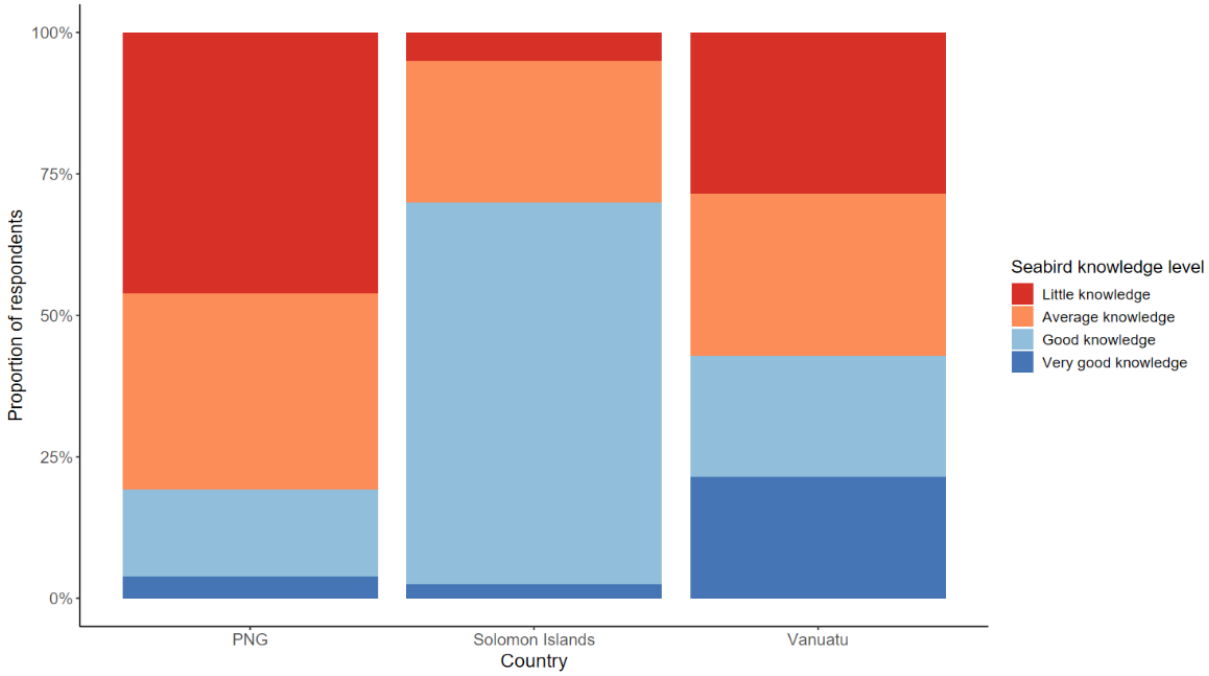

Figure 4. Self-assessed seabird identification skill level of indigenous community members from three Pacific countries. Skill levels are represented proportionally, PNG n = 26, Solomon Islands n = 40, Vanuatu n = 14.

Self-perceived knowledge of seabirds scaled close to linearly with real experience with locally-occurring seabird species (Figure 5). Ratios of encounter rates from frequently encountering birds to never encountering them were approximately similar to ratios of self-perceived knowledge, with the Solomon Islands standing out as a region where all community members surveyed had encountered their nominated locally-occurring species, Heinroth's Shearwater (*Puffinus heinrothi*) at least once. Further, in PNG and Vanuatu, the locally-occurring seabirds (Beck's Petrel *Pseudobulweria becki* and Vanuatu Petrel *Pterodroma occulta* respectively), were relatively routinely encountered by those who had good knowledge of seabirds, but were unfamiliar to those who evaluated themselves as having less extensive knowledge. False positive rates were also well explained by levels of knowledge within communities. Generally, communities with less seabird knowledge more readily

Figure 5. Encounter frequency with locally-occurring seabird species for indigenous community members from three Pacific countries. Encounter frequencies are represented proportionally, PNG n = 26, Solomon Islands n = 40, Vanuatu n = 14. The seabird species participants were shown for each country were Beck's Petrel *Pseudobulweria becki* (PNG), Heinroth's Shearwater *Puffinus heinrothi* (Solomon Islands), and Vanuatu Petrel *Pterodroma occulta* (Vanuatu).

identified that they had encountered seabirds that are absent from the local area, while these assumptions were not frequent in communities that possessed more extensive knowledge.

4.2.2 Human-seabird connections

Seabirds were considered highly important by all communities surveyed in this project (Figure 6). From all participants in all three countries, all identified seabirds as at least sometimes important, with the substantial majority indicating that seabirds are highly important in their communities and cultures. From stories with survey respondents, key aspects of this importance were identifying productive fishing areas, predicting weather, and for spiritual reasons. Spiritual reasons were especially prominent in Vanuatu, where the Vanuatu Petrel (Betlap in the local language) is considered to embody the spirits of deceased relatives as they travel between our world and the afterlife visiting surviving family members.

Traditional regulation of community interactions was relatively uncommon in communities we surveyed (Figure 7). We only documented a formalised Tabu structure for preventing access to, and harvesting of, seabirds in Vanuatu, in the village of Lalngetak on Vanua lava. Despite this, seabird harvesting experiences were also relatively uncommon among local peoples, with only community members from PNG having harvested seabirds. No conflict between harvesting in Tabu areas was recorded, with the only harvesting documented in PNG, and an absence of any traditional regulation in these communities (Figure 7).

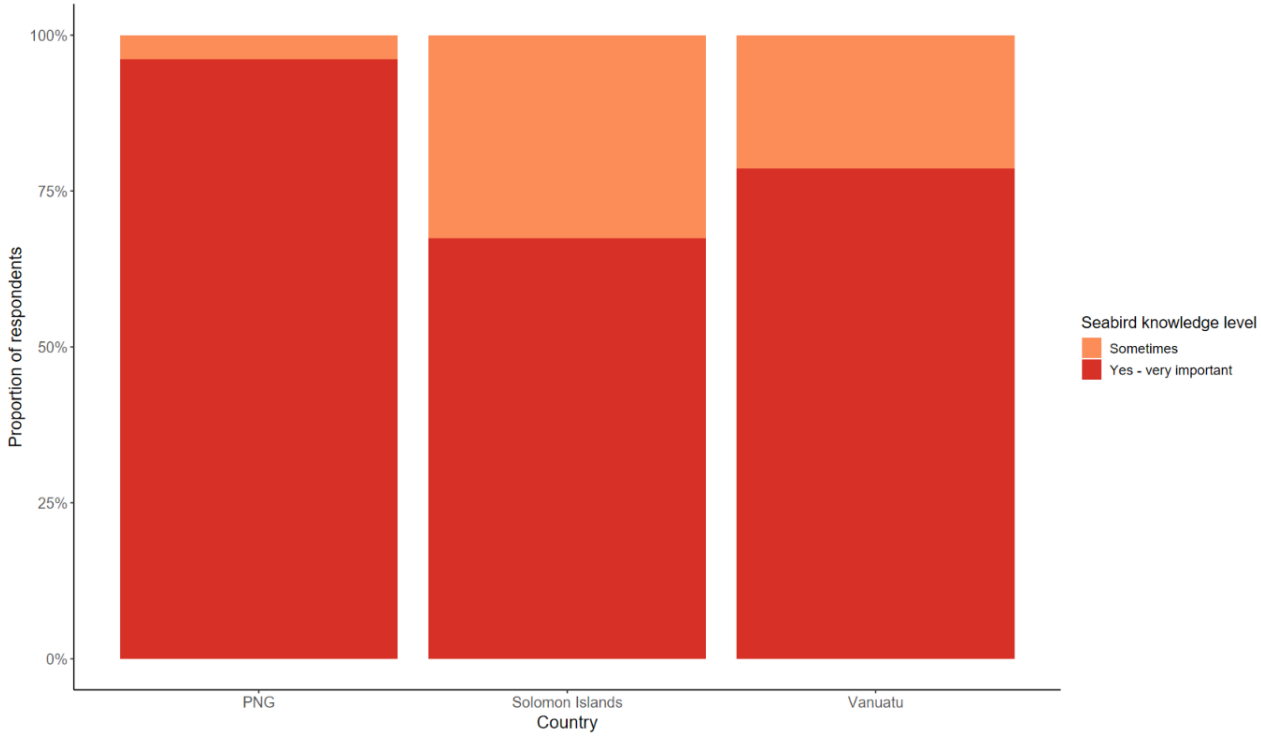

Figure 6. Importance of seabirds for indigenous communities from three Pacific countries. Responses are represented proportionally, PNG n = 26, Solomon Islands n = 40, Vanuatu n = 14.

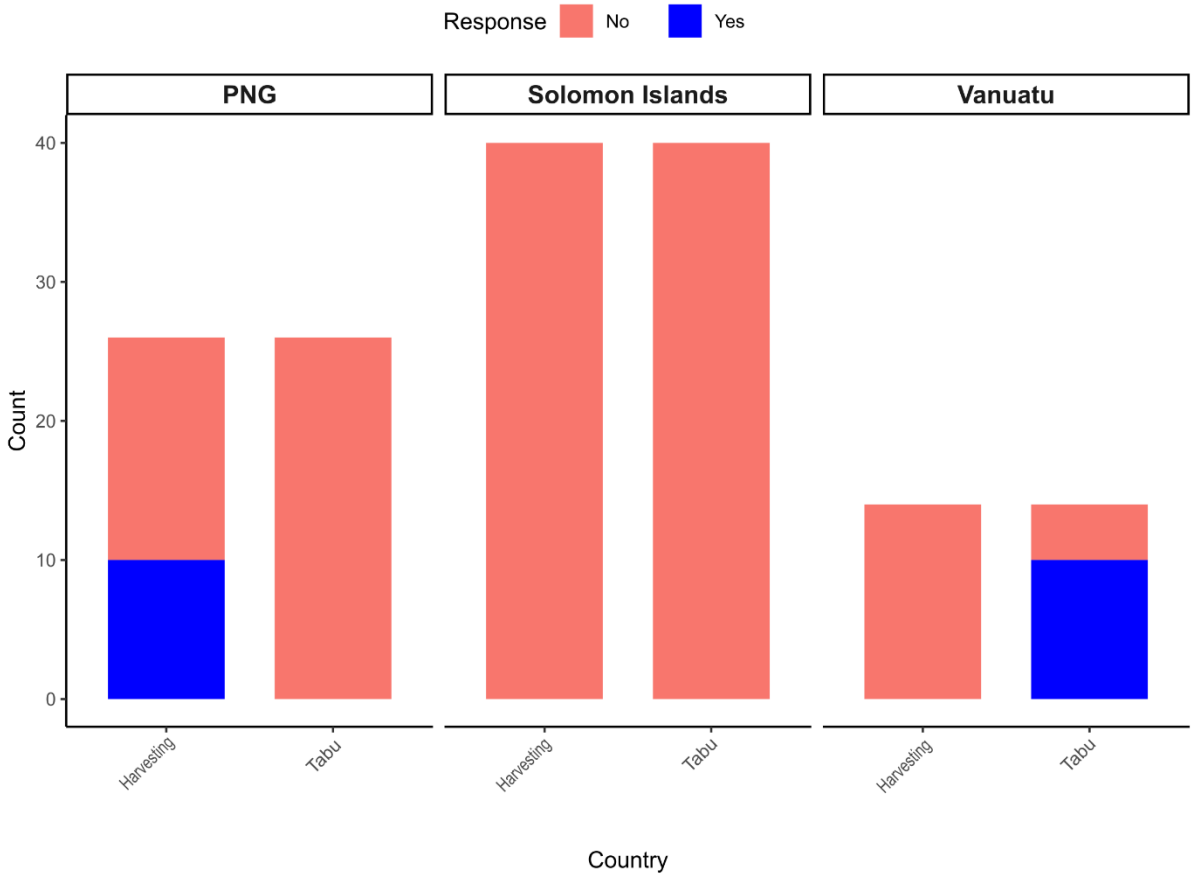

Figure 7. Relationship between Tabu areas and harvesting activity for indigenous communities from three Pacific countries. PNG n = 26, Solomon Islands n = 40, Vanuatu n = 14.

5. Discussion

While there is a lack of capacity for systematic surveys for seabirds in much of the Oceania region, there is no lack of knowledge and understanding of seabirds by Indigenous peoples in the region (Richter-Gravier, 2019; Tidemann & Gosler, 2010; Tidemann & Gosler, 2012). Over time, Indigenous peoples around the world, including people in the Pacific, have preserved distinctive understandings, rooted in cultural experiences, that guide relations among humans and nonhumans in local ecosystems (Berkes et al., 1994; Colding & Folke, 1997; Feinstein, 2004). In the face of globalisation and threats causing biodiversity loss, the rich, time-honoured body of traditional knowledge Pacific people hold regarding seabirds should be revisited and explored to provide nuanced, locally-specific solutions to contemporary challenges in seabird conservation.

5.1 Cultural and traditional knowledge of Seabirds

It is evident in that the TK of seabirds often held by Indigenous local communities in the Pacific region has played a vital role in the conservation and sustainable management of seabird populations (Moller, Charleton, et al., 2009), as well as ecosystems (Johannes, 1978). This knowledge system, accumulated over generations, which encompasses a range of practices, beliefs, and observational insights, can enhance scientific understanding and contribute to more effective conservation efforts (Berkes et al., 2000; Berkes et al., 1994; Colding & Folke, 1997, 2001). By incorporating TK into contemporary conservation strategies, a holistic approach to seabird management can be achieved, respecting the cultural ties between communities and these species leading to more sustainable and culturally relevant conservation outcomes (Ahlgren, 2016; Bayliss-Smith & Christensen, 2008; Michiko & Masaki, 2009; Moller, Charleton, et al., 2009; Moller, Kitson, et al., 2009).

Traditional knowledge held by indigenous Pacific societies demonstrates a mutual (symbiotic) relationship between communities and their natural environments (Berkes, 2009; Mitchell, 2023; Winter et al., 2023). The knowledge systems that form the basis of these relationships are being lost at a fast rate across the Pacific (Langton & Rhea, 2005; McCarter & Gavin, 2014; Wilder et al., 2016). Scholars have expressed that the eroding of TK in the Pacific region started well in the 1900s (Bayliss-Smith & Christensen, 2008; Steadman, 2006; Steadman et al., 1990), which has led to extinction of bird species on some outlying islands such as pigeons and parrots in the Marquesas (Pillay, 2024; Steadman, 2006; Steadman et al., 1990). This loss of biodiversity has also been attributed to a loss of linguistic diversity (Gorenflo et al., 2012).

5.2 Contemporary challenges

In 2012, it was estimated that the annual global loss of species was at 1,000 times greater than historic rates (Gorenflo et al., 2012). It was also predicted that 50-90% of the world's languages will disappear by the end of the century (Gorenflo et al., 2012). Almost a decade later, in 2022, an alarming prediction was made - the world is losing a language per month, with an estimated 1,500 languages likely to be lost by end of century if no intervention is taken (Bromham et al., 2022). These figures are concerning, as each language that might be lost is inextricably linked to knowledge of a place, a culture, and traditions passed on for generations around the Pacific. With a language comes the knowledge of a place, its environment, biological diversity, how to use it, and when to use it. When these languages are lost, knowledge of the significance of the natural environment is lost as

well, and this compounds challenges and reduces available knowledge for biodiversity conservation. Indeed, numerous scholars have highlighted that the loss of traditional knowledge is one of the factors causing biodiversity loss in the Pacific region (Friedlander, 2018; Johannes, 1978; Jupiter, 2017; Jupiter et al., 2014; Reyes-Garcia et al., 2013; Wilder et al., 2016).

While a rich body of cultural knowledge of seabirds still remains in the Pacific, exemplified be records of songs, dances, arts, and totems, the application of TK is not uniform or consistent across the region. For instance, the information provided by Johannes (1978) on the intentional measures taken by traditional communities to conserve species and ecosystems primarily focuses on other marine and terrestrial vertebrates, with only a single mention of seabird management. This indicates how important and useful a specific resource was to a certain group of people (Colding & Folke, 1997, 2001), it also highlights the urgent need for collaboration between researchers and communities. By collaborating with local communities, managers can learn from TK to formulate guidelines that enable both the wildlife conservation of seabirds and the sustainable livelihoods of communities (Lyver & Moller, 2012; Moller, Kitson, et al., 2009). Thus, the principles of sustainable harvesting embedded in TK could inform conservation policies, balancing species protection with community needs, while information on the significant contributions of seabirds to islands restoration (Lorrain et al., 2017) and building reefs (Lorrain et al., 2017; Wiedenmann et al., 2023) could be shared with local communities.

While the benefits of integrating TK into seabird conservation are considerable (Moller et al., 2004; Weiss et al., 2013; Winter et al., 2023), challenges remain. Bridging the gap between scientific methods and TK requires mutual respect and understanding, as well as the establishment of equitable partnerships (Moller, O'Blyver, et al., 2009; Newman & Moller, 2005). Often, scientific frameworks and funding structures do not prioritise Indigenous knowledge systems, limiting the potential for collaborative conservation efforts (Moller, O'Blyver, et al., 2009). Additionally, there is a risk of TK being commodified or misinterpreted, without adequate context or respect for the knowledge holders (Moller, Kitson, et al., 2009; Picart & Fox, 2013). To address these challenges, it is crucial for conservationists to adopt approaches where indigenous and local communities retain ownership of knowledge (Picart & Fox, 2013), involve them as equal partners, and work towards policies that respect both scientific and cultural perspectives (Damodaran, 2008; Downes, 2000; Moller, O'Blyver, et al., 2009; Weiss et al., 2013).

5.3 Collaborative conservation efforts

Seabirds often hold spiritual and cultural significance for societies in the Pacific, symbolising resilience, adaptability, and guidance. By recognising and respecting these cultural connections, research and conservation practitioners can foster stronger partnerships with local communities, leading to more successful and lasting conservation outcomes. Projects that integrate community-driven goals and cultural respect are likely to achieve higher levels of local buy-in, as they align with the community's perspective and requirements. On a regional scale, local organisations focused on birds and seabirds are working in their respective countries and regions to restore habitats and eradicate invasive species affecting seabird's population (Aylesworth, 2009). However, such groups are absent in some Pacific countries that host Important Bird Areas (Aylesworth, 2009), such as Papua New Guinea, the Solomon Islands, and Vanuatu in Melanesia (Birdlife International; Steibl et al., 2024). This does not imply a lack of effort, but calls for proper pathways and guidelines to be established to facilitate collaborative conservation efforts for seabirds in the Pacific. These local groups present an important avenue for involvement of traditional and cultural knowledge holders

and communities, with local groups providing connections between communities and managers where evidence indicates that seabirds are breeding on their lands.

Table 4. Seabird conservation programs in the Pacific Ocean by country.

Country	Organisation	Region
Cook Islands	Te Ipukarea Society (TIS)	Polynesia
Fiji	NatureFiji-MareqetiViti	Melanesia
French Polynesia	Ornithological Society of Polynesia (MANU)	Polynesia
New Caledonia	Société Calédonienne d'Ornithologie (SCO)	Melanesia
Palau	Palau Conservation Society	Micronesia

Source: Birdlife Pacific (https://www.birdlife.org/pacific/)

6. Recommendations

Researchers seeking to draw upon TK across the Pacific and conservation practitioners planning to initiate seabird management in Indigenous communities would benefit from considering key actions highlighted by the findings of this report. These actions fall into two categories of recommendations, research recommendations for future academic study of seabird TK in the Pacific, and conservation management recommendations for new and ongoing interventions to protect seabirds in the region.

Many questions remain to be answered about the spread, type, and origins of seabird TK in the Pacific. While research to date has captured much information that has informed scientific study and management, a substantial amount of this has been collected incidentally or compiled from the accounts of researchers not primarily engaged in studying cultural or other traditional knowledge. Further targeted studies broadly replicating the approach adopted here would be of great value to researchers and managers in the Pacific. In light of this, primary recommendations for future research are to:

1. Expand the spatial scale of the approach utilised here. While there is much to be drawn from surveying multiple communities in three Melanesian countries, expanding information gathering at local (community level) and regional (national and international) scales would yield more nuanced information for application to species- and system-specific questions.

2. Focus on novel questions to capture more extensive information about TK in the Pacific. A prime example is that the gender bias in respondents to surveys prevented meaningful analysis of gendered knowledge of seabirds in local communities, a challenge that might be overcome by including female researchers in survey teams. In systems where seabirds are harvested, detailed information on what species are harvested would be able to inform specific conservation research actions.

3. Formulate interdisciplinary research teams that integrate biological, ecological, sociological, historical, and other research steams to comprehensively understand seabird TK as a cultural phenomenon. One example is the study of the local language surrounding seabirds, where similarities in terminology from distant regions may reflect as yet unknown movement of peoples and new streams of knowledge transfer.

An understanding of seabird TK across Pacific peoples also indicates important practical considerations for conservation practitioners and managers seeking to affect long-term outcomes for seabirds of conservation interest across the region. These stem primarily from the deep, ancient connections between people and place across the Pacific, where long-held cultural practices and knowledge systems reflect a symbiotic understanding in indigenous communities of the natural functioning of seabirds in Pacific ecosystems. Fundamental recommendations for conservation that arise from this connection are to:

1. Foster collaboration between researchers, conservation managers, and communities. By collaborating with communities, conservationists can learn from their practices and develop guidelines to support conservation in parallel with local livelihoods. These inclusive approaches must consider ethical structures that recognise the IP rights of Indigenous and local communities, so that communities maintain stewardship and ownership of the ecosystems they occupy.

2. Build conservation goals that are community-informed and driven by cultural respect. Aims and objectives that are defined with consideration of local needs and attitudes are more likely to achieve higher levels of local support and compliance, as they align with community values and heritage.

3. Engage local communities in management and monitoring activities, providing upskilling and training opportunities to local people during conservation work. By establishing local presence, conservation initiatives can gain consistent, accurate data arising from a sense of stewardship, as community members can become active participants and effective owners in seabird conservation. Furthermore, this process can provide a platform for younger generations to learn traditional and cultural knowledge about their environment and seabirds.

7. Conclusion

The integration of traditional and cultural knowledge into seabird conservation represents a powerful tool for achieving ecological and cultural sustainability. Traditional knowledge offers insights that may not be readily accessible through conventional scientific methods, especially by capturing long-term, historical information about seabird occurrence and abundance, while also ensuring that conservation efforts respect and strengthen cultural ties to these important species. This is very much needed in an era where the loss of biodiversity is parallel with linguistic loss and TK globally. By fostering collaboration between conservationists and Indigenous communities across Oceania, seabird conservation can be enhanced, with the goals of protecting biodiversity and preserving cultural heritage. This approach could offer a model for broader conservation efforts that respect, and harness the knowledge systems of diverse cultures in the Pacific and globally.

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