The potential and issues surrounding local ecological knowledge in fisheries science and management

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Indigenous rangers from the Yuku Baja Muliku Traditional Owners in Cape York, Australia. (image: © Andrew Chin)

The Fish and Fisheries Lab (www.fishandfisheries.com), based at James Cook University in Australia, teaches several undergraduate and masters level subjects about fisheries management. One of the most popular subjects is "Managing Tropical Fisheries", where students learn about the importance and complexity of tropical fisheries, and how they need very different management approaches compared to more traditional industrialised fisheries such as cod or swordfish. As part of the course, students are required to submit an essay on a complex area of tropical fisheries. Many students submit well written, well researched, and insightful essays that we felt are worth sharing. This essay by Rachel Mather was the pick of the essays submitted in 2020, and we are pleased to share it with you through the* SPC Fisheries Newsletter. *Well done Rachel.

Dr Andrew Chin – Course Coordinator

Abstract

The cumulative body of ecological knowledge held by local communities and developed through extensive interaction with the ecosystem, and shared over generations, is referred to as local ecological knowledge (LEK). This knowledge may be held by indigenous groups, and those who rely on an ecosystem for their livelihoods, such as commercial fishers. The LEK held by fishers often includes detailed information about the biology and abundance of economically or socially important species, and how their population size and distribution are influenced by interannual, seasonal and diel changes in the environment. This information is of considerable value to fisheries scientists and managers, particularly in data-poor fisheries where the collection of such data through scientific field surveys may not be viable. This paper outlines several examples of the application of LEK in fisheries science and management, and describes the challenges and considerations associated with this.

Introduction

Local ecological knowledge

Local ecological knowledge (LEK) refers to the cumulative body of knowledge held by local communities about an ecological system, gained through a history of close interaction with the environment (Zukowski et al. 2011). This includes traditional ecological knowledge (TEK), which refers to the local knowledge held by indigenous communities. TEK can be thought of as an integrated system of knowledge, belief and practice – ecological information is embedded within an understanding of resource management systems and techniques, and is in turn nested within a social system with norms and worldviews influencing how the community perceives their relationship with the environment (Butler et al. 2012; Schafer and Reis 2008). These integrated systems of TEK are cumulative and dynamic, founded upon observations and practical experience, transmitted across generations and adapted through time (Schafer and Reis

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2008; Zukowski et al. 2011). However, LEK also refers to the knowledge held by other resource users, such as commercial fishers who rely on a local ecosystem for their source of livelihood, spend a considerable amount of time on the water, and require a detailed understanding of the ecosystem (Mackinson and Nottestad 1998; Maurstad 2002).

LEK knowledge differs from Western science and management knowledge (SMK) in several ways, and while it is often dismissed by scientists for not conforming to Western scientific standards and norms, the potential for both knowledge systems to complement one another in environmental management is gaining recognition (Pita et al. 2016). The primary difference between LEK and SMK is the method of obtaining and sharing knowledge (Maurstad 2002). SMK is obtained through systematic observation following the scientific method, usually with the aim of quantifying natural phenomena and identifying statistically significant patterns or trends. This information is then compiled and published in academic journals to be accessed by scientists and managers. LEK is based on long-term observations, and is adapted and strengthened with each generation, through its applications within livelihood systems. LEK is often shared orally among peers or across generations (Maurstad 2002). Given its significance to livelihoods (e.g. enabling access to a food source for isolated communities, or giving a competitive edge to commercial fishers), those who hold LEK may be selective when it comes to sharing this knowledge, and outsiders may not be granted access to it (Maurstad 2002).

These knowledge systems also differ in spatial and temporal scale. SMK typically aims to understand ecological processes across a large spatial scale but a relatively short time frame (Butler et al. 2008; Zukowski et al. 2011). Conversely, LEK is able to provide detailed knowledge about localised systems, often over multigenerational timeframes that are generally inaccessible using scientific methods (Butler et al. 2012; Zukowski et al. 2011). Furthermore, LEK is often qualitative rather than quantitative, which may pose some challenges when integrating this knowledge with SMK (Zukowski et al. 2011).

Potential of LEK in fisheries science and management

Communities that are reliant on fisheries for their livelihoods will often have extensive ecological knowledge of the ecosystems where they fish, as a result of close observation of factors affecting fish distribution and fishing success (Mackinson and Nottestad 1998). This knowledge may include critical information about the biological and ecological characteristics of economically or culturally important species, such as juvenile and adult habitat preferences, migration patterns, spawning or feeding grounds, and changes in stock status (Butler et al. 2012; Mackinson and Nottestad 1998; Zukowski et al. 2011).

With this information, LEK has the potential to improve the overall understanding and management of fished ecosystems. Its integration into fisheries management would be particularly beneficial for data-poor fisheries such as tropical artisanal fisheries, which are often underreported and take place in remote areas where the collection of detailed scientific data to support management may not be feasible (Silvano and Valbo-Jørgensen 2008). LEK has also provided valuable insights into other data-poor fisheries such as the recreationally targeted Murray crayfish in Australia, and long-term population trends in Arctic whales (Johannes et al. 2000; Zukowski et al. 2011). In these scenarios, fishers' LEK has been demonstrated to be an accurate and reliable source of information that may otherwise be missed by outsiders such as fisheries scientists and managers. In addition to providing an alternative source of information about fished ecosystems, the incorporation of LEK into fisheries science and management can help to engage resource users to produce a greater sense of environmental stewardship, build trust and understanding between fishers and managers, facilitate co-management and improve compliance (Butler et al. 2012; Schafer and Reis 2008).

This paper considers several examples of the contribution of LEK to fisheries science and management, in order to understand the potential and limitations of these knowledge systems, along with the challenges and considerations associated with their application in the management of environmentally, economically and socially sustainable fisheries.

Examples of LEK in fisheries science and management

Presented in this section are some examples of the application of LEK in fisheries, demonstrating its value and reliability as an information source, the factors driving its application, and the consequences of overlooking LEK in favour of traditional scientific methods.

Reliability of fishers' LEK

One of the primary reasons LEK is overlooked by fisheries scientists and managers is the widespread perception that this knowledge is unreliable because it does not adhere to scientific conventions. However, a study by Zukowski and colleagues (2011) suggests that fisher LEK can provide reliable information to improve fisheries management. The study gathered LEK through face-to-face interviews, mail and telephone surveys, and catch data through logbooks and diaries. This information was then compared with scientific data on the size and sex ratios of Murray crayfish, collected via field surveys in the Murray River in Australia (Zukowski et al. 2011). The authors found no significant difference between the LEK data obtained through fisher interviews, and the scientific data obtained through catch cards and field surveys. Thus, it was recommended that fishery management could be improved by LEK to identify ecosystem changes, which could then be verified through scientific surveys and used to inform proactive management decisions.

The authors also noted that where fishers' knowledge differed from scientific knowledge, this did not necessarily indicate a lack of reliability of LEK. Instead, these differences may be the result of differences in methods, experience, and spatial or temporal scales used when collecting the data, pointing out that LEK is often based on much longer-term observations than scientific data (Zukowski et al. 2011).

Value of fishers' LEK

In addition to providing reliable information, fishers' LEK has been shown to provide scientists and managers with new information that may be overlooked or beyond the scope of scientific surveys (Bergmann et al. 2004; Maurstad and Sundet 1998). Lavides and colleagues (2010) used LEK to infer reductions in finfish diversity in Bohol, Philippines, where fish provide an important protein source and long-term time-series data for marine biodiversity are scarce. Based on information gathered from local fishers, the authors identified 21 species that had disappeared from catches, with two species recommended as a priority for further monitoring, including the giant grouper (*Epinephelus lanceolatus*) and the "highly vulnerable" African pompano (*Alectis ciliaris*) (Lavides et al. 2010). The use of scientific field surveys to collect such information would be expensive, and data would still be limited to a short time-scale with no historical baseline.

In their study on artisanal fishing areas in the Patos Lagoon, Brazil, Schafer and Reis (2008) highlighted the value of LEK for providing information that is new to fisheries scientists and managers. Through interviews with local fishers, 124 fishing areas were identified and geo-referenced, 80% of which were previously unregistered and known only to fishermen. This information is important for managers as it indicates the extent of fishing pressure within the lagoon, and how fishers may interact with nursery or spawning areas, in turn influencing population dynamics of the stock and showing which areas may require protection. It may also be used in conjunction with total catch and gear-type information to produce yield models to help inform management strategies (Schafer and Reis 2008).

Consequences of overlooking fishers' LEK

The LEK held by fishers can provide critical information on how the abundance and behaviour of target species may be influenced by habitat and interannual, seasonal, lunar and diel environmental variation (Johannes et al. 2000). Fisheries scientists and managers who overlook this information may put these resources at risk, compromising both the health of the ecosystem and the livelihoods of those who rely on them, as demonstrated in five examples presented by Johannes and colleagues (2000). One such example was that of the declining spawning runs of bonefish, an important source of food security in Kiribati. The construction of causeways blocking migration routes, and overfishing by gill nets during spawning runs, had caused a significant reduction in successful spawning of the species. While this was evident to older fishermen around the atoll, interviews based on a questionnaire, conducted by the Fisheries Department with younger fishers, failed to bring this issue to light, and thus fisheries managers were unaware of the impending demise of the stock. Johannes conducted less-structured interviews with well-respected older fishermen, which revealed that a single spawning run remained, and that this too was in decline. Upon recognising the dire condition of their vital resource, the villagers of North Tarawa initiated an informal protection effort for the spawning run. Almost a decade later, in 1999, catch per unit effort and average size of bonefish were both on the rise, owing to the culmination of each island's LEK compiled by collaborating fisheries scientists, despite the shortcomings of formal fisheries management (Johannes et al. 2000). Current regulations on the harvesting of bonefish in Kiribati, both formal and informal, vary among islands. For example, a complete ban on harvesting and possession was implemented in Kiritimati in 2008, while bylaws in North Tarawa prohibit splash fishing of bonefish, although enforcement of both regulations remains a challenge (Campbell and Hanich 2014). Unfortunately, the IUCN Red List estimates that since 1999, Kiribati's bonefish stocks have declined by roughly 30% as growing human populations have led to further overfishing and pollution, along with increased fishing pressure from an emerging recreational catch-and-release fishery (Campbell and Hanich 2014; Jansen and Bakineti 2020)

Incorporating fishers' LEK with SMK

Despite its potential for information and perspectives new to fisheries science and management, the integration of LEK with SMK remains in its infancy in most fisheries (Zukowski et al. 2011). Butler and colleagues (2012) studied the progression of this integration in the Torres Strait, providing insight into the factors driving this development in fisheries science and management. Earlier studies identified three main factors initiating this process: depleted fishery stocks, limited scientific knowledge, and ownership of resources by local communities (Johannes et al. 2000). However, surveys conducted with fisheries managers and scientists in the Torres Strait revealed that LEK had only been applied to the turtle, dugong, lobster and hand-collectable fisheries, and that only two of the seven species exploited by these fisheries matched these criteria (Butler et al. 2012). Instead, co-management characteristics and a species' cultural value were proposed as the primary drivers of LEK integration. In particular, turtles and dugong are recognised as cultural keystone species in the Torres Strait, playing an important role in islanders' livelihoods while also receiving significant international conservation interest. It was revealed that the integration of LEK with science and management for these species has driven co-management between indigenous and government stakeholders. In turn, this has catalysed the co-management of other species with less cultural importance, for example the establishment of community-based management of hand-harvested beche-de-mer and trochus in the Torres Strait (Butler et al. 2012). These findings reveal the value of finding common ground, such as cultural significance, between managers and stakeholders to catalyse co-management efforts.

Indigenous rangers like those from the Yuku Baja Muliku Traditional Owners in Cape York, Australia, have extensive and valuable knowledge about the fish populations in their rivers and sea country. (image: ©Andrew Chin)

Challenges and considerations

Quality of LEK information

Several challenges arise in the incorporation of LEK with SMK for the benefit of fisheries science and management, and as a result this remains "the exception, rather than the rule" (Zukowski et al. 2011). The first challenge is mistrust of TEK by many scientists who consider it to be "anecdotal knowledge", and of lesser value than information gathered by trained scientists according to scientific convention (Mackinson and Nottestad 1998; Silvano and Valbo-Jørgensen 2008). Because LEK does not meet the indicators used in Western society to establish validity (e.g. replicable studies, statistical significance and formal peer review), fisheries managers may be hesitant to make decisions based on information that cannot be substantiated in this way.

LEK has been demonstrated as a reliable source of valuable fisheries information, and should not be excluded from management on the basis that it is not "scientific". However, it should be noted that both fishers' and scientists' knowledge are fallible and subject to bias, and should be verified when possible (Johannes et al. 2000). This may be achieved through field surveys in some situations, although LEK cannot always be reproduced; for example, when gauging historical baselines. In such situations, information should be corroborated by more than one individual, for example when mapping spawning locations using LEK, Ames (2003) required the independent identification of a site by two or more fishers. Furthermore, Ames (2003) checked that the depth and substrate at each site was conducive to the known biology of the species. Finally, given the long time-span of much LEK, timelines should be established using supporting information to determine the approximate timing of significant events and changes within the fishery (Ames 2003).

It should be noted that discrepancies between SMK and LEK do not necessarily mean one is wrong, but may be a product of how the data are collected (e.g. over a different spatial or temporal scale, or using different gear and techniques), shining an alternative perspective on the situation (Silvano and Valbo-Jørgensen 2008). Rather than dismissing LEK as incorrect, researchers should strive to understand the cause of the discrepancy in order to better understand the ecosystem.

Ethical considerations

There is also the ethical challenge of how LEK may be applied, and with whom it may be shared. Fishers may be hesitant to share their ecological knowledge with scientists and managers for a number of reasons, including fears that competitors may gain access to this information, or that fisheries managers will close off areas that are heavily fished, and therefore economically important (Maurstad 2002; N. Rynn, professional net fisherman, pers. comm. 27 November 2020). There may also be cultural limitations on who has the rights to access TEK in some communities; for example, outsiders may be restricted, while in many indigenous Australian cultures it is law that certain knowledge, known as "men's business" and "women's business" must not be shared across gender groups.

By gathering, recording and publishing fishers' LEK, which has traditionally been shared orally among exclusive groups, the nature of the knowledge system is changed. Once included in published scientific works, fishers no longer have control of this information (Maurstad 2002). This may be particularly harmful to communities where such information is held and traded as social currency, or where fisheries are regulated largely on the basis of social norms. As described by Maurstad (2002), outsiders with access to this information are less likely to adhere to these norms, leaving local fishers at a competitive disadvantage and changing the dynamics of the local social-ecological system. Thus, fisheries researchers must be mindful not to put fishers and their communities at a disadvantage when sharing their LEK with managers or the public. Maurstad (2002) states that the best way to achieve this is to ensure that fishers are actively engaged in cooperative management, rather than simply being consulted.

Conclusion and recommendations

By including LEK in fisheries science and management, we have the potential to improve the quality and detail of ecological information used to inform management decisions. Through gathering and applying LEK, we also have the opportunity to increase engagement with fishers and facilitate co-management, improving compliance and ultimately improving both environmental and social outcomes. The incorporation of LEK with SMK for culturally important species can help put the co-management networks in place to facilitate its incorporation with other species in the future.

While the value of LEK in fisheries is clear, just as with scientific knowledge, quality assurance of information should be conducted and multiple lines of evidence sought. Additionally, it is important for researchers to communicate effectively and build mutually beneficial relationships with fishers, in order to obtain the most accurate information and apply it in the most effective way possible (Mackinson and Nottestad 1998). Failure to consider the interests of the fishers sharing their LEK, whether cultural or commercial, may result in negative outcomes for the fishers and their community, and is likely to create further distrust of scientists and managers in the future. It is recommended that a social scientist be included in the team when collecting LEK to maximise engagement with fishers while ensuring research is conducted in an ethical manner.

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